US012392145B2

(12) **United States Patent**
Neubauer

(10) **Patent No.: US 12,392,145 B2**
(45) **Date of Patent: Aug. 19, 2025**

(54) **STABILIZATION AND ANTI-ROTATION APPARATUS FOR SCAFFOLDING SYSTEM**

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(72) Inventor: **Dale Martin Neubauer**, Bend, OR (US)

(73) Assignee: **Blue Moon Designs, LLC**, Bend, OR (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1066 days.

(21) Appl. No.: **17/379,560**

(22) Filed: **Jul. 19, 2021**

(65) **Prior Publication Data**

US 2021/0348399 A1 Nov. 11, 2021

Related U.S. Application Data

(63) Continuation-in-part of application No. 16/278,113, filed on Feb. 17, 2019, now Pat. No. 11,187,000, which is a continuation-in-part of application No. 15/435,342, filed on Feb. 17, 2017, now Pat. No. 10,246,939.

(60) Provisional application No. 62/297,247, filed on Feb. 19, 2016.

(51) **Int. Cl.**
E04G 1/30 (2006.01)
E04G 1/24 (2006.01)

(52) **U.S. Cl.**
CPC ***E04G 1/30*** (2013.01); ***E04G 1/24*** (2013.01); *E04G 2001/246* (2013.01); *E04G 2001/307* (2013.01)

(58) **Field of Classification Search**
CPC E04G 1/15; E04G 1/30; E04G 7/28; E04G 2001/302; E04G 2001/307; E04G 1/14; E04G 2001/158; E06C 1/39; B25H 1/06
See application file for complete search history.

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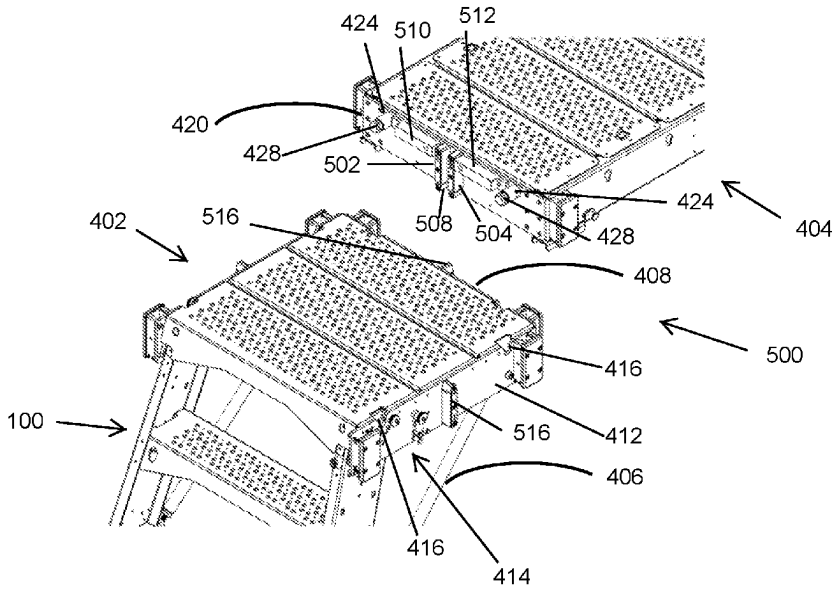
Primary Examiner — Colleen M Chavchavadze
(74) *Attorney, Agent, or Firm* — Leber IP Law; Celia H. Leber

(57) **ABSTRACT**

A stabilization and anti-rotation system provides for secure interconnection between a scaffolding work platform and two primary platforms, each of which is attached to a ladder, and prevents relative movement between the primary platforms and the scaffolding platform. A locating block is attached to a plate of each primary platform **402**. A pair of spaced apart and vertically oriented guide blocks are attached to a facing plate on each end of the work platform and positioned so that a guide slot is defined between the blocks. When assembled, the locating block is closely captured between the guide blocks and the structure provides stability and prevents rotation of the work platform relative to the primary platforms.

13 Claims, 36 Drawing Sheets



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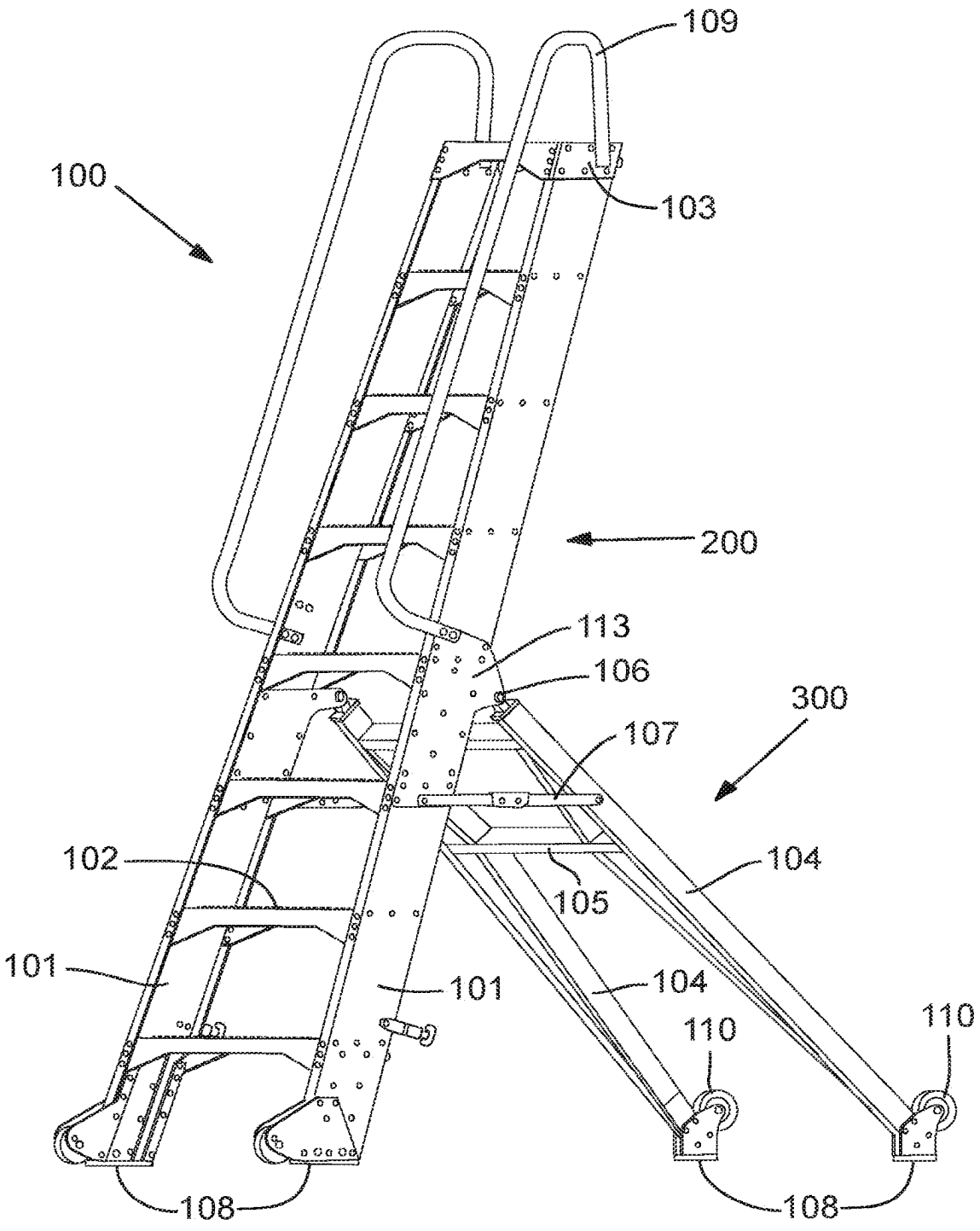
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FIG. 1

