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**Kohlmeier et al.**

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(54) **RESTRAINT SYSTEM, APPARATUS AND METHOD FOR LADDER SYSTEM**

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(76) Inventors: **Scott Kohlmeier**, 3000 Niagara St., Bellingham, WA (US) 98226; **Ronald H. Parks**, 1014 W. 54<sup>th</sup> La., Bellingham, WA (US) 98226

\* cited by examiner

*Primary Examiner*—Hugh B. Thompson, II  
(74) *Attorney, Agent, or Firm*—Hughes Law Firm, PLLC; Robert B. Hughes

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(57) **ABSTRACT**

A fall restraint system to be incorporated in an existing ladder system where there are ladder stations, each having a platform, a ladder extending up from the platform, a safety cage around an upper portion of the ladder, and a perimeter guard rail. There is a plurality of adjustable fall restraint sections extending from the upper rail member of the guard rail to a lower cage element of the safety cage. The end connecting members and their intermediate restraint members are made adjustable to accommodate different locations and configurations.

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(51) **Int. Cl.**<sup>7</sup> ..... **E06C 7/18; E04G 1/00**

(52) **U.S. Cl.** ..... **182/106; 182/230**

(58) **Field of Search** ..... 182/194, 94, 93, 182/230, 106, 179.1, 107, 113

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**20 Claims, 11 Drawing Sheets**