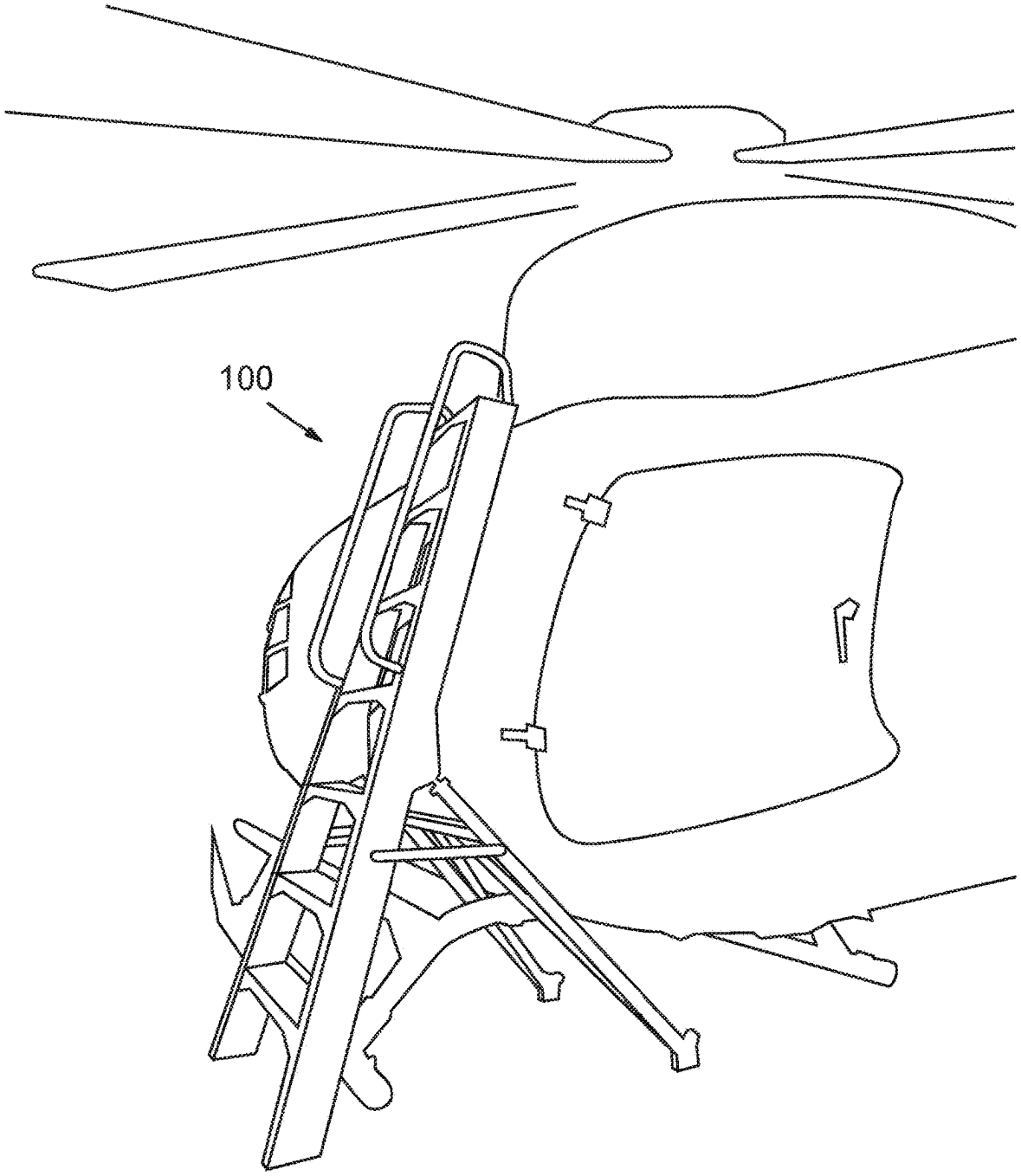

FIG. 2

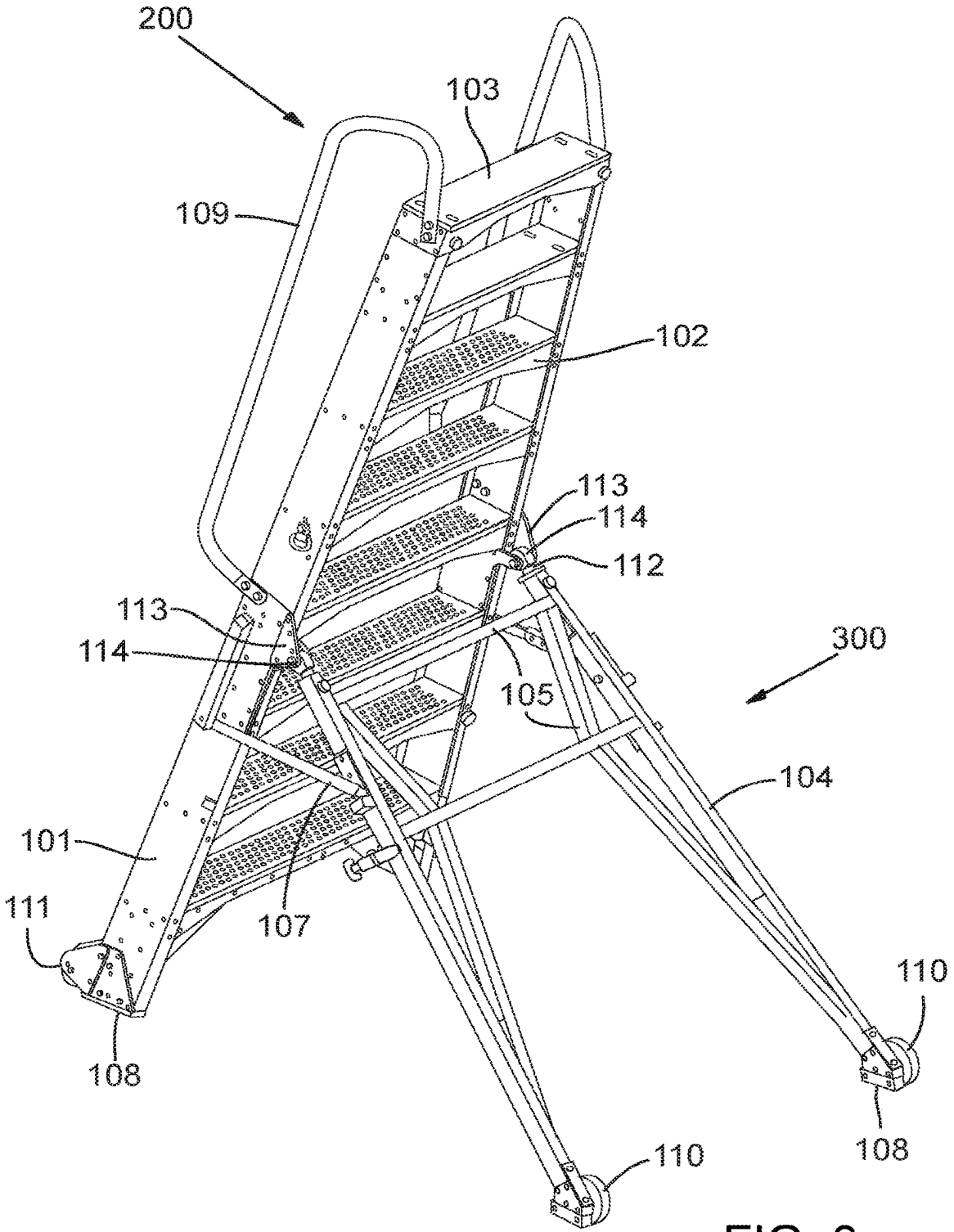
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FIG. 3

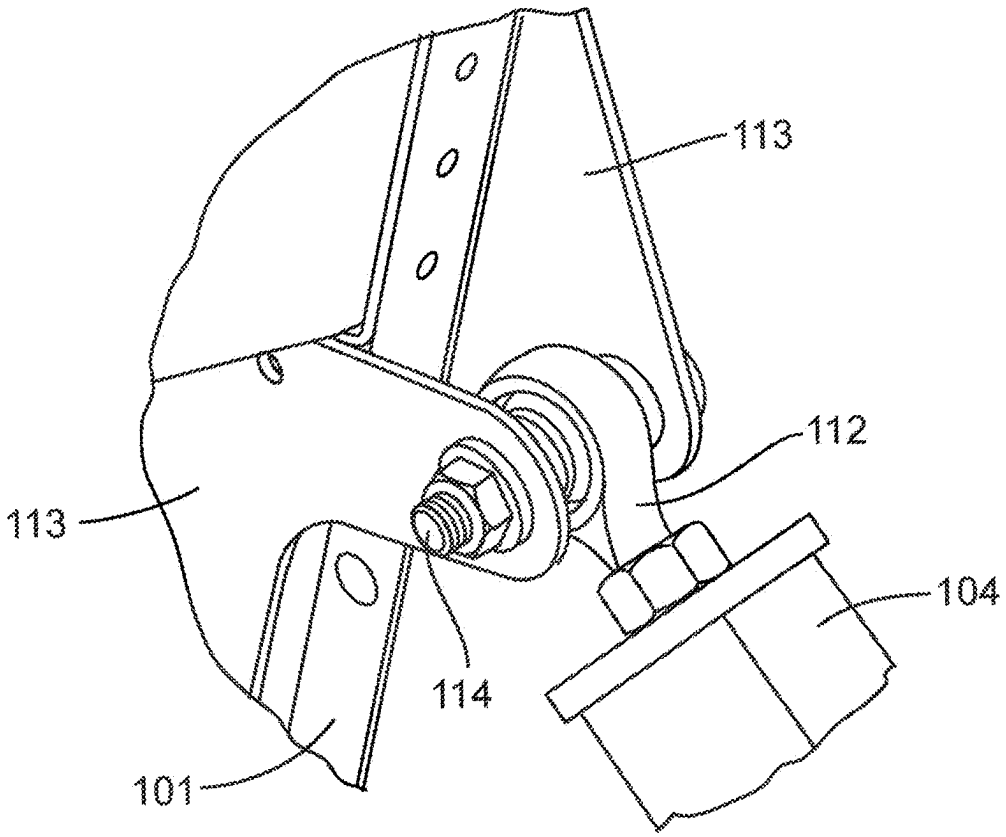

FIG. 3A

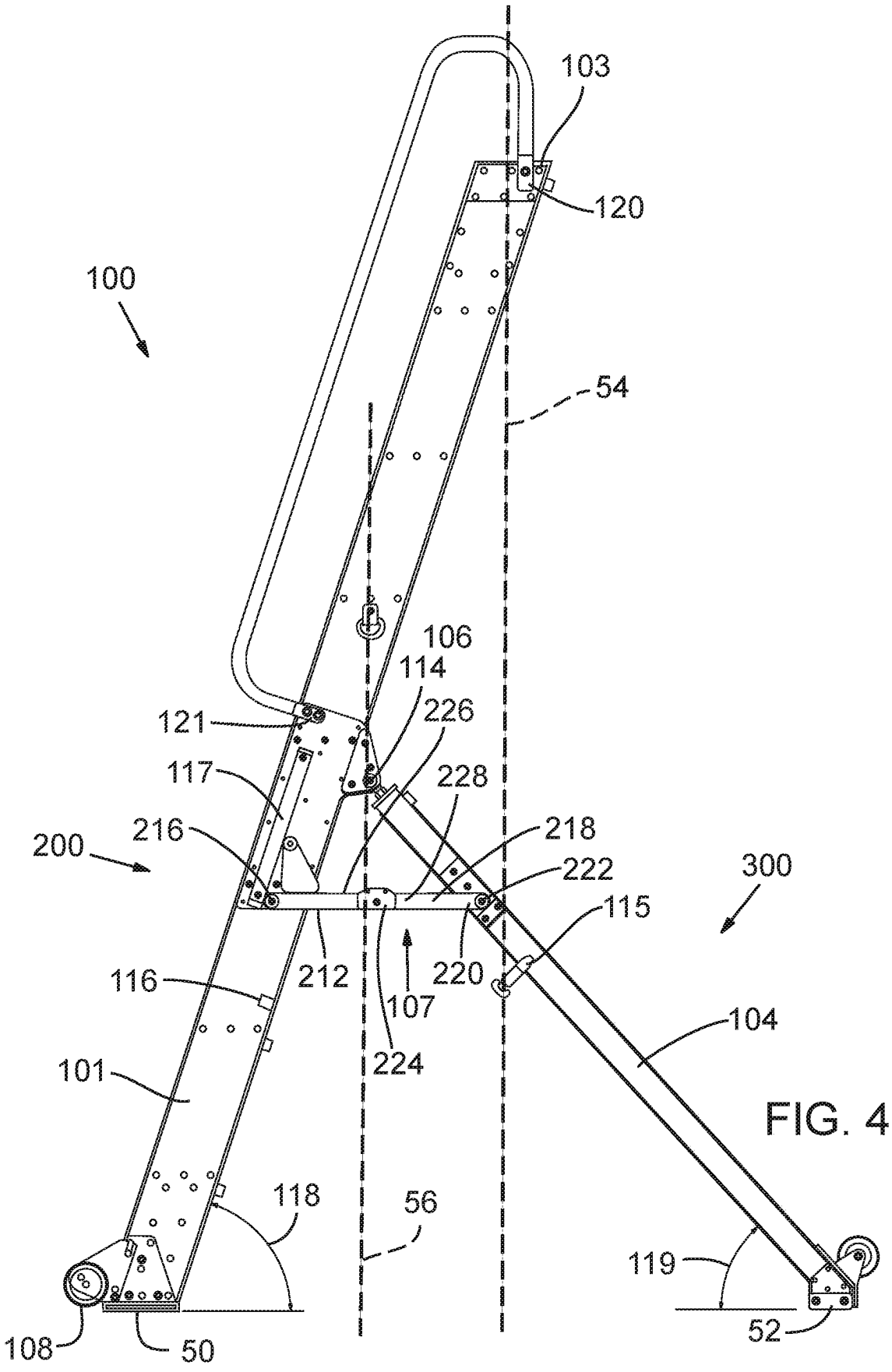
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FIG. 4

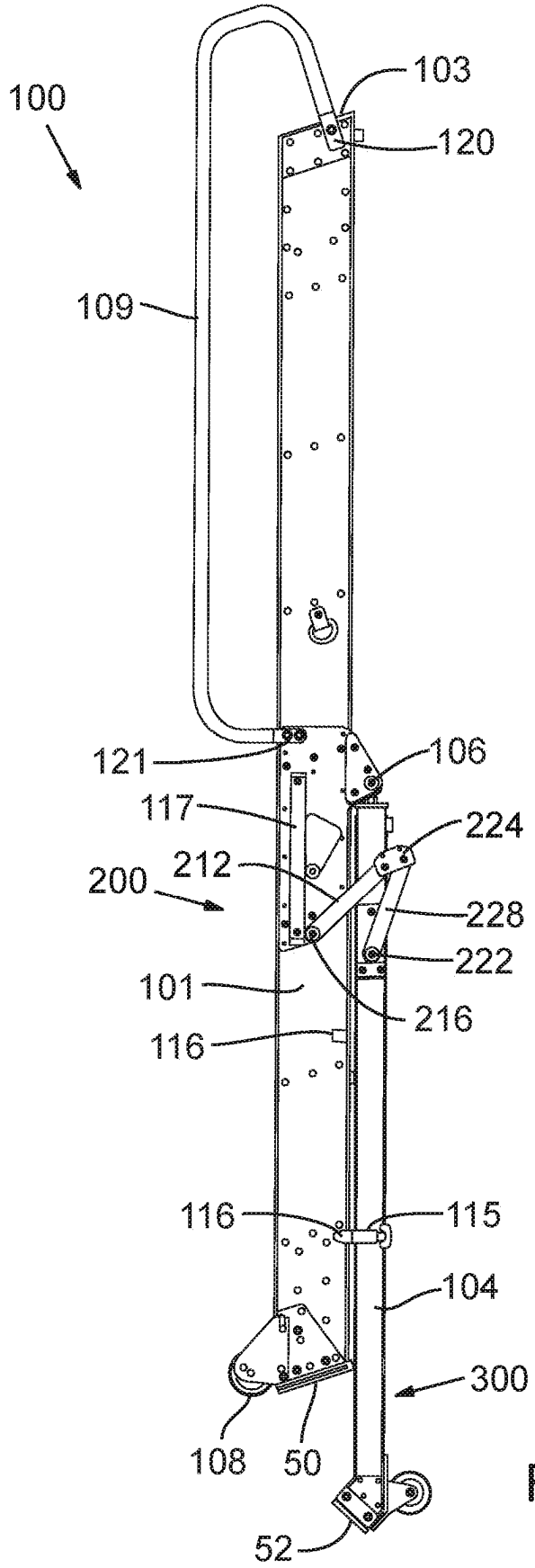
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FIG. 5