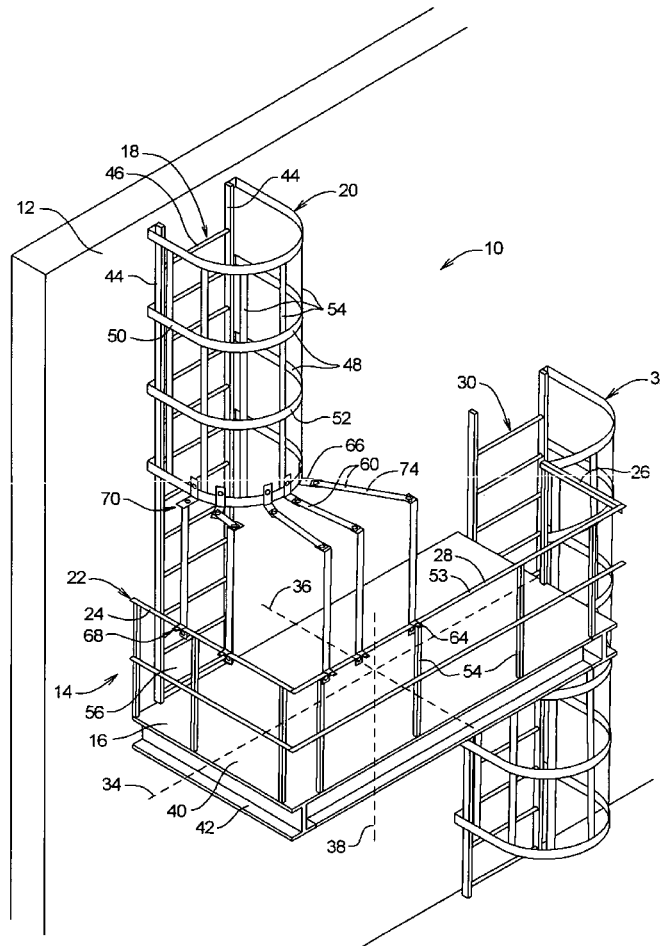


FIG. 1

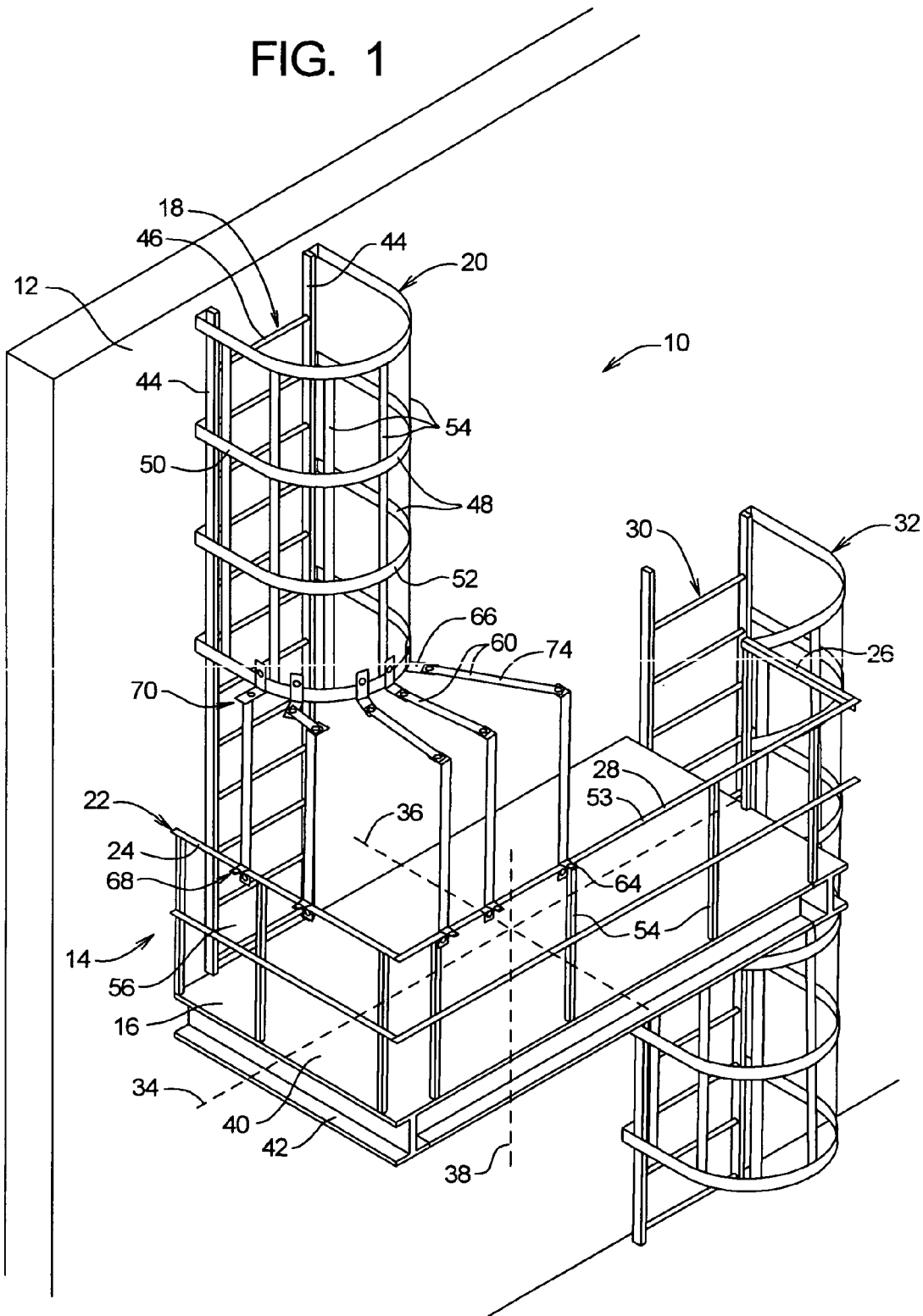


FIG. 2

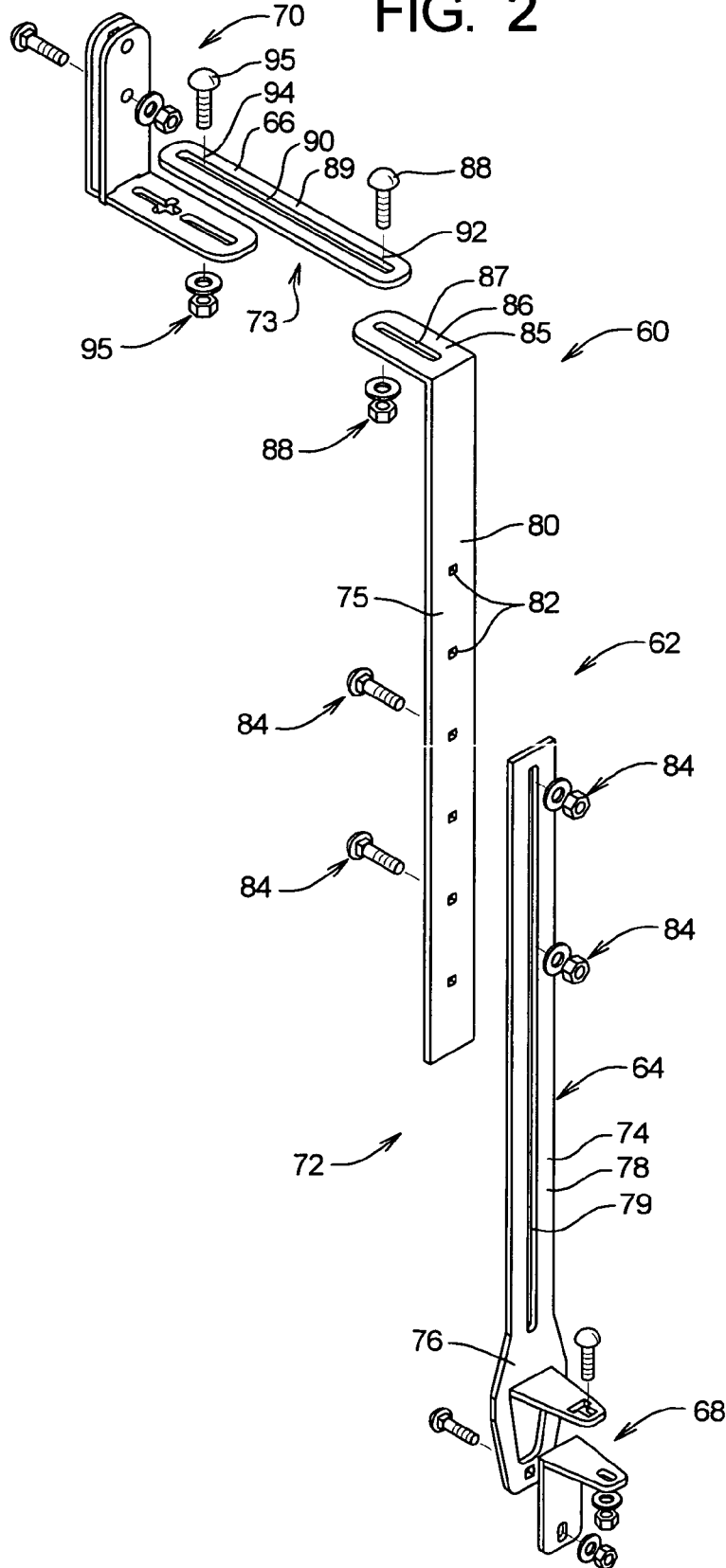


FIG. 3

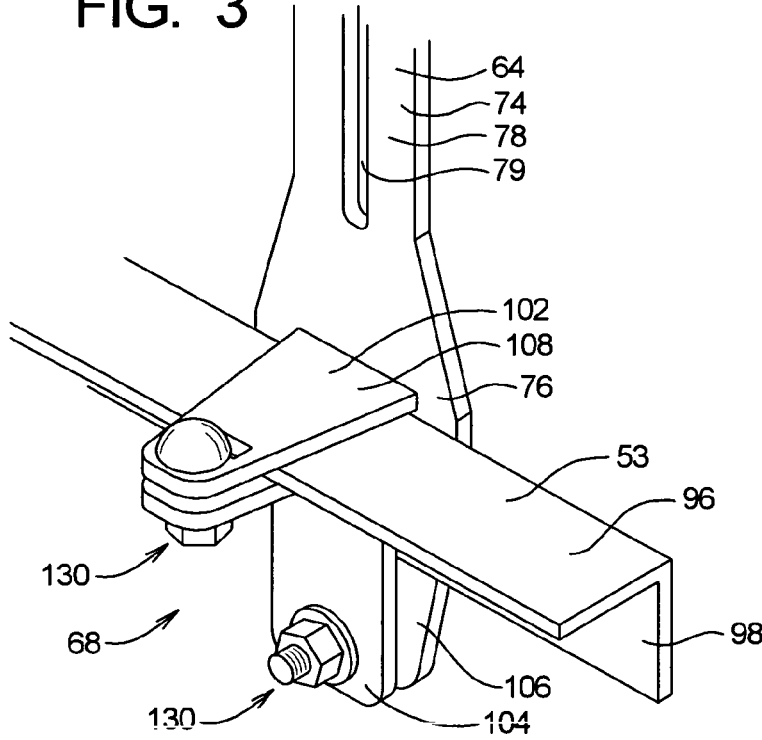


FIG. 4

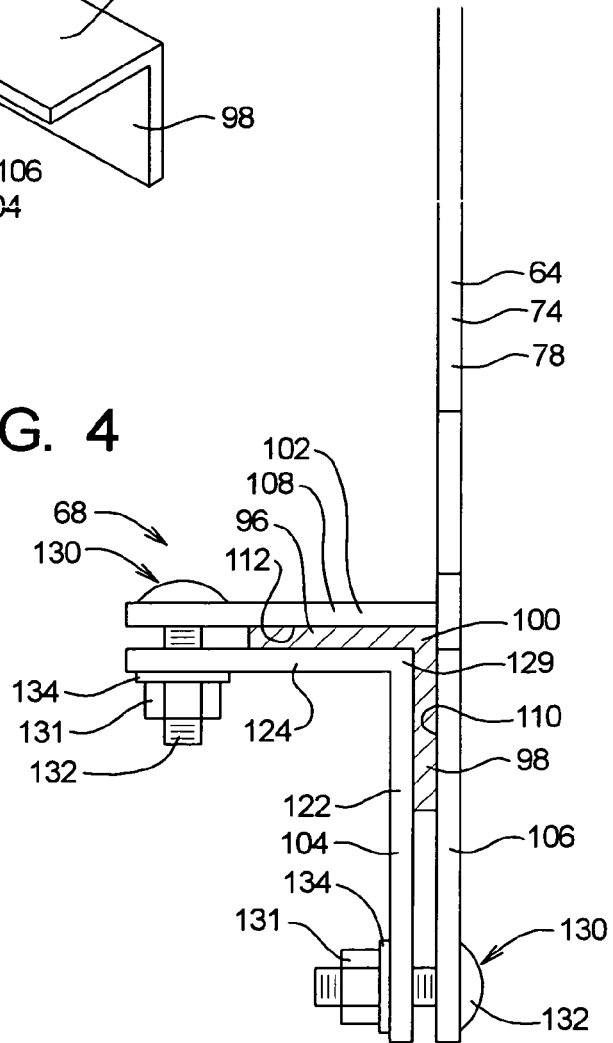


FIG. 5

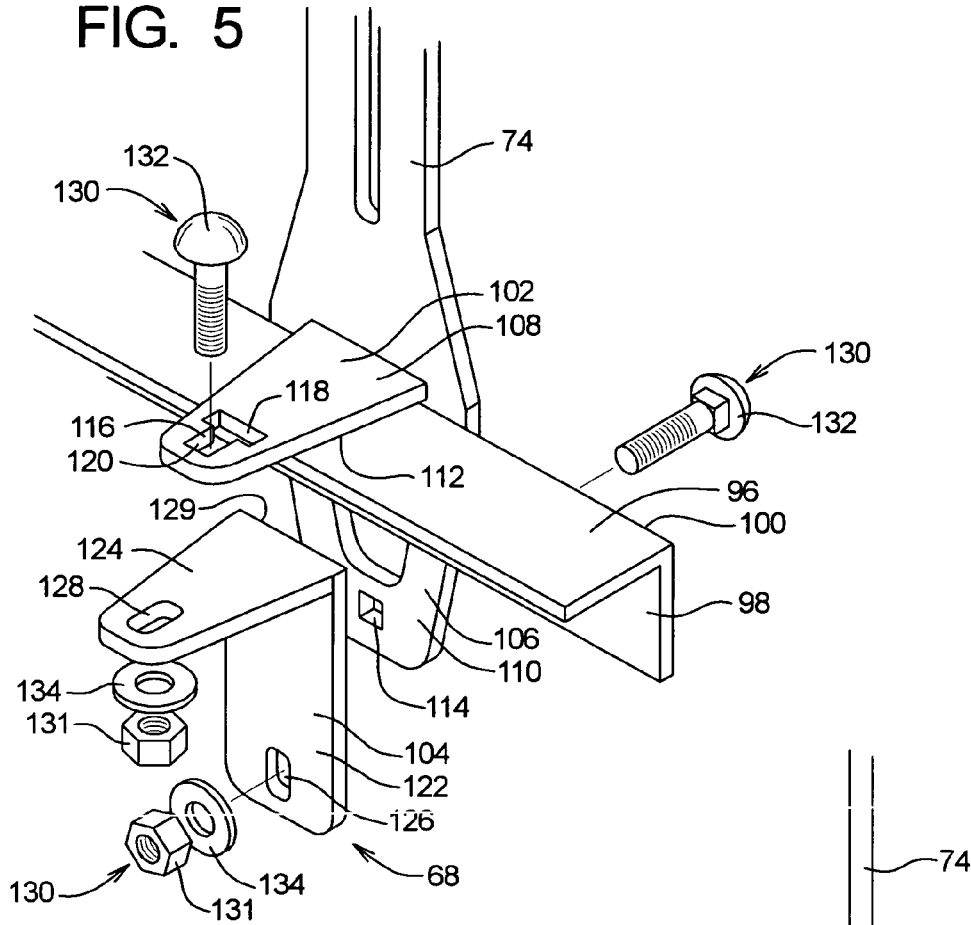


FIG. 6

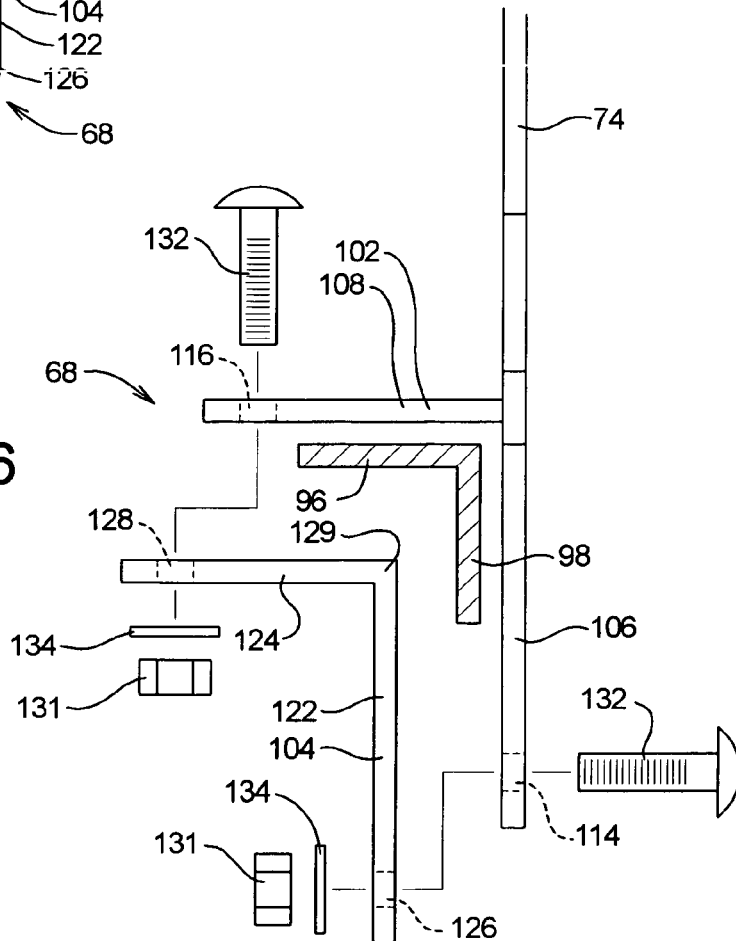


FIG. 7

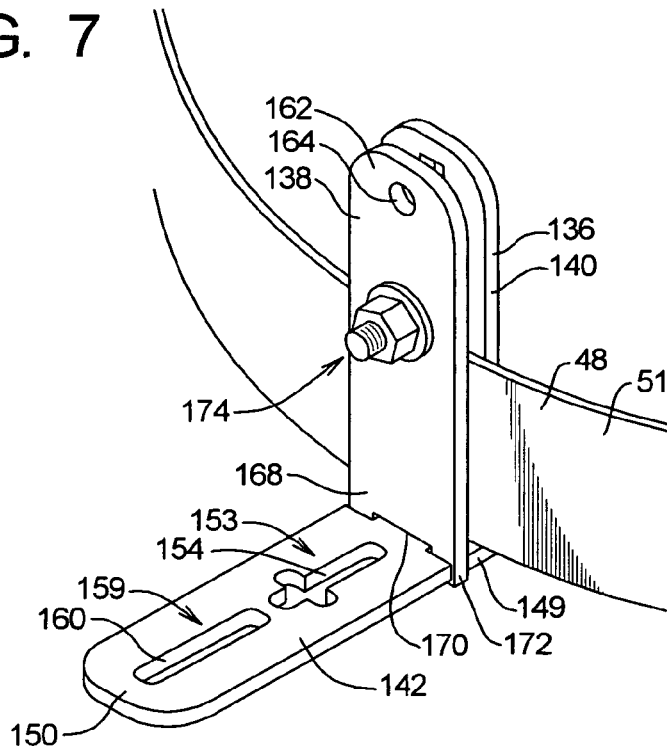


FIG. 8

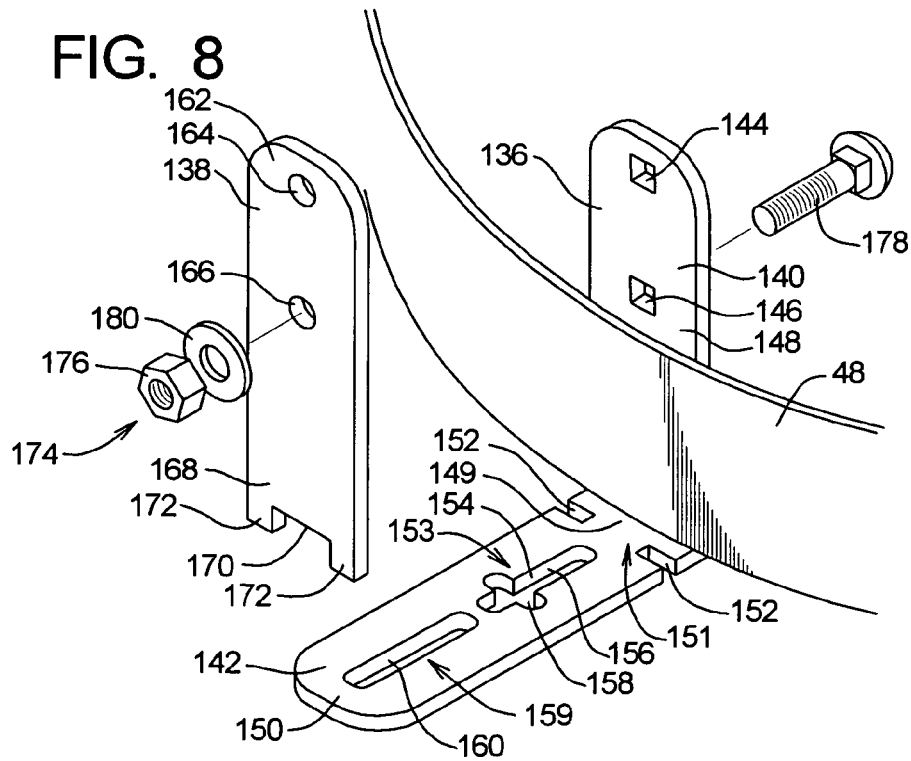


FIG. 9

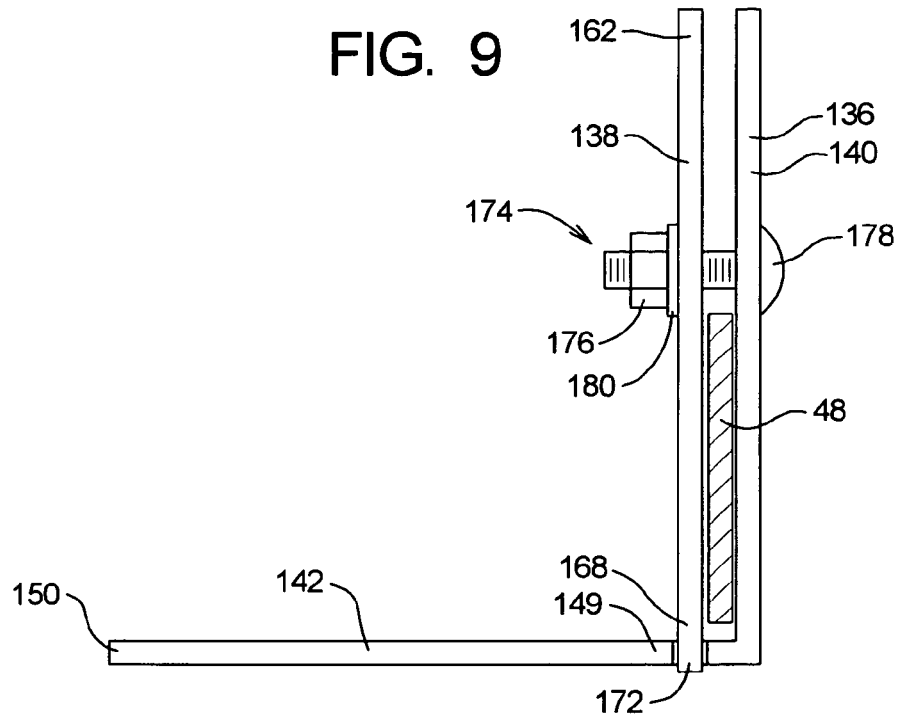


FIG. 10

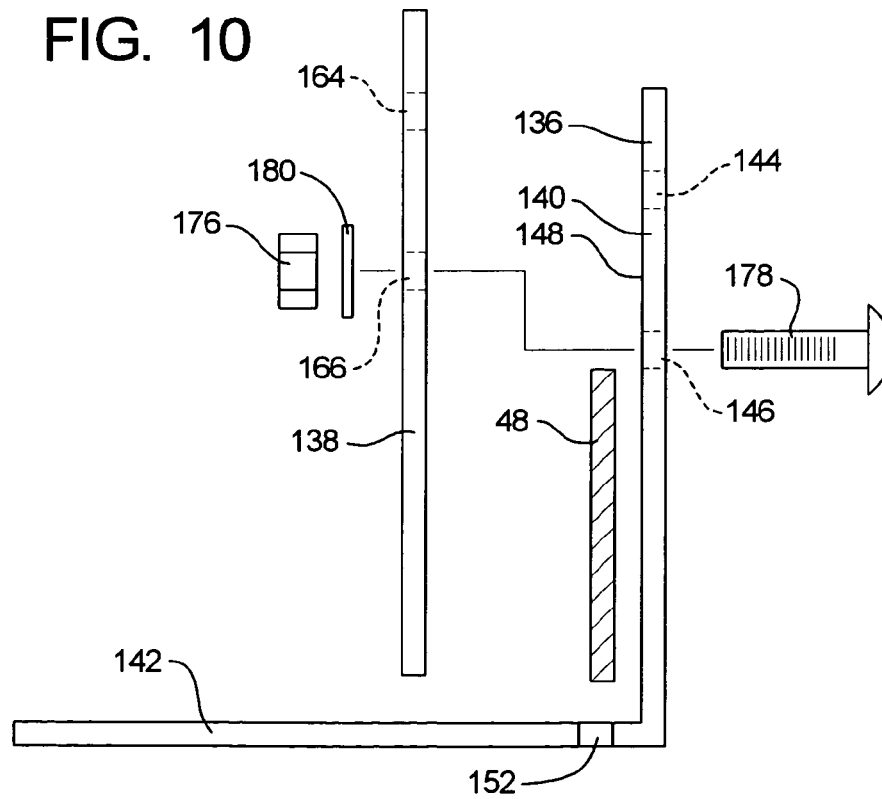


FIG. 11

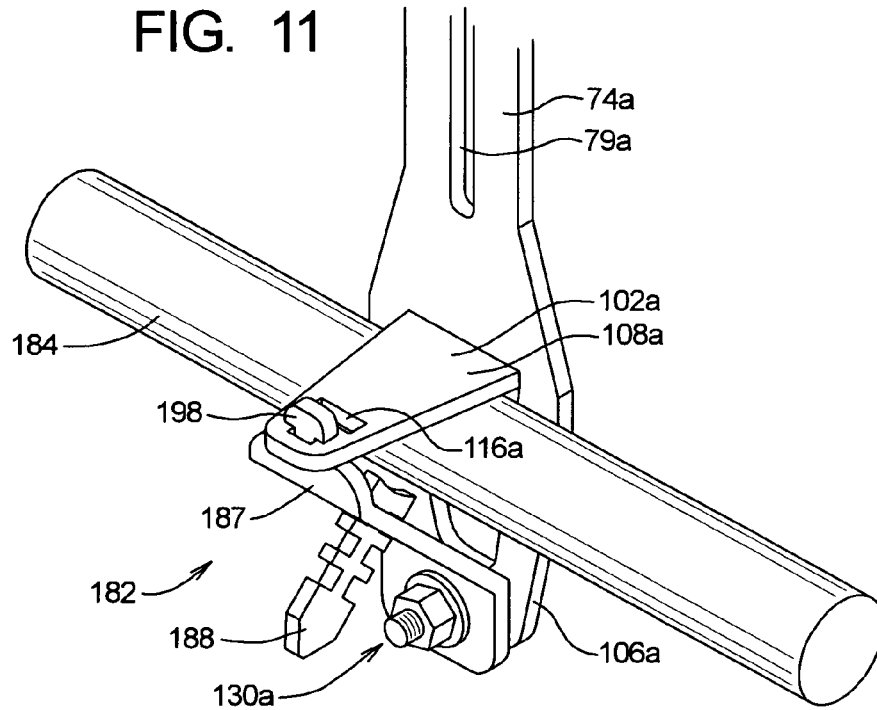


FIG. 12

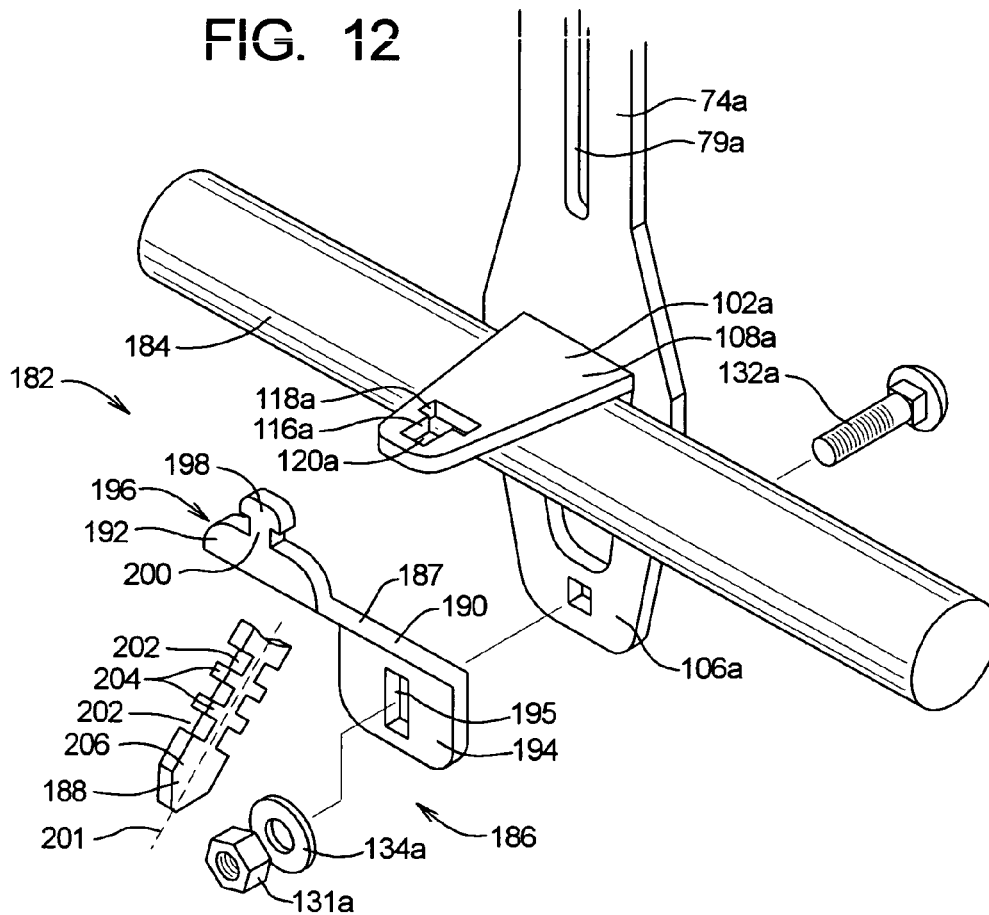


FIG. 13

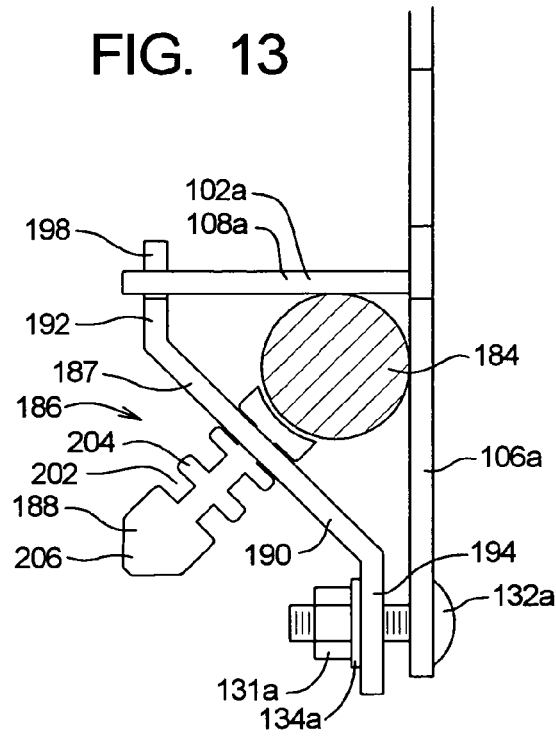


FIG. 14

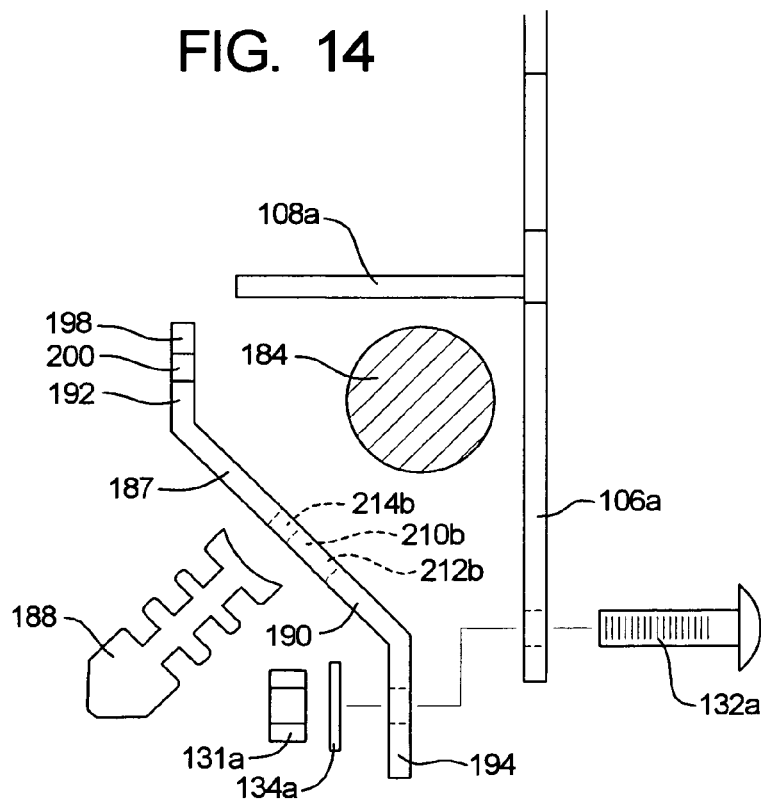


FIG. 15

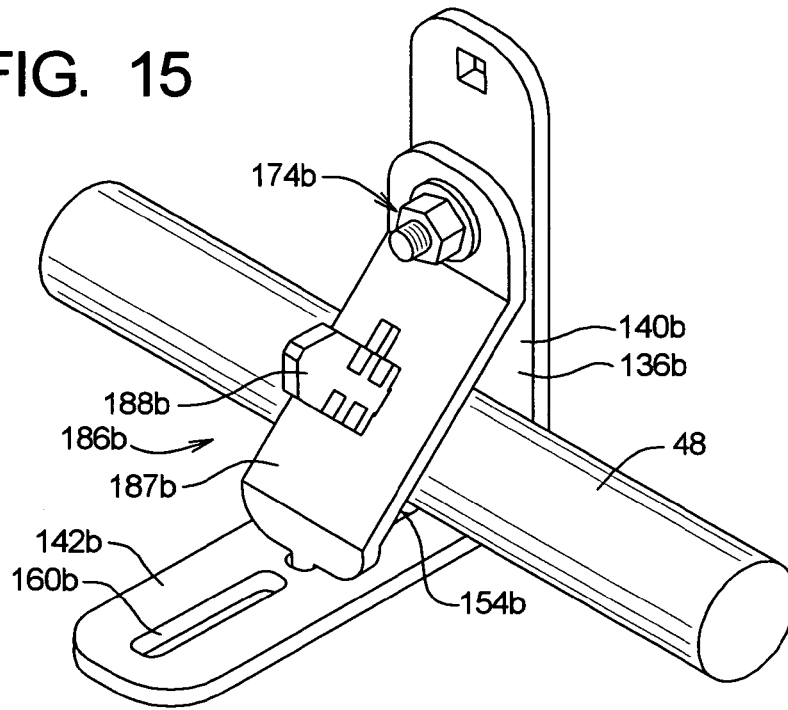


FIG. 16

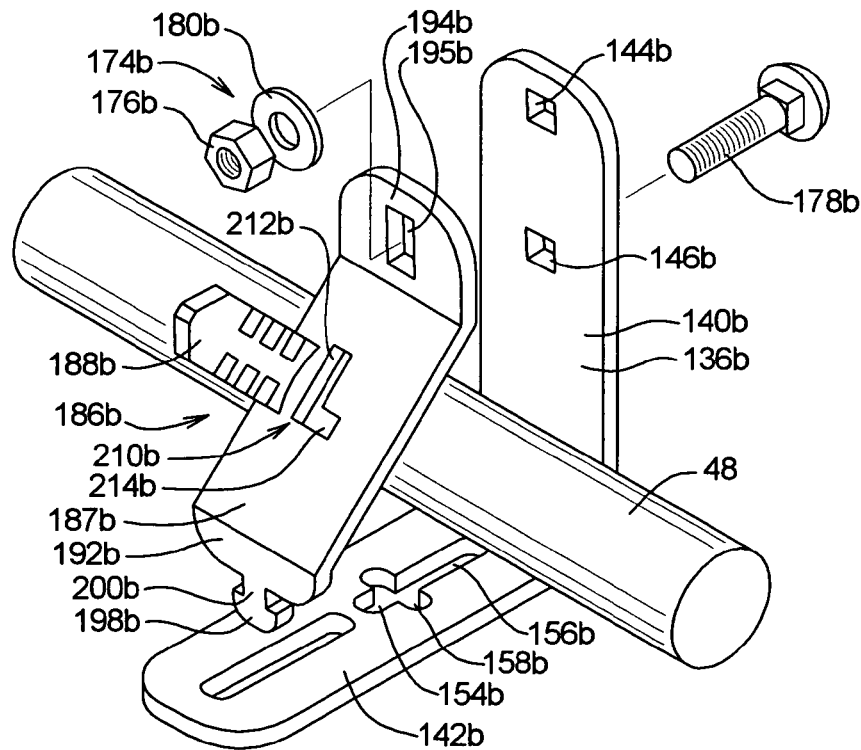


FIG. 17

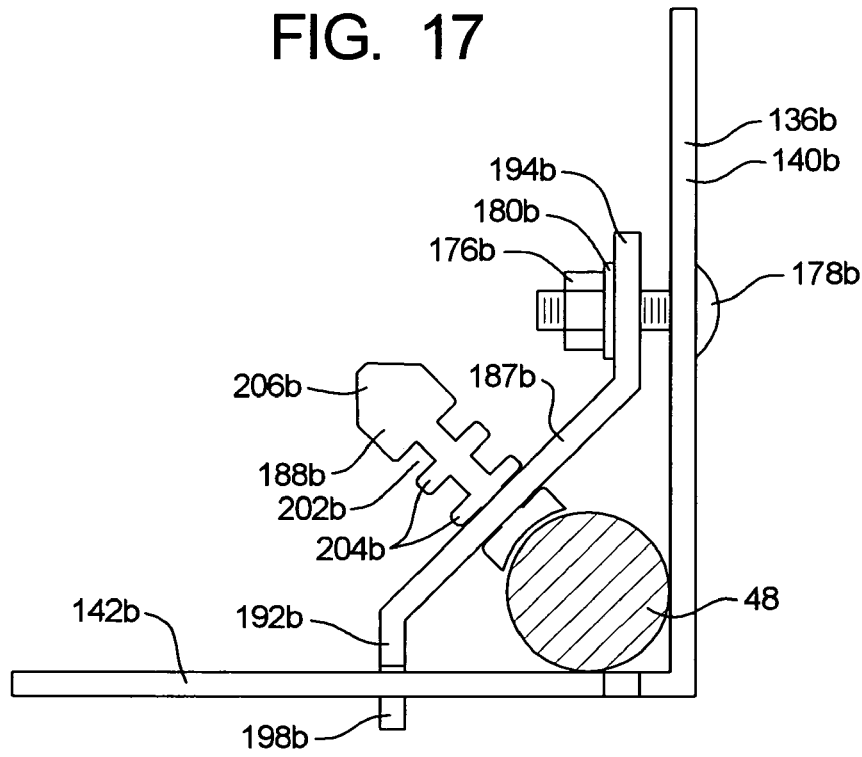


FIG. 18

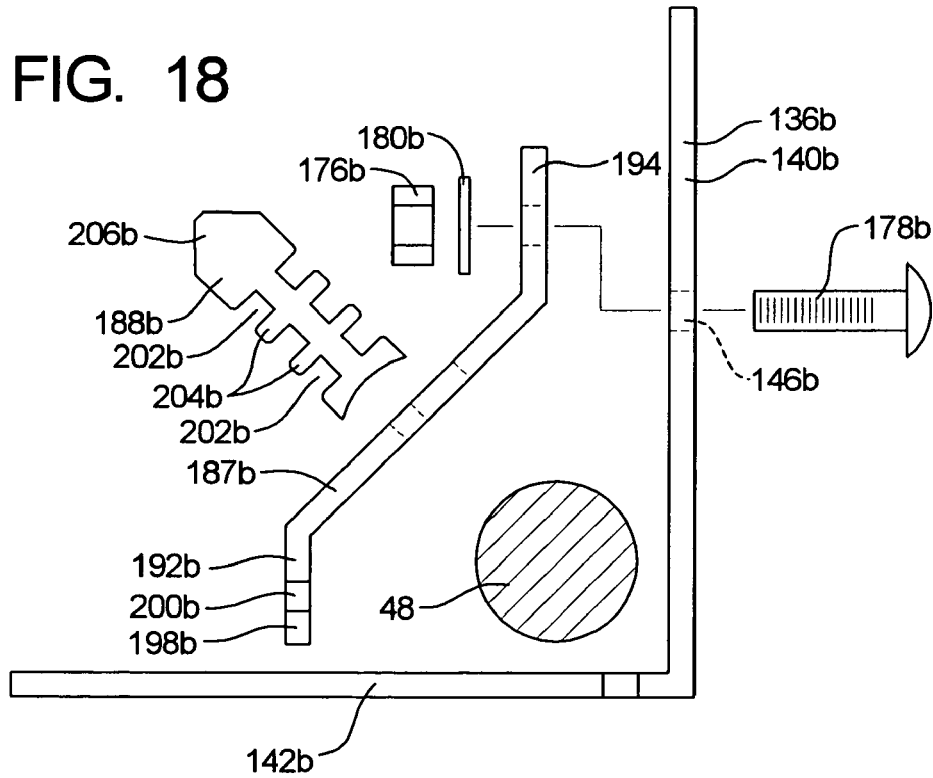


FIG. 19

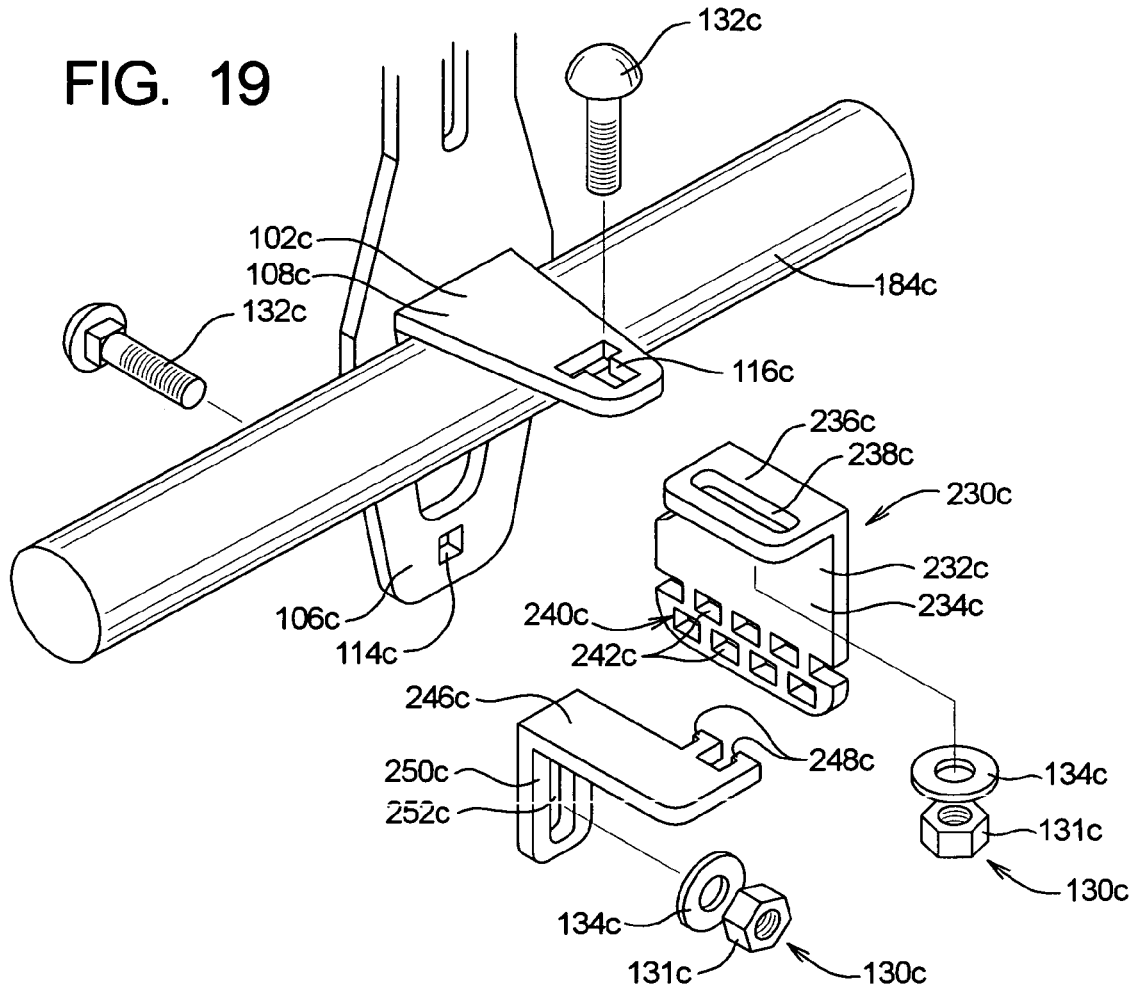
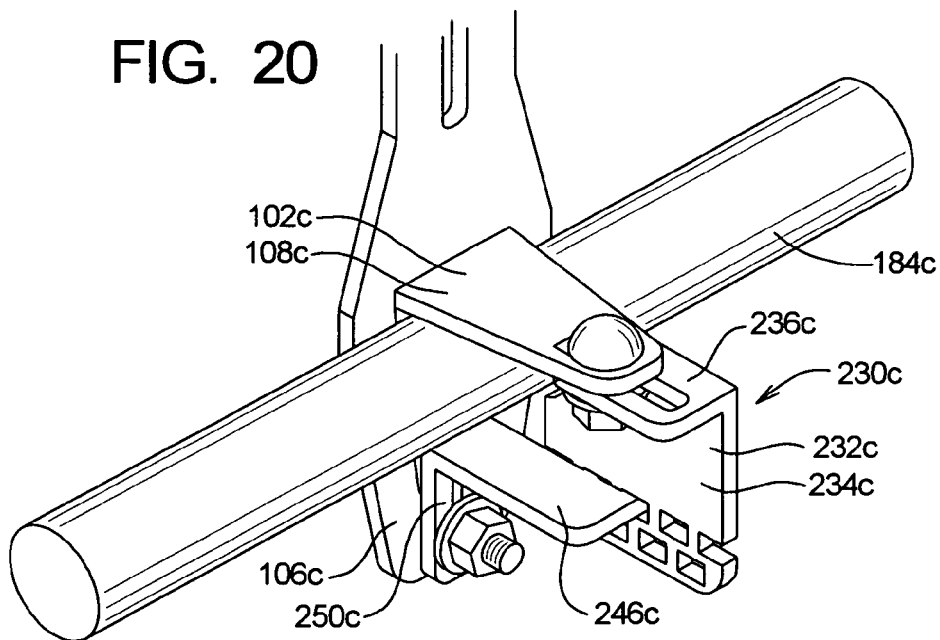


FIG. 20



1

## RESTRAINT SYSTEM, APPARATUS AND METHOD FOR LADDER SYSTEM

The present invention relates to a restraint system to be used in a ladder system where there is an open area which needs to be enclosed by a restraint system, and more particularly, to a restraint system which is used in a ladder system where there are ladder stations vertically aligned with one another and each station comprises a platform, an upwardly extending ladder, a safety cage and a guardrail.