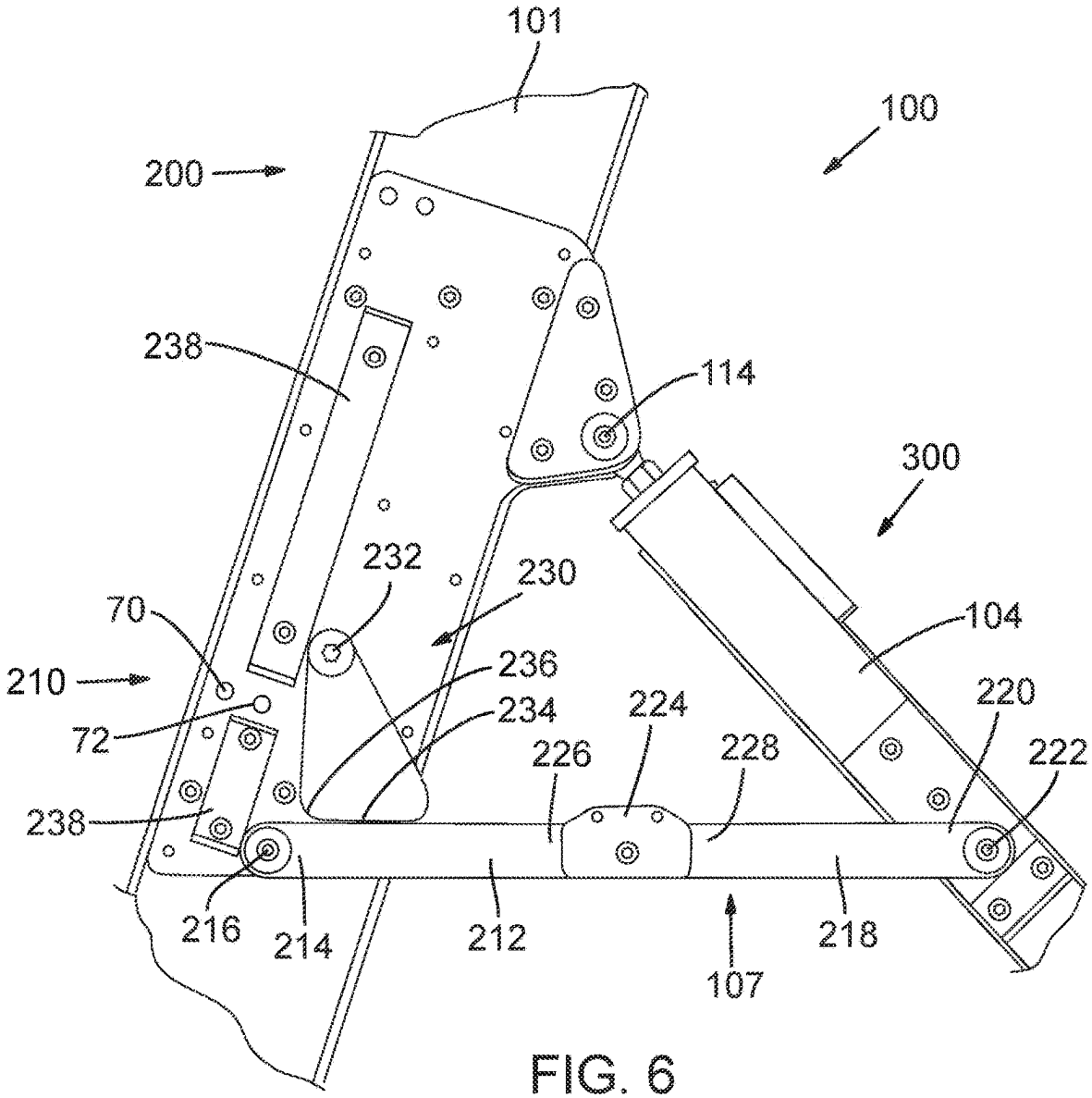
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FIG. 6

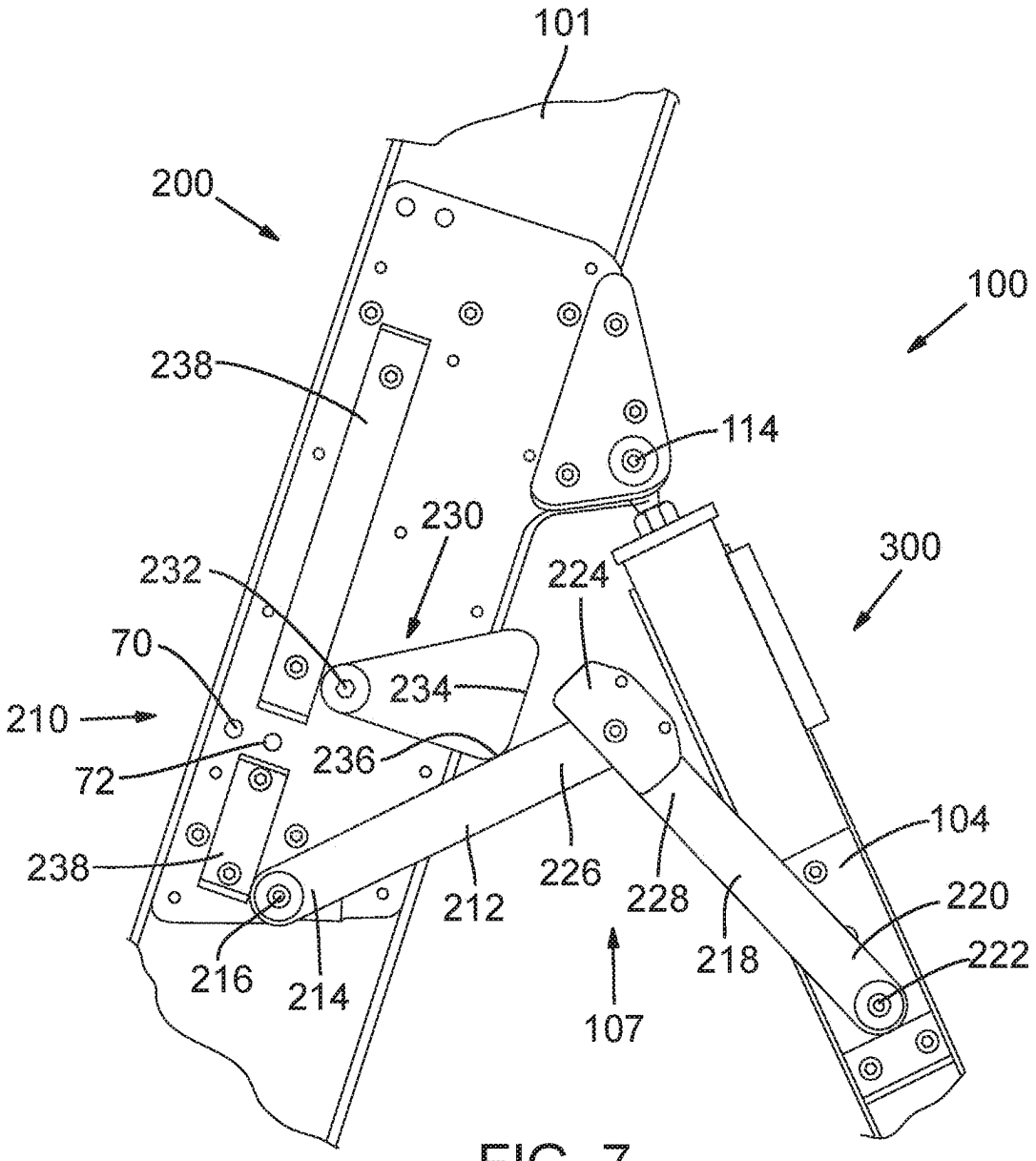
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FIG. 7

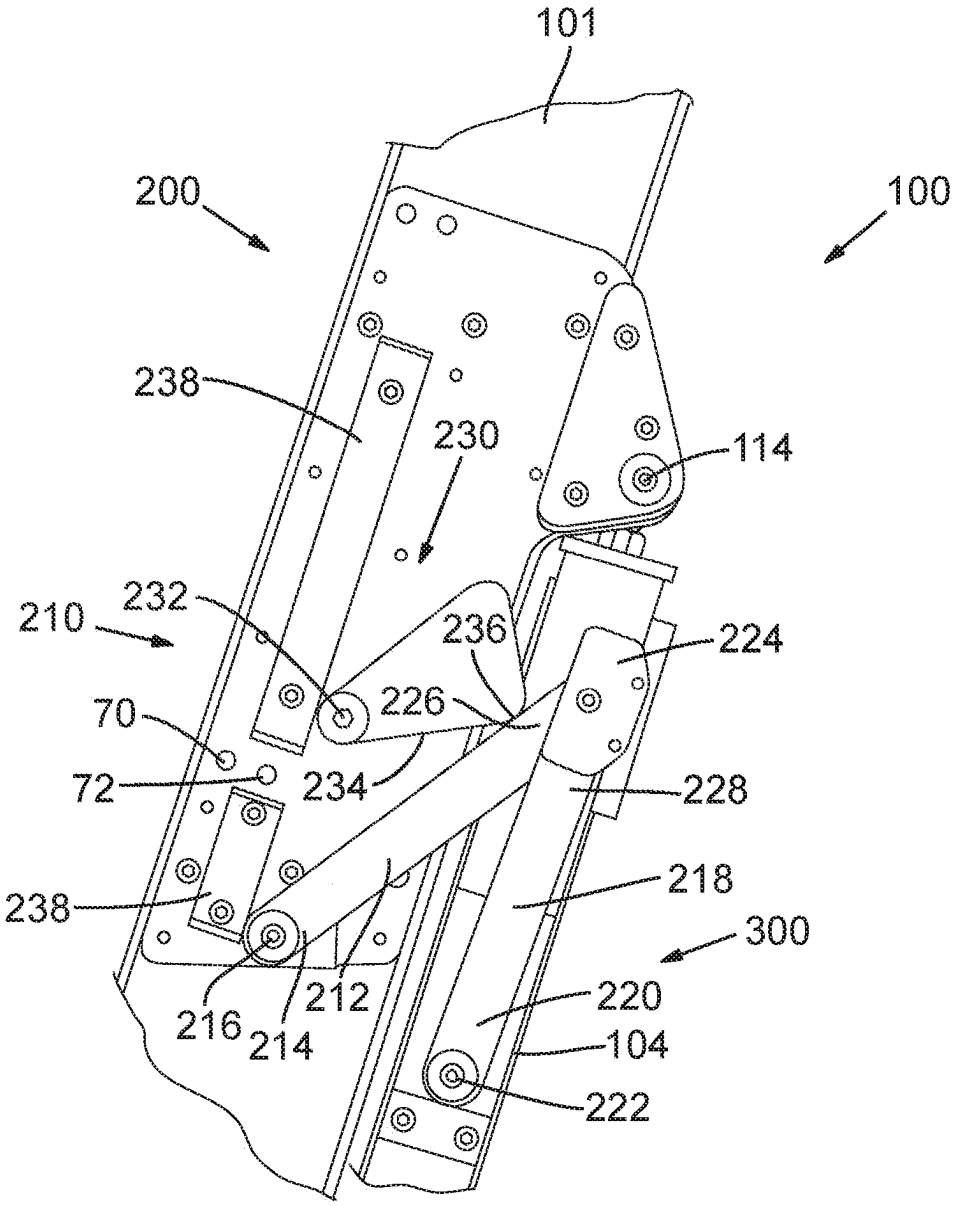
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FIG. 8

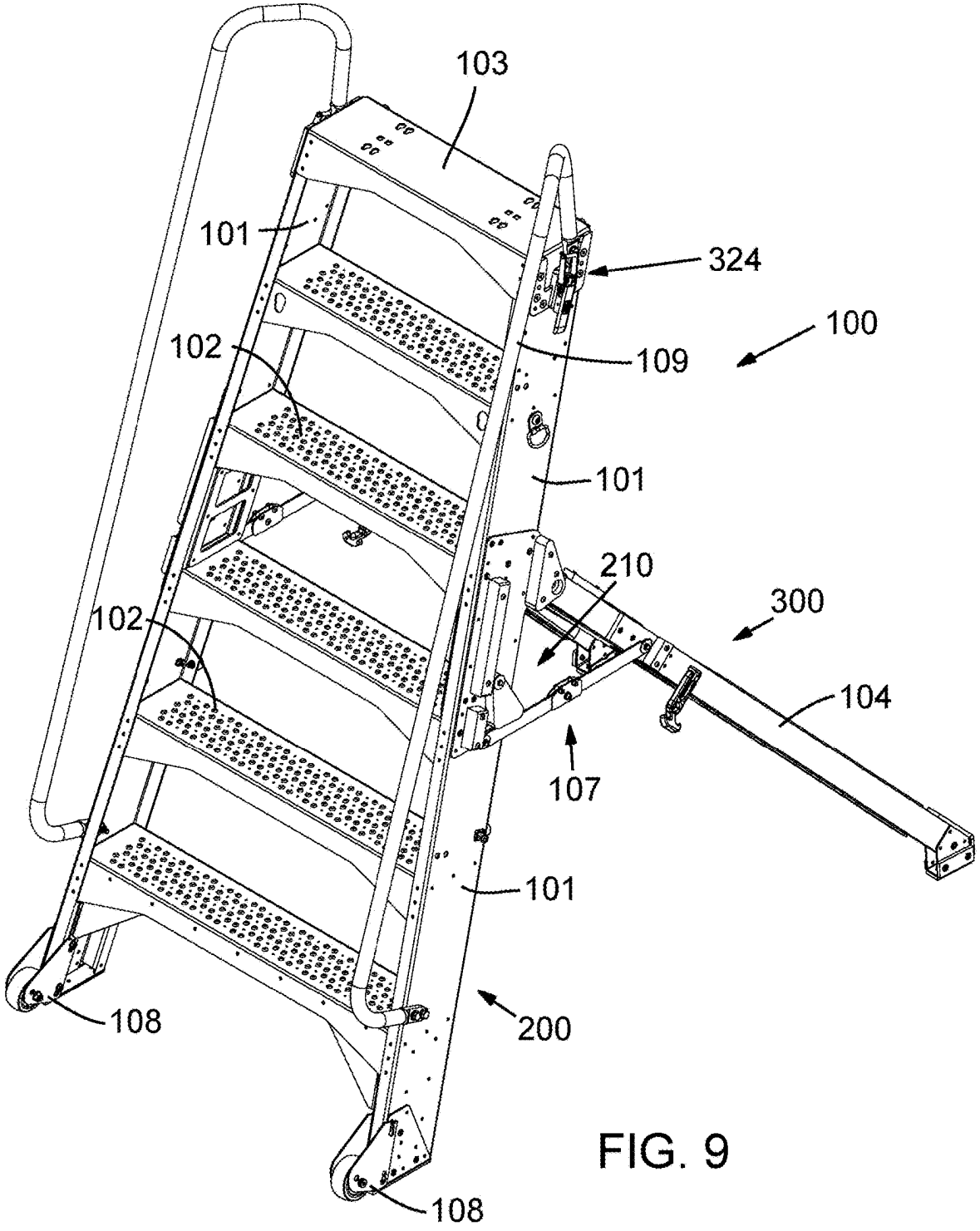

FIG. 9

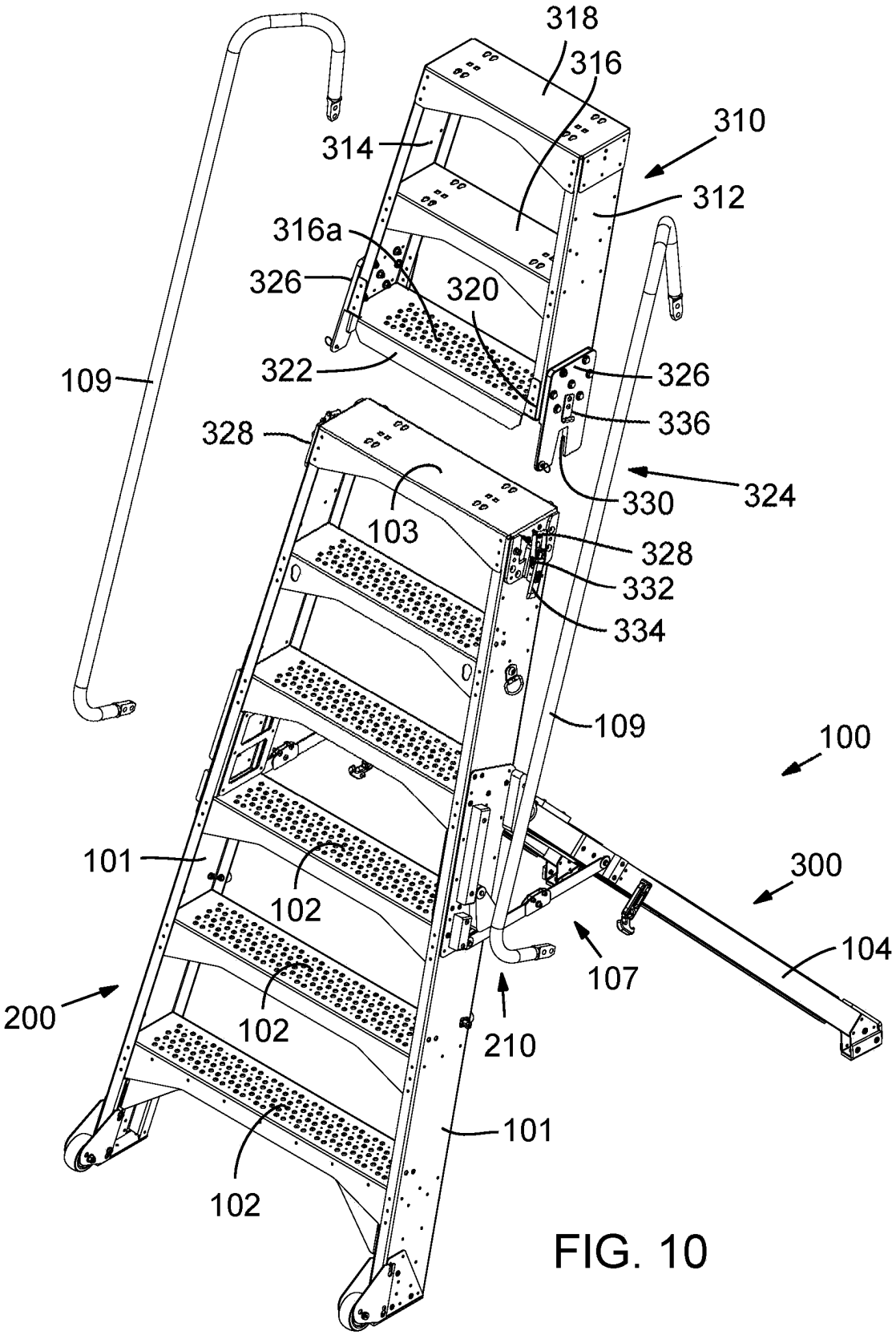
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FIG. 10