### BACKGROUND OF THE INVENTION

For a number of decades, there have been ladder systems adjacent to towers, building structures, etc. Quite commonly these ladder systems will have a plurality of ladder stations (approximately twenty feet in height) positioned one above the other. Each station comprises a platform which would be positioned against a wall or other structure, with a ladder extending upwardly from one side of the platform and adjacent to the wall or other structure. At a level of about six or seven feet above the ladder, there is a safety cage that surrounds the ladder, and also a guardrail that extends around the parameter of the platform.

Quite commonly the lower end of the safety cage would be about six or seven feet above the level of the platform to provide clearance for people to move around on the platform, and the guardrail would be at a lower elevation, possibly four feet high. Thus, there is a gap or open region between the lower end portion of the safety cage and the upper rail member. Some time ago there were enacted OSHA regulations which required that these ladder systems should have a restraint system to enclose the open area between the lower part of the safety cage and the upper part of the rail. The problem was that if a person fell of a ladder and dropped through the area defined by the safety cage, upon arriving at the platform, the person might accidentally fall over the guard rail. (For example the person might stumble and thus move sideways in an off balance position.)

To the best knowledge of the applicants, the task of retrofitting the ladder stations with a restraint system has to some extent lacked adequate designs and in large part the retrofit has been made by taking various iron or steel components and welding them