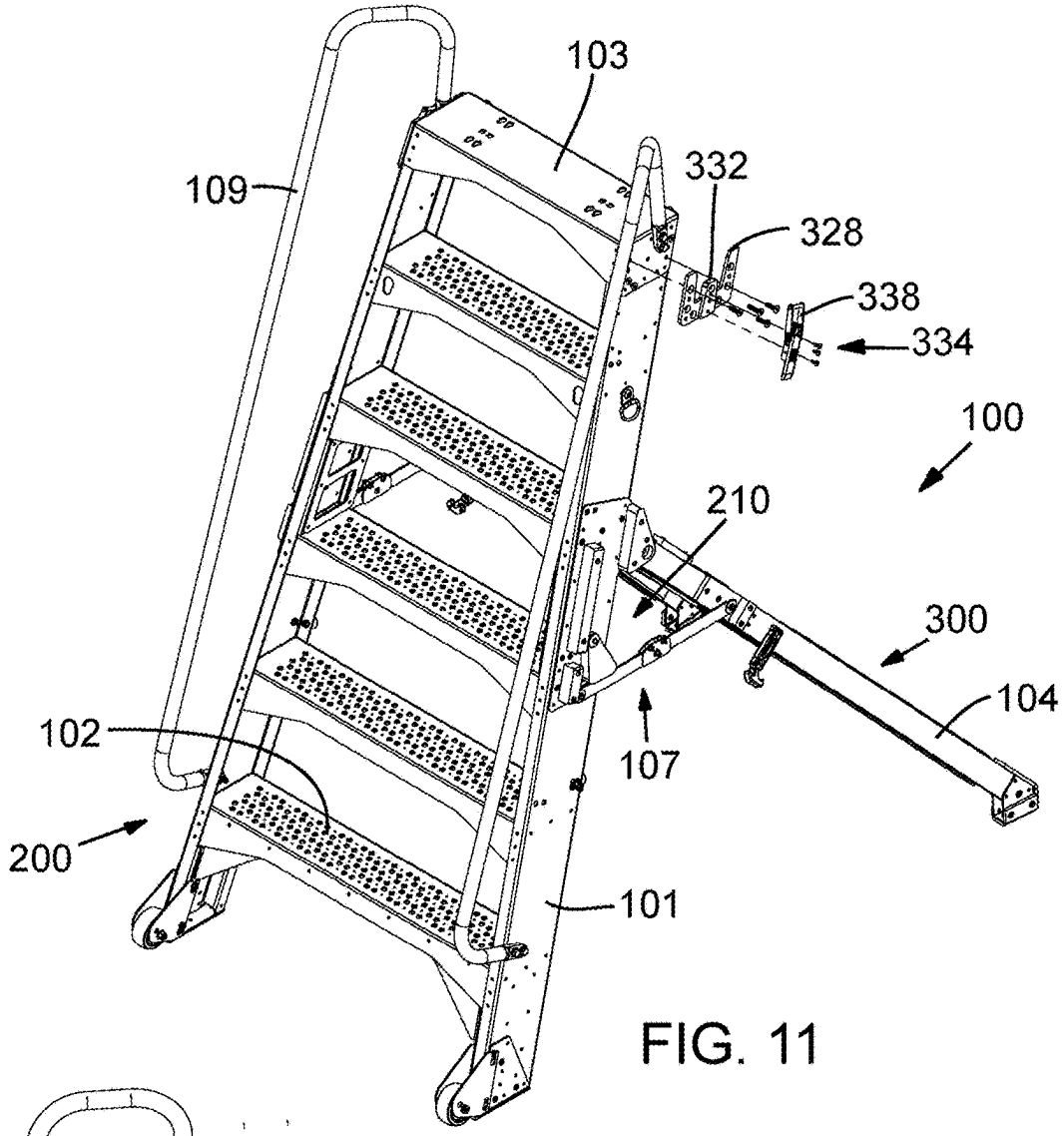
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FIG. 11

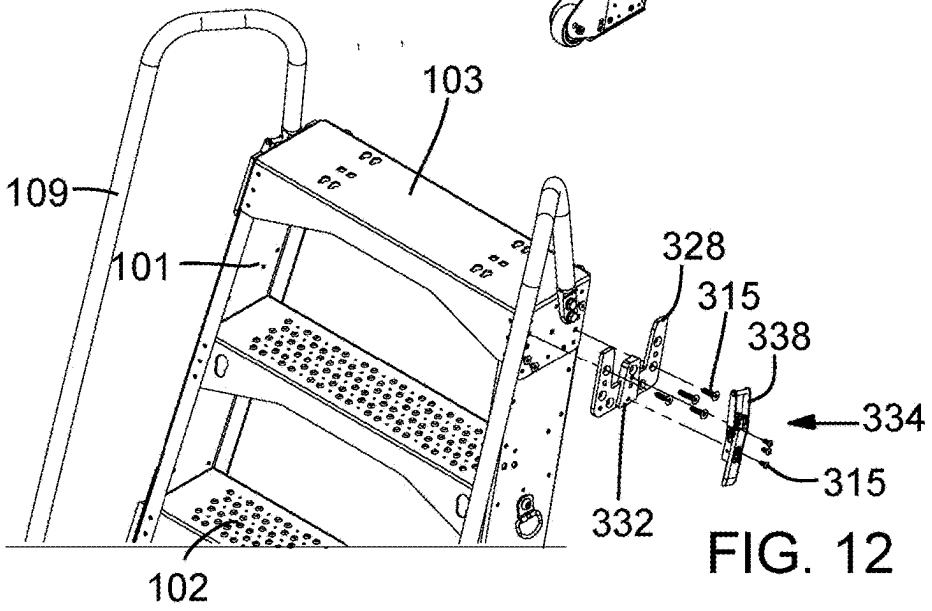
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FIG. 12