in place. Also, one of the problems in attempting to find a design for such restraint systems is that while the guard rail and the safety cage have generally the same overall arrangement, there are differences in their positioning, and also in the configuration of some of the components.

The embodiments of the present invention are particularly designed to provide a restraint system which would be relatively easy to install, and also be adaptable for various arrangements of the ladder systems.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view showing a typical prior art ladder system with a first embodiment of the present invention being utilized in this ladder system;

FIG. 2 is an isometric exploded view of a restraint section of the present invention;

FIG. 3 is an isometric view of a rail in it's assembled condition;

FIG. 4 is a side elevational view, partly in section, of FIG. 3;

FIG. 5 is an exploded isometric view of FIG. 3;

FIG. 6 is a side elevational exploded view of FIG. 3;

2

FIG. 7 is an isometric view of an assembled cage connecting element;

FIG. 8 is an isometric exploded view of FIG. 7;

FIG. 9 is a side elevational view of FIG. 7;

FIG. 10 is a side elevational exploded view of FIG. 7;

FIG. 11 is an isometric view of a rail clamping component of a second embodiment;

FIG. 12 is an isometric exploded view of FIG. 11;

FIG. 13 is a side elevational view of FIG. 11;

FIG. 14 is a side elevational exploded view of FIG. 11;

FIG. 15 is an isometric view of a cage element connecting component of a third embodiment;

FIG. 16 is an isometric exploded view of FIG. 15;

FIG. 17 is a side elevational view, partly in section, of FIG. 15;