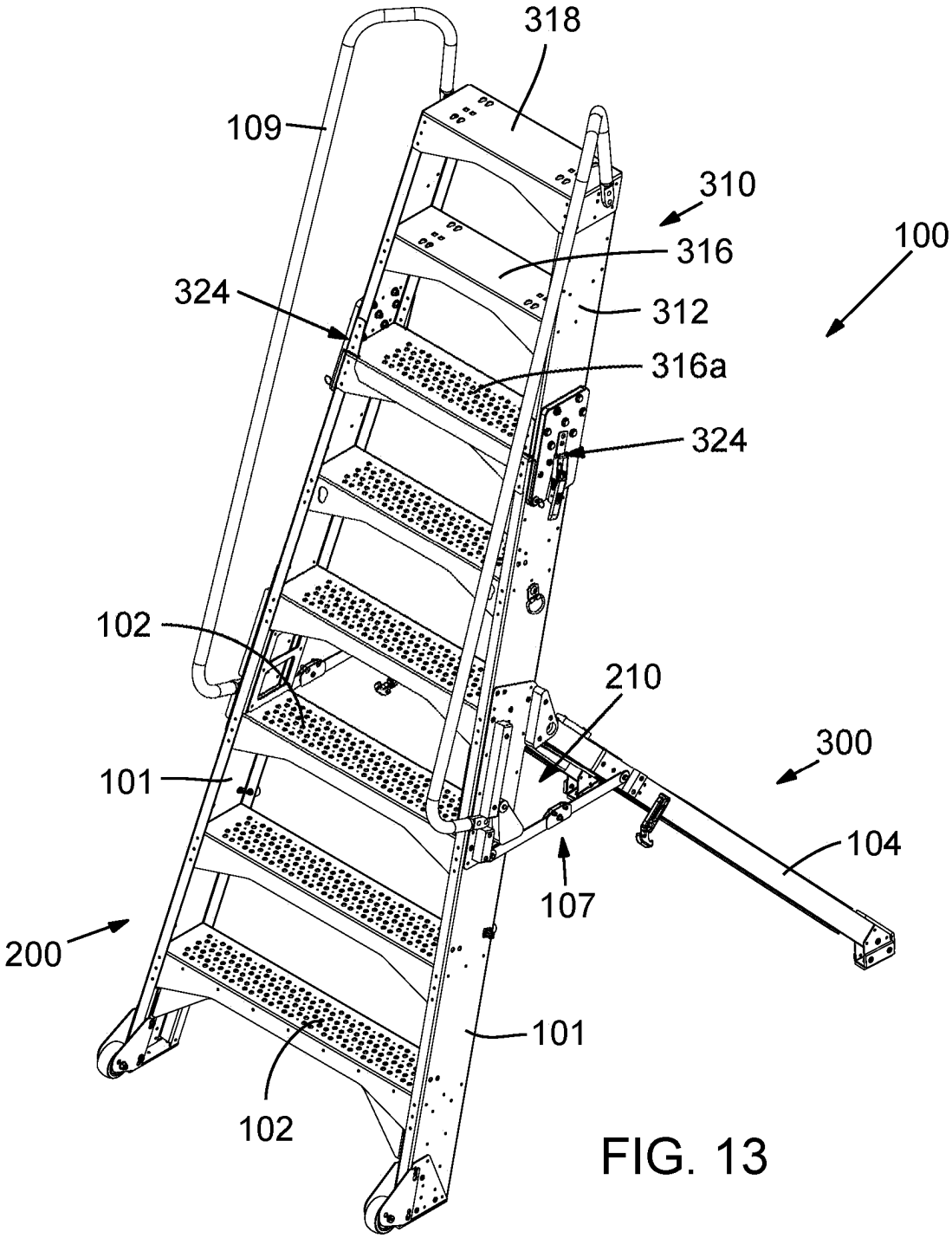
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FIG. 13

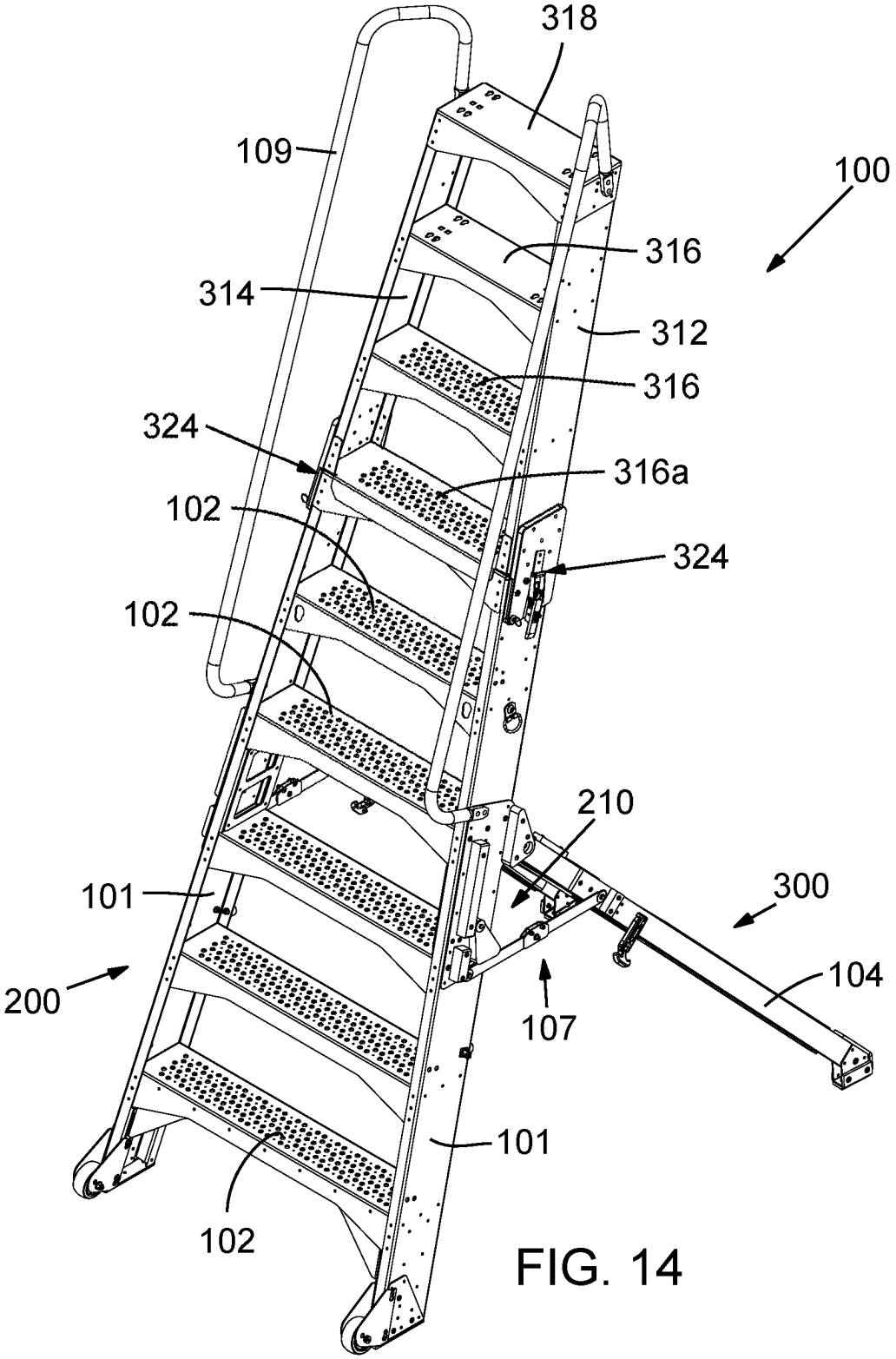
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FIG. 14