FIG. 18 is a side elevational exploded view similar to FIG. 17.

FIG. 19 is a isometric view showing a fourth embodiment of the present invention, with the fasteners being shown as an exploded view;

FIG. 20 is an isometric view of FIG. 19, also showing the clamping member of an exploded view.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In describing the embodiments of the present invention, there will first be described, with reference to FIG. 1, a commonly used prior art ladder system. After that, there will be a description of the four embodiments of the fall restraint system of the present invention which is to be used in this ladder system 10.

#### a) The Prior Art Ladder System

In FIG. 1, there is shown a typical prior art ladder system 10 and also a fall restraint system 10 of a final embodiment of the present invention the ladder system 10 is shown mounted to a wall structure 12 which could be a tower, a wall of an industrial structure such as a refinery, etc. The ladder system 10 comprises a plurality of ladder stations 14 which are positioned one above the other and mounted to the wall section 10. There is shown one station 14 of the ladder system 10, and this station comprises a platform 16, a ladder section 18, a safety cage 20, and a guardrail 22. The platform 16 as shown herein is a horizontal rectangular structure, with it's rear side being in contact with, or connected to, the wall structure 12. The guardrail 22 extends along the perimeter of the platform 16 and comprises first and second side rail sections 24 and 26 respectively, and a front rail section 28 running along the front of platform 16.

At the right rear corner of the platform 16, there is a second ladder section 30 and a cage section 32 which are part of the ladder station immediately below.

For purposes of description and to provide a frame of reference for various components, the platform 16 shall be considered as having a lateral axis 34 which runs along a lateral center line of the platform 16 and is parallel to the wall structure 12, a front to rear axis 36 that extends along a front to rear center line of the platform 16 and is perpendicular to the lateral axis 34, and a vertical axis 38 extending perpendicular to the axis 34 and 36 and extending through the intersection point of the axis 34 and 38.

The platform 16 comprises a flat deck 40 and three support beams 42 extending beneath the edge portions of the platform 20. The ladder section 18 comprises two vertically extending side members 44 with rungs 46 extending between the side members 44.

The safety cage **20** comprises a plurality of cage elements **48** which are connected to the ladder side members **44** and are vertically spaced from one another. Each cage element in this embodiment is made as a single flat metal strip having two straight side portions **50**, the rear ends of which are connected to ladder side and a front 180 degree curved portion **52** extending at the forward ends of side portions **50**. Vertical bracing members **52** connect the cage elements **50** and **48** to one another form a rigid structure. The guardrail comprises 22 horizontal rail members **53** and vertical rail members **54**.

The components **10-54** which have been described in the text above already exist in the prior art, and while there are variations in the various ladder systems **10**, the components which are described above are typical of these installations. Commonly, each ladder system station **14** has a height dimension of approximately twenty feet or more.

To describe the manner in which the ladder system **10** is used, let us assume that a workman is climbing up each ladder section **18** of each system station **14**, and the workman is now climbing up the lower ladder section **32** shown in FIG. **1** and reaches the platform **16**. The workman then steps onto the platform **16** and walks over through the next ladder section **18** climbs up that ladder section **18** and to a platform which is positioned above the platform **16**. After arriving at the upper platform opening, the workman walks across the platform to the opposite side to climb up another ladder, and continues in that pattern to the desired location along the wall structure **12**. Substantially the same procedure is followed with the ladder system shown in FIG. **1A**.

If the workman slips while he is ascending the ladder section **18**, for example, the safety cage **20** will prevent the workman from falling outwardly from the ladder **18** and from the building structure **12**, so that if he continues falling he will be confined along a vertical path defined by the cage **20** to land on the platform **16**. Also, the guardrail **22** (as it's name implies) further provides a safety benefit.

However, while the safety cage **20**, the platform **16** and the guardrail **22** have provided substantial safety benefits, there has remained a problem. The lowermost cage element **48** of the safety cage **20** is generally six or seven feet above the upper surface of the platform **16**, and with the upper edge of the guardrail **22** being at an elevation well below that, there is still a gap (i.e. an empty air space) between the lowermost cage element **48** and the upper horizontal rail member **53** of the guardrail **22**, and this open air space is indicated at **56** in FIG. **1**. Thus, there is also the risk that a person who is falling from the ladder and moving down through the safety cage might upon falling from the bottom part of the cage **20** stumble or lose his balance and fall over the guardrail **22**.

Accordingly, some time ago section 11910.27 of the OSHA requirements was implemented and this requires that any elevated platform that does not extend four feet beyond the center of the ladder rungs must use some method of extending the ladder cage to the hand rail. Thus, there are a large number of these ladder systems **10** which require some remodel or retrofit to come into compliance. One of the problems however is that while there is a basic commonality among these ladder systems **10** in terms of the overall structure, the dimensions and the relative positioning components generally vary from one system **10** to the other. Also, some of the components differ, in terms of their structure. For example, the guardrail may use round tubing or angle irons as some of the horizontal rail elements. Also, there are variations in the specific structures of the safety cage elements **48**.

The embodiments of the present invention were designed to alleviate these problems and provide an apparatus and method that could be used with essentially any and all of the existing system **10** by in spite of these variations in shape, dimensioning and relative location.

#### b) The Final Embodiment of the Present Invention

To describe now the first embodiment of the present invention, reference is first made to FIGS. **1** and **2**. The restraint system **11** comprises a plurality of restraint sections **60** which are connected to, and extend between, a lower cage element **48** and the upper rail member **53**, and these are positioned at laterally spaced intervals around the open region **56** that is proximate to of the cage **20** and the ladder section **18**.

Each restraint section **60** comprises an elongate restraint component **62** having first and second end portions **64** and **66**, and further comprises a rail connecting component **68** and a cage connecting component **70**. The rail connecting component **68** connects the first end portion **64** of the restraint component **62** to an upper one of the rail members **53**. In like manner, the cage connecting component **70** connects the second end portion **66** of the restraint portion **60** to a lower one of the cage elements **48**.

The restraint component **62** of each of the restraint sections **60** comprises a rail engaging restraint section **72** and a cage engaging restraint section **73** that connect to one another at adjacent end portions and collectively from the elongate restraint component **62**.

The rail engaging restraint section **72** (as it's name implies) is attached to an upper rail member **53** and extends generally vertically in an upward direction from the upper rail member **53** and is extendable and retractable. Further, this rail engaging restraint section **72** comprises a rail engaging portion **74** that is attached to the upper rail member **53** and an extension portion **75** which is adjustably connected to the rail engaging portion **74** so as to be positioned in various positions along it's length.

The rail engaging portion **74** in turn comprises a rail connection portion **76** that connects directly to the rail member **53** and an upwardly extending restraint portion **78** to which the extension portion is adjustably engaged. The rail connecting portion **76** will be described later in this text in connection with the description of rail connecting component **68** (described later in the text).

The upwardly lower extending restraint portion **78** is formed as a flat elongate generally rectangular member having a vertically aligned center slot **79**. The above mentioned extension portion **75** comprises a vertically aligned extension element **80** which is formed as a flat bar member having a rectangular configuration substantially matching the cross sectional configuration of the upwardly extending lower restraint member **78**. This extension element **80** has a plurality of holes **82** along a vertical alignment axis of the extension element **80**, with these holes being equally spaced from one another.

There are provided two fasteners, in the form of two fastener assemblies **84** which extend through the slot **79** and through selected holes **82** of the extension element **80** to position the extension portion **75** at the desired location. The extension portion **75** further comprises an upper connecting portion **85** which is connected to (or internally formed with) the upper end portion of the vertical extension portion **80**. This upper connection portion **85** comprises a horizontally extending flat connecting member **86** having a slot **87** extending along a center of the connecting portion **85**. There

is a fastener assembly **88**, the same as (or similar to) fastener assembly **84**, and this is used to connect to the cage engaging restraint section **73**.

This cage engaging restraint section **73** has a configuration of a flat elongate bar **89** which has a slot **90** extending along a lengthwise central line of the bar **89**. This slot **90** provides two connecting locations **92** and **94**. The connecting location **92** is at the location of the connector assembly **88** where the connecting portion **85** of the rail engaging restraint section **72** connects to cage engaging restraint section **73**. The second connecting location **94** is at the location of a second connecting assembly **95** which extends through the slot **90** and the slot **94**.

It is apparent by viewing FIG. 2 that the horizontal angular orientation of the bar **89** of the cage engaging restraint section **73** relative to the cage connecting component **70** and also to the upper connecting portion **85** can each be changed. Also, the position of this bar **89** can be varied simply by positioning the fastener assembly **88** at various locations along the length of the slot **90** of bar **89**. Thus both the effective length and the angular position of the cage engaging restraint section **73** can be adjusted independently of one another.

#### c) The Rail Connecting Component of the First Embodiment

Let us now turn our attention to the aforementioned rail connecting component **68**. Reference is first made to FIGS. 3 through 6 which shows this component **68**, with FIGS. 3 and 4 showing it in its assembled operating configuration, and with FIGS. 5 and 6 being two exploded views, and with FIG. 5 being an isometric view and the FIG. 6 being a side elevation view.

In this particular embodiment, the upper rail member **53** to which the rail connecting component **68** is attached is in the form of an angle iron comprising in cross section horizontal and vertical flanges or webs **96** and **98** are made at right angle with respect to one another and meet at a junction location **100**. The term "angle iron" is used in the conventional sense of meaning this particular type of a beam, and it is not necessarily limited to the meaning that it is made of a material which is iron or steel. However, in this embodiment, all of the components can be made of steel but could also be made from other metals, composites, plastic, etc.

This rail connecting component **68** of the embodiment is particularly configured to be connected to a rail member **53** having the angle iron configuration. The connecting component **68** comprises a positioning component **102** and a clamping component **104**. In the particular arrangement shown herein the positioning component **102** is made integrally as part of the rail engaging portion **74** of the rail engaging restraint section **72** and has previously been given of the designation **76**. However, in the description that follows, the component that is the aforementioned rail connecting portion **76** will be referred to as a positioning component **102**, since this positioning component **102** could be made as a separate member that is then attached to the rest of the structure of the rail engaging restraint section **72**.

The positioning component **102** comprises a flat plate like vertical portion **106** and a flat plate like horizontal portion **108**, with these being connected to one another at adjacent edge portions so as to form a right angle configuration matching that of the right angle guard rail member **53**. As shown here in, for convenience of manufacture, the horizontal portion **108** is made integrally with the lower end of the rail engaging portion **74** by making a U-shaped cut and then bending or otherwise forming the portion so that it

extends outwardly at a right angle orientation, with the remaining end portion of the rail connecting portion **76** remaining in its original coplanar position, and forming the vertical portion **106**.

The vertical and horizontal portions **106** and **108** have flat positioning surfaces **110** and **112** respectively to bear against matching side surfaces of the right angle rail member **53**. There are fastener openings **114** and **116** at end locations of the vertical and horizontal portions of **106** and **108**, respectively. The opening **114** of the vertical portion **106** has a square configuration, to receive a matching square head portion of a connecting carriage bolt. In the drawings for ease of illumination the bolts are shown without the square head portion, and it is understood that these bolts could have that configuration. The opening **116** has a T shaped configuration where the leg **120** of the T is aligned in a forward to rear direction, and the top rear part **118** of the T extends at right angles thereto. The reason for this will become apparent later in this description, but to comment briefly on it at this time, one of the advantages of the present invention is that it is able to use some of the same components to accommodate different configurations of both the rail member **53** and the cage element **48**. The opening **116** is designed to receive an end portion of one of those members.

The clamping component **104** is a right angle member and comprises a vertical clamping portion **122** and a horizontal portion **124** which join to one another at edge portions in a right angle configuration to match that of the rail member **53** and of the positioning component **102**. The vertical and horizontal clamping portions **122** and **124** have at outer end portions thereof openings **126** and **128** respectively, with each of these being a slotted opening in a direction perpendicular to the alignment of a juncture location **129** of the two clamping portions **122** and **124**, to allow for different thicknesses of the flanges **96** and **98** of the rail member **53**.