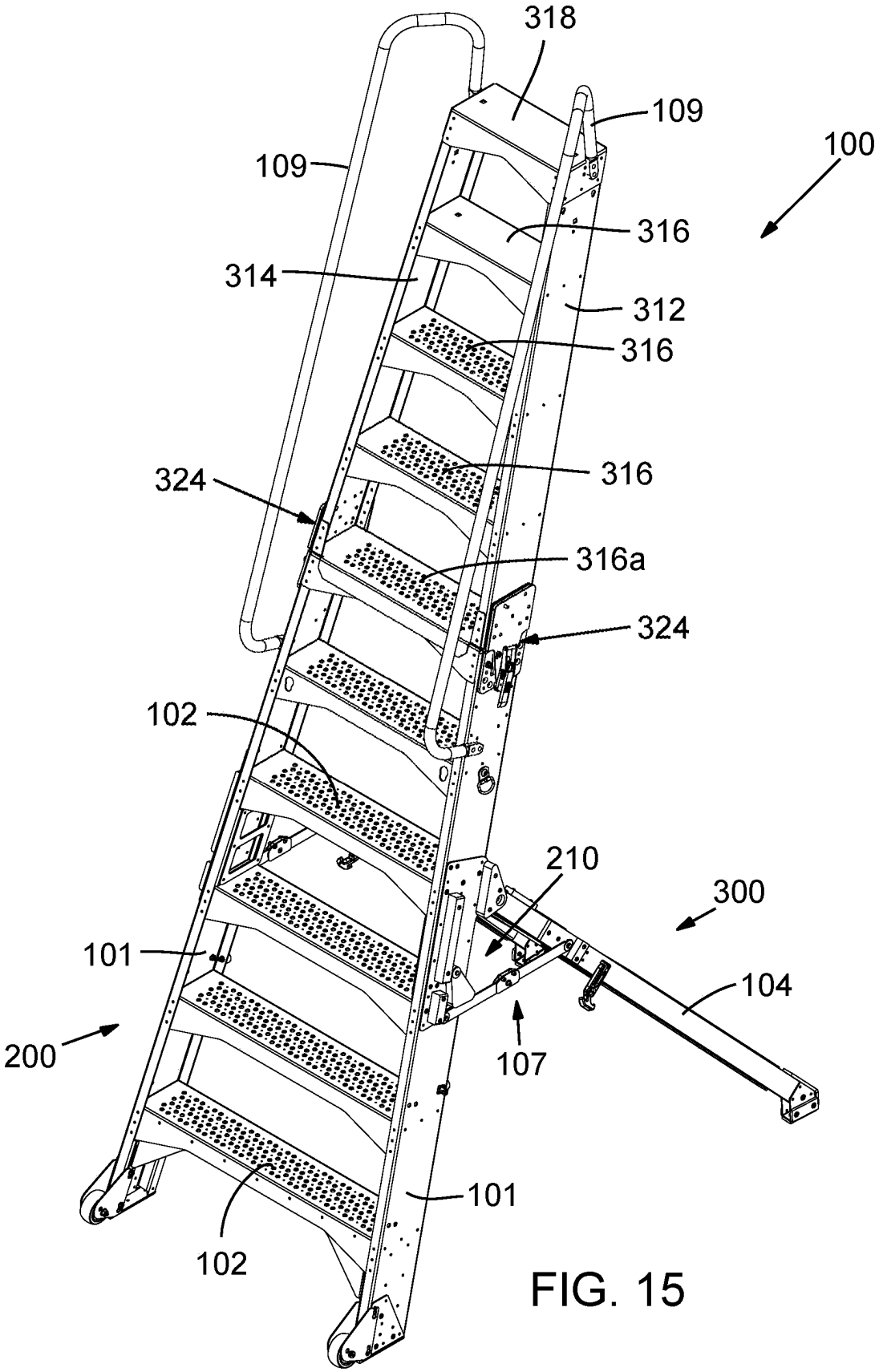
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FIG. 15

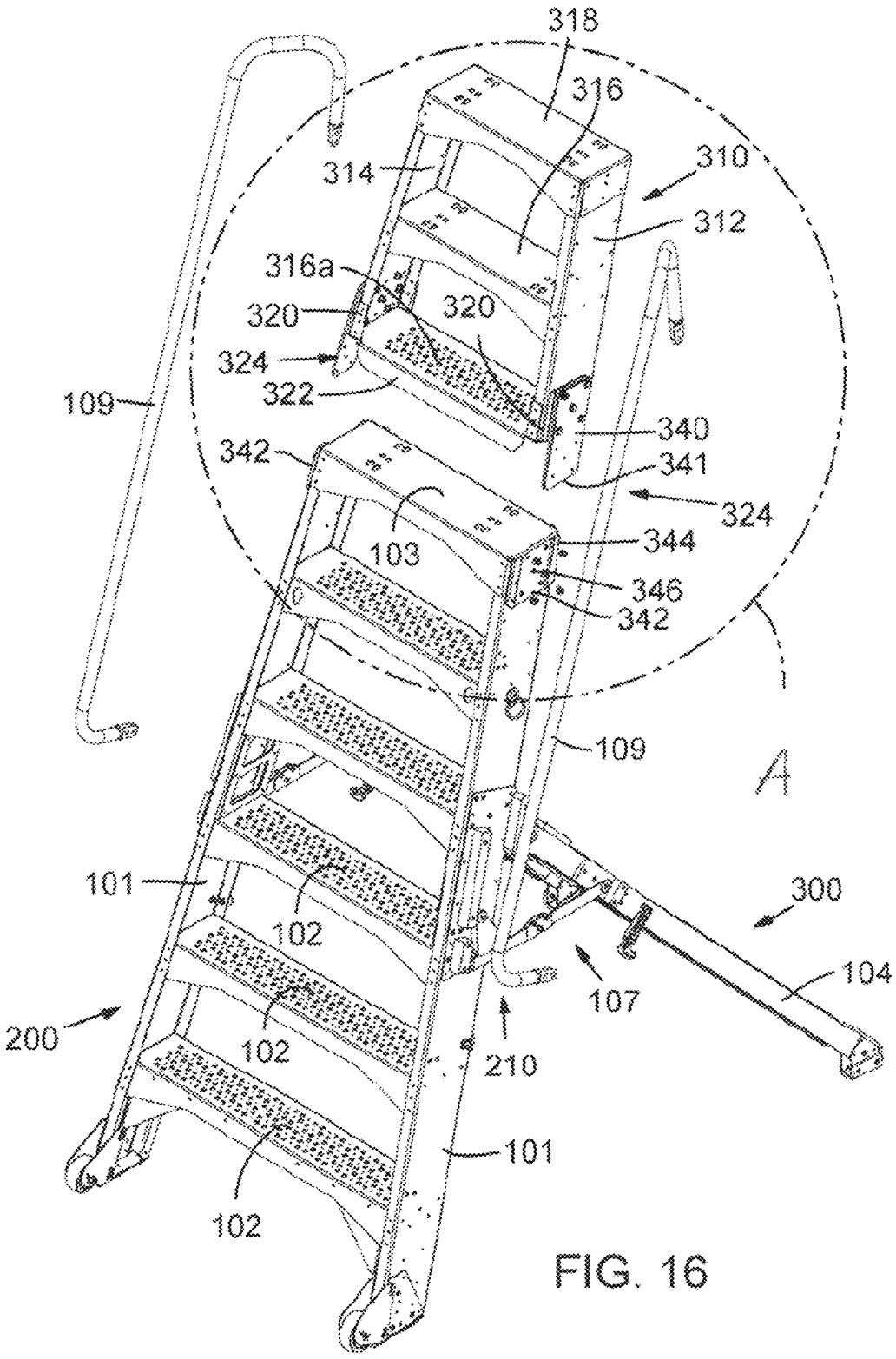
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FIG. 16

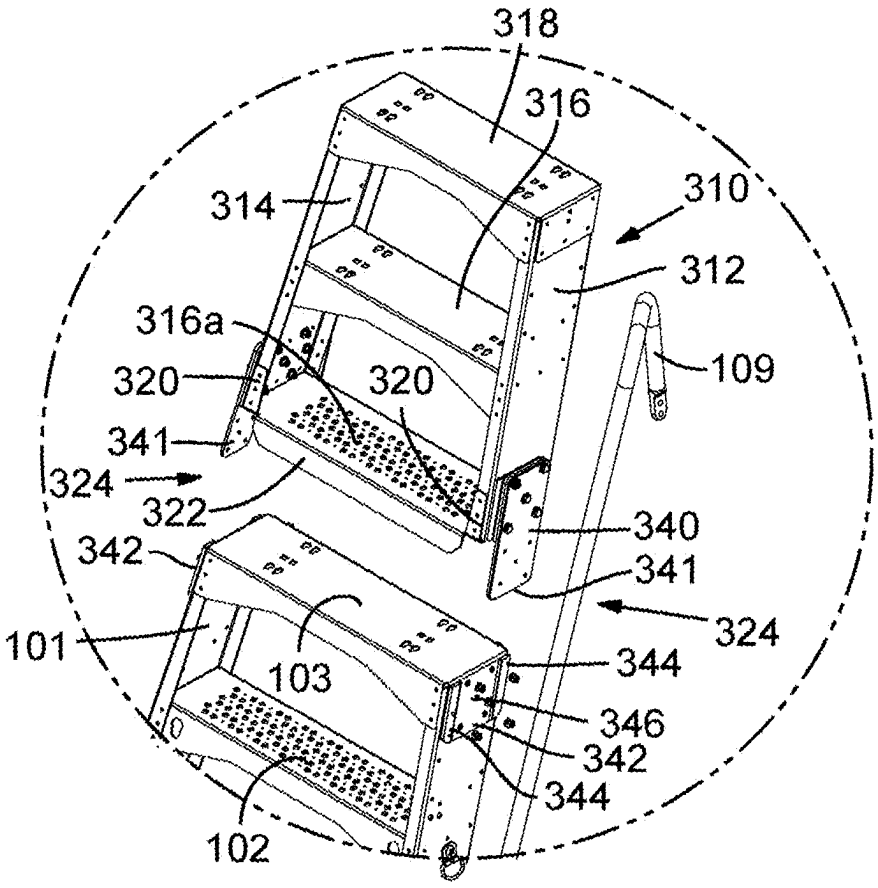
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