There are provided two fasteners **130**, each of which comprises a nut **131**, a bolt **132** and a washer **134**. These fasteners **130** are desirably the same as the fasteners **84** and **95** disclosed earlier in this text. With the positioning component **102** and the clamping component **104** positioned in the clamping position of FIG. 4, with the two bolts **132** being positioned so as to extend through the pair of openings **116** and **128**, and also through the pair of openings **114** and **126**, the nuts **31** of these fasteners are tightened so as to hold the positioning component **102** and the clamping component **104** in place and to press tightly against the rail member **53**, so that the rail connection portion **76** of the rail engaging portion **74** is fixedly positioned relative to the rail member **53**. Thus, the orientation of the entire rail engaging restraint section **72** is also fixed.

#### d) The Cage Connecting Component **70** and the First Embodiment

Reference is now made to FIGS. 7 through 10 to describe the cage connecting component **70**. The cage element **48** shown in FIG. 7 is formed of an elongate planar metal strip which has the afore mentioned side portions **50** and front curved portion **51**. There is a positioning component **136** and a clamping component **138**. The positioning component **136** comprises a vertical portion **140** and a horizontal portion **142** which connect to one another at adjacent edge portions, and are at right angles to one another. The upper part of the vertical portion **140** has vertically spaced openings **144** and **146**, each of these having a square configuration to mate with matching square portions of the carriage bolts used as connectors, and a forwardly facing positioning surface **148**.

The horizontal portion **142** of the positioning component **136** shall be considered as having an inner end portion **149**

that is located only a short distance away from the lower rear end portion of the vertical portion 140, and an oppositely positioned outer end portion 150 at a further distance vertical position 140. At a location of the inner end portion 149 closely adjacent to the cage element 48, there is a first connecting location 151 where side portions of the horizontal portion 142 are formed with laterally aligned notches 152. There is a second connecting location 153 which is positioned outwardly of the first connecting position in location 151, and there is at this location 153 an opening 154 having the configuration of a cross where there is an elongate forward to rear slot 156 and a cross slot 158 which is positioned at that portion of the slot 156 that is closer to the outer end portion 150.

Then there is a third connecting location at 159, and at this location 159 there is an elongate connecting slot 160 which extends along a lengthwise center line of the horizontal portion 142. As will be described later, this slot 160 is to receive the aforementioned connector 95 that was mentioned previously in describing the connections of the cage engaging restraint section 73.

The function of the notches 152 at the connection location 151 is to engage the lower end of the clamping component 134. The clamping component 134 has the overall configuration of a flat metal bar with an upper portion 162 that has two vertically spaced openings 164 and 166. At a lower portion 168 of the clamping component 134 there is a central downwardly facing rectangular notch or cut out 170 which forms a pair of oppositely positioned downwardly extending lower legs 172 which fit in the notches 152.

There is a single nut, bolt and washer fastener generally designated 174, and including the nut 176, the bolt 178 and the washer 180. In the assembled position of FIG. 7, the vertical portion 140 of the positioning component 136 is positioned immediately behind the cage element 48, and the clamping component 138 is positioned at the opposite outside surface of the cage element 48. The two legs 172 of the clamping component 134 are positioned in the notches 152 to retain the lower portion 168 of the clamping component 134 in the proper position, adjacent to the outer surface of the cage element 48 and the connector 174 is tightened up to press the upper portion 162 of the clamping component 174 against the cage element 148.

In the particular configuration shown in FIG. 8, the bolt 178 is inserted through the two openings 146 and 166. However, in some instances the vertical dimension of the cage element 48 is greater, and in those instances the bolt 178 is inserted into the upper openings 164 and 144. Thus, the cage connecting component 70 is clamped rigidly to the cage element 48.

As indicated earlier in this text, there is a cage engaging restraint section 73 which comprises the elongate bar 89 having a lengthwise slot 90. Also as described previously, there is the fastener 88 which connects at the forward connecting location 92 with the fastener 88 extending through the slot 90 and also through the bolt of the slot 87 to connect the cage engaging restraint section 73 to the upper connecting portion 85 of the rail connecting component 68. At the second connecting location 94 (see FIG. 2) there is a second connecting assembly 95 which comprises a bolt that extends through the slot 90, and it also extends through the slot 160 which is at the forward end of the horizontal portion 142. This slot 160 is also indicated in the FIG. 2.

As can be seen from examining FIG. 2, when the cage engaging restraint section 73 is in its operating position, it is connected at the connecting location 92 by means of the fastener assembly 88, with the bolt of the fastener extending

through the slot 90 the member 89. The cage engaging restraint section 73 is connected at its second connecting location 94 to the horizontal portion 142 of the positioning component 136 by the bolt of the connecting assembly 95 extending through the slot 90 of the cage engaging restraint section 73 and the slot 160 of the horizontal portion 142 of the positioning component 136. Also by loosening two fastener assemblies 88 and 95 the angular position of the cage engaging restraint section 73 can be changed, and also by moving the fasteners 88 and 90 along their related slots, the distance between the two connecting locations 92 and 94 can be changed.

e) Installation of the First Embodiment of the Present Invention

The first step in installation of one of the fall restraint sections 60 is to first locate the position on the rail 53 where it is to be connected and position the rail engaging portion 74 of the rail engaging restraint section 72 so that its lower rail connecting portion 76 is in engagement with the upper rail 53 so that the vertical and horizontal positioning portions 106 and 108 are positioned against the flanges 96 and 98 of the rail 53. Then the clamping compound 124 is pressed against the rail 53 and the two connecting assemblies 130 are used to make the connections as shown in FIG. 4.

The next step is to position the extension portion 75 against the upwardly extending restraint portion 78 of the rail engaging portion 74. The extension portion 75 is positioned so that its upper end is at approximately the same level as that of the lowermost cage element 48, and then the bolts of the two fasteners 84 are inserted through two selected openings 82 of the vertical extension element 80 of the extension portion 75 and also through the slot 79 of the upwardly extending portion 78. Then the nuts are threaded on to the bolts and tightened.

The next step is to connect the cage connecting component 70 to the lowermost cage element 48. This is accomplished by placing the positioning component 136 against the inside surface of the lowermost cage element 48 as shown in FIG. 8, and then placing the clamping component 138 against the outside surface of the cage element 48 and lowering it so that the two legs 172 fit into the notches 152 of the positioning member 142. Then the bolt 178 of the fastener 174 is inserted through one or the other of the pairs of holes 146-166 or 144-164, and the nut 176 with the washer 180 is threaded on to the bolt 178 to press the clamping member 138 tightly against the cage element 48. After this, the cage connecting component 70 is positioned as shown in FIG. 2 being just above the connecting portion 85 and the horizontal portion 142 of the positioning component 136. The fastener assemblies 88 and 95 then are utilized to rigidly attach the cage engaging restraint section to both the cage connecting component 70 and also to the upper connecting portion of the elongate rail component 62.

Then the other restraint sections 60 are installed in the same manner. The locations of these restraint sections 60 are selected to be at sufficiently close intervals to properly perform their safety function.

f) The Rail Connecting Component of the Second Embodiment of the Second Invention

The second embodiment of the present invention is in large part the same as the first embodiment, except that the rail connecting component 68 of the first invention differs in this second embodiment so that a connect to the rail connecting component can be connected to a rail member having a cylindrical cross section. However, the rail member

could have other cross sectional configurations such as square, rectangular, oblong, etc.

To describe this second embodiment, reference is made to FIGS. 11 through 14. Some of the members of the rail connecting component 68 of the first embodiment are utilized in this second embodiment, and in describing this second embodiment, those corresponding components will be given the same numerical designations as in the first embodiment, but with an "a" suffix distinguishing those of the second embodiment.

This second embodiment is shown in FIGS. 11 through 14. Reference will initially be made to FIGS. 11 and 12 which are isometric views, with FIG. 11 showing the second embodiment in its operating position, and with FIG. 12 being an exploded view.

This second embodiment is given the general designation 182, and it is designed to engage the round upper rail which is indicated at 184. The positioning component 102a is shown as being the same as the positioning component 102 of the first embodiment. Thus, there is the vertical portion 106a and the horizontal portion 108a. Also, there is a lower connecting assembly 130a.

The difference in the second embodiment is that the clamping component 104 of the first embodiment is not used. Rather, there is a clamping assembly 186 that comprises a clamping connecting member 187 and a clamping rail engaging member 188.

The clamping connecting member 187 comprises a central connecting portion 190 an upper connection portion 192 and a lower connection portion 194. The upper and lower connecting portions 192 and 194 are substantially parallel to one another, and both of these make an angle with the central connecting portion 190 of approximately 135 degrees. Thus, in the operating position of FIG. 11, it can be seen that the lower connecting portion 194 is pressing against the vertically aligned portion 106a of the positioning component 102a. The lower connecting portion 194 has a slot opening 195 to receive the bolt 132a.

With reference to FIG. 12, the upper connecting portion 192 has a T shaped connecting portion 196 having a upper cross member 198 of a greater width, and a smaller width connecting portion 200. It will be recalled that in the description of the first embodiment, in FIG. 5 there is shown the T-shaped opening 116. There is the same T shaped opening 116a in the second embodiment, and there is a wider opening portion 118a at what would be the upper cross member of the T, and a narrow opening portion 120a which would be at the leg portion of the T.

It can be seen that the connection is made by moving the cross member portion 198 upwardly through the wider opening portion 118a until it is above the level of the upper surface of the horizontal portion 108a, and then moving the clamping connecting member 187 forwardly (i.e. away from the vertical portion 106a) so that the broader connecting cross member 198 is over the narrower opening portion 120a, with the narrower smaller width portion 200 being positioned within the narrower opening portion 116a.

The aforementioned rail engaging member 188a can be seen more clearly in FIG. 12. This has an overall configuration of rectangular flat bar having a lengthwise axis 201, and at space intervals along the lengthwise axis 201 there are pairs of oppositely formed notches 202 on opposite sides of the lengthwise axis 201, thus forming a plurality of oppositely extending pairs of fingers 204. At the outer end of the clamping connecting member 187 there is an end portion 206 which can be manually grasped to manipulate this clamping connecting member 187 into the proper position.

The clamping assembly 186 is also used in a third embodiment which is shown in FIGS. 15-18, and the connecting member 187 can be seen more clearly in the FIG. 16 with regard to the central connecting portion 190. Accordingly, reference will be made to FIG. 16 for the following several sentences to describe this central connecting portion 190 this connecting portion 190 has an L shaped opening 210b which comprises a lengthwise slot 212b and a lateral slot portion 214b. The rail engaging member 188 can be inserted so that one of the pairs of notches 192 is within slot portion 212b of the L shaped opening after which the rail engaging member 188 can be moved a short distance laterally so that two adjacent pairs of the fingers 194 fit on opposite surfaces of the central connecting portion 190. Thus, by selecting the particular pair of notches 192, the rail engaging member 187 can be positioned at various engaging positions, depending on the diameter of the cylindrical rail member 184. Then when the fastener 130a is tightened to rail engaging member is pressed against the rail member 88 to make a rigid connection.

#### g) The Cage Connecting Component of a Third Embodiment

The third embodiment of the present invention is in large part the same as the first and second embodiment except that the cage connecting component differs in this third embodiment so that the cage connecting component can be connected to a cage element having a cylindrical cross section.

To describe this third embodiment, reference is made to FIGS. 15 through 18. As it turns out, all of the members of the cage connecting component of the third embodiment are the same as corresponding components of the first and second embodiment. Accordingly, so these can be better identified, those components that first appear in the first embodiment will be given the same numerical designations as used in the first embodiment, and those which are derived from the second embodiment will be given the same numerical designations as those appearing in the second embodiment. However, a "b" suffix will be added to distinguish that these are in the third embodiment.

With reference first to FIGS. 15 and 16, there is shown a cylindrical cage element 48. There is a positioning component 136b which in turn comprises the vertical portion 140b and the horizontal portion 142b. Further, there are the two upper openings 144b and 146b. The lower member 142b has the double slotted opening 154b that has the lengthwise aligned longitudinal slot 156b and the cross slot portion 158b. There is the fastener assembly 174b comprising the nut 176b, the washer 180b and the bolt 178b, and this connects the connecting portion 194b of the clamping connecting member 187b to the vertical portion 106b by means of the slot like opening 195b.

The clamping component is essentially the same as that shown in the second embodiment. According, the clamping component is in the form of a clamping assembly 186b which comprises the clamping connecting member 187b and the rail engaging member 188b.

In this third embodiment, the positioning section 136b functions as in the first embodiment so as to engage at least two surface portions of the cage element 48, and the clamping assembly 186b functions in essentially the same way as the clamping assembly 186 of the second embodiment. Thus, the clamping connecting member 187b has its cross member 198 inserted through the slot like cross member portion 158b to secure that end of the clamping connecting member 187b and there is the opening at 195b to connect with the bolt 178b. It is believed that the functions of the components of this third embodiment are readily

understandable are from the early disclosure of the corresponding components of the same.

h) The Rail Clamping Component of a Fourth Embodiment of the Present Invention

In describing this fourth embodiment, components which are similar to the components of earlier embodiments will be given like numerical designations, with a "c" suffix distinguishing those of this fourth embodiment.

In this fourth embodiment, there is shown a round rail section **84**, a positioning component **102c** and a clamping component **230c**. The positioning component **102c** is substantially the same as that shown in FIG. 4 and in some of the other embodiments. Thus, there is the vertical positioning portion **106c** and the horizontally aligned positioning portion **108c**. Also, there is a lower opening **114c** and the upper opening **116c**. Also, there are two fastening assemblies **130c**, each comprising the nut **131c**, the bolt **132c** and the washer **134c**.

The clamping component **230c** comprises a clamping member **232c** having a vertically aligned plate like portion **234c** and a laterally extending plate like member **236c**. There is elongate slot **238c** in the laterally aligned member **236c**. At the lower part of the vertical member **234c** there is a position adjustment portion **240c** comprising a plurality of aligned square openings **242c**. There is provided a connecting member **246c** that has a pair of outwardly extending hook like fingers **248c**. These fingers **248c** arrange to fit in an adjacent pair of the square openings **242c**. At the forward end of the connecting member **246c** there is a downwardly extending flat member **250c** having an elongate slot **252c**.

In the operating position, the connecting member **246c** is attached to the clamping member **232c** as shown in FIG. 20, and then is moved to be adjacent to the positioning component **104c**. The slot **238c** is aligned with the opening **116c** and the fastener assembly **130c** is then utilized to secure the clamping member **232c** to the horizontal positioning portion **108c**. Also, the slot **252c** is aligned with the opening **114c**, and the clamping assembly is utilized to make the connection at that location.

It is believed that the operation of this fourth embodiment is readily apparent from the prior description of the various embodiments.

It is to be understood that various modifications could be made to the present invention without departing from the teachings thereof. For example, while one type of fastener is shown being used, other types of fasteners could also be employed. Further, there are shown extendable and retractable elements and it is known in the art that there are other methods of making members extendable and retractable, and these could have different cross sectional configurations. Also, for example, the cage engaging restraint section has been shown as a single member by having varying connection locations, so that it effectively functions as an extendable and retractable member and this could have other configurations.

The above instances are given by way of example, and it will be obvious of one of ordinary skill in this art to substitute other functional equivalents and be within the scope of the present invention.

What is claimed is:

1. A fall restraint system to be used for a ladder system, where the ladder system comprises a platform, a ladder extending upwardly from said platform, a safety cage extending around said ladder and having a cage element located at a first elevation above said platform, a guard rail extending at least partly around said platform and having a rail element positioned at an elevation above said platform

and below said cage element so that there is an open region located between said rail element and said cage element, said fall restraint system comprising:

- a) a plurality of restraint sections located at spaced locations at said open region, each restraint section comprising:
  - i) an elongate restraint component having first and second end portions and arranged to be positioned between said cage element and said rail element;
  - ii) a rail connecting component arranged to mechanically attach the first end portion of the restraint component to the rail element;
  - iii) a cage connecting component arranged to mechanically attach the second end of the portion of the restraint component to the cage element;
- b) said restraint component being arranged to be able to be extended or retracted to enable it to be joined to the cage element and rail element so that when the rail element and the cage element are at different positions relative to one another, the restraint section can be extended or retracted as needed to made a proper connection to said rail element and said cage element.

2. The restraint system as recited in claim 1 wherein each restraint section comprises:

- a) a generally vertical first restraint section having a substantial vertical alignment component and being adapted to be connected to said rail element so as to extend upwardly therefrom;
- b) a generally horizontal second restraint section having a substantial horizontal alignment component and adapted to be connected between an upper portion of said first restraint portion section and to extend to said cage element and be connected thereto.

3. The restraint system as recited in claim 2, wherein said first restraint section is arranged to be extendable and retractable along a first lengthwise axis having a substantial vertical alignment component.

4. The restraint system as recited in claim 3, wherein second restraint section is arranged to be positioned at different angular positions extending between the first restraint section and the cage element.

5. The restraint system as recited in claim 2, wherein said generally vertical first restraint section comprises a rail engaging portion and a vertically adjustable upper connecting portion adapted to be connected to said second restraint section at different elevations.

6. The restraint system as recited in claim 5, wherein said vertically adjustable upper connecting portion comprises an elongate extension portion; and said rail engaging restraint section has an upwardly extending restraint portion, said elongate extension portion and said upwardly extending restraint portion being arranged to be adjacent and in alignment with one another so as to be extendable and retractable relative to one another.

7. The restraint system as recited in claim 6, wherein said rail connecting component is adapted to be rigidly connected to said rail element and also rigidly connected to said upwardly extending restraint portion, so that said upwardly extending restraint portion is able to be fixed in an upwardly extending restraint position.

8. The restraint system as recited in system 5, wherein said vertically adjustable upper connecting portion is arranged to be fixedly connected to the rail engaging portion so that a location of the vertically adjustable upper connecting portion can be fixed, said second restraint section having a first connection portion that connects to the vertically

## 13

adjustable upper connecting portion in a manner that its angular location in a horizontal plane can be changed.

9. The system as recited in claim 8, wherein said second restraint section has a second connection portion connecting to said cage connecting component that permits change of angular position of said second restraint section relative to said cage connecting component.

10. The system as recited in claim 9, wherein said second restraint section has first and second connecting locations, which are arranged so that a distance between said first and second connecting locations of the second restraint section can be changed.

11. The restraint system as recited in claim 1, wherein at least one of said rail engaging component and said cage engaging component comprises a positioning component having two spaced surface portions that are arranged to engage spaced contact locations of one said rail element or said cage element, and a clamping component to engage said one of the rail element or the cage element in the clamping position, a fastener to engage said positioning component and said clamping component to press said clamping component into clamping engagement in the clamping position.

12. The restraint system as recited in claim 11, wherein said one of said rail engaging component and said cage engaging component comprises an elongate element having a right angle configuration where there are two flanges at right angles to one another, said positioning component having first and second positioning portions having a right angle configuration and are arranged to engage the surfaces of the right angle element that have an outside angle of about 270 degrees with respect to one another.

13. The restraint system as recited in claim 12, wherein said clamping component has two clamping portions connected to one another at a right angle, and having a configuration to engage surfaces of said right angle element that make an angle between each other of about 90 degrees.

14. The restraint system as recited in claim 11, wherein said positioning component and said clamping component are arranged to engage an elongate element having three outer surface contact locations, said positioning component comprising two positioning portions which join each other at an angle other than a straight angle, and having adjacent surfaces of less than 180 degree angle and which have two contact locations, said clamping component having a contact surface portion that is positioned to engage said third contact location of the elongate element and press the elongate element into a clamping engagement so as to be clamped between the two contact surface portions of the positioning component and the contact surface portion of the clamping member.

15. The restraint system as recited in claim 14, wherein said clamping component has a first connecting location which is mechanically connected to said positioning element, and a second connecting location where a fastener engages said clamping element and said positioning element, said fastener being arranged to exert a force on said clamping element to move the clamping element into clamping engagement.

## 14

16. The restraint system as recited in claim 15, wherein said clamping component further comprises an adjustable clamping contact member being capable of connecting to said clamping component at different clamping locations so as to accommodate elongate elements of different sizes.

17. A combination of a ladder system and a fall restraint system, said combination comprising:

- a) said ladder system comprising: a platform, a ladder extending upwardly from said platform, a safety cage extending around said ladder and having a cage element located at a first elevation above said platform, a guard rail extending at least partly around said platform and having a rail element positioned at an elevation above said platform and below said cage element so that there is an open region located between said rail element and said cage element;
- b) said fall restraint system comprising: a plurality of restraint sections which are connected to be able to be extended or retracted to a selected operating position, and which are located at spaced locations at said open region and are at selected operating positions relative to the rail element and the cage element, each restraint section comprising:
  - i) an elongate restraint component having first and second end portions which are positioned between said cage element and said rail element;
  - ii) a rail connecting component mechanically attached to the first end portion of the restraint component to the rail element;
  - iii) a cage connecting component mechanically attached to the second end of the portion of the restraint component to the cage element.

18. The combination as recited in claim 17 wherein each restraint section comprises:

- a) a generally vertical first restraint section having a substantial vertical alignment component and being adapted to be connected to said rail element so as to extend upwardly therefrom;
- b) a generally horizontal second restraint section having a substantial horizontal alignment component and adapted to be connected between an upper portion of said first restraint portion and to extend to said cage element and be connected thereto.

19. The combination as recited in claim 18, wherein said first restraint section is arranged to be extendable and retractable along a first lengthwise axis having a substantial vertical alignment component.

20. The combination as recited in claim 19, wherein said cage engaging restraint section is arranged to be positioned at different angular positions extending between the rail engaging restraint section and the cage element.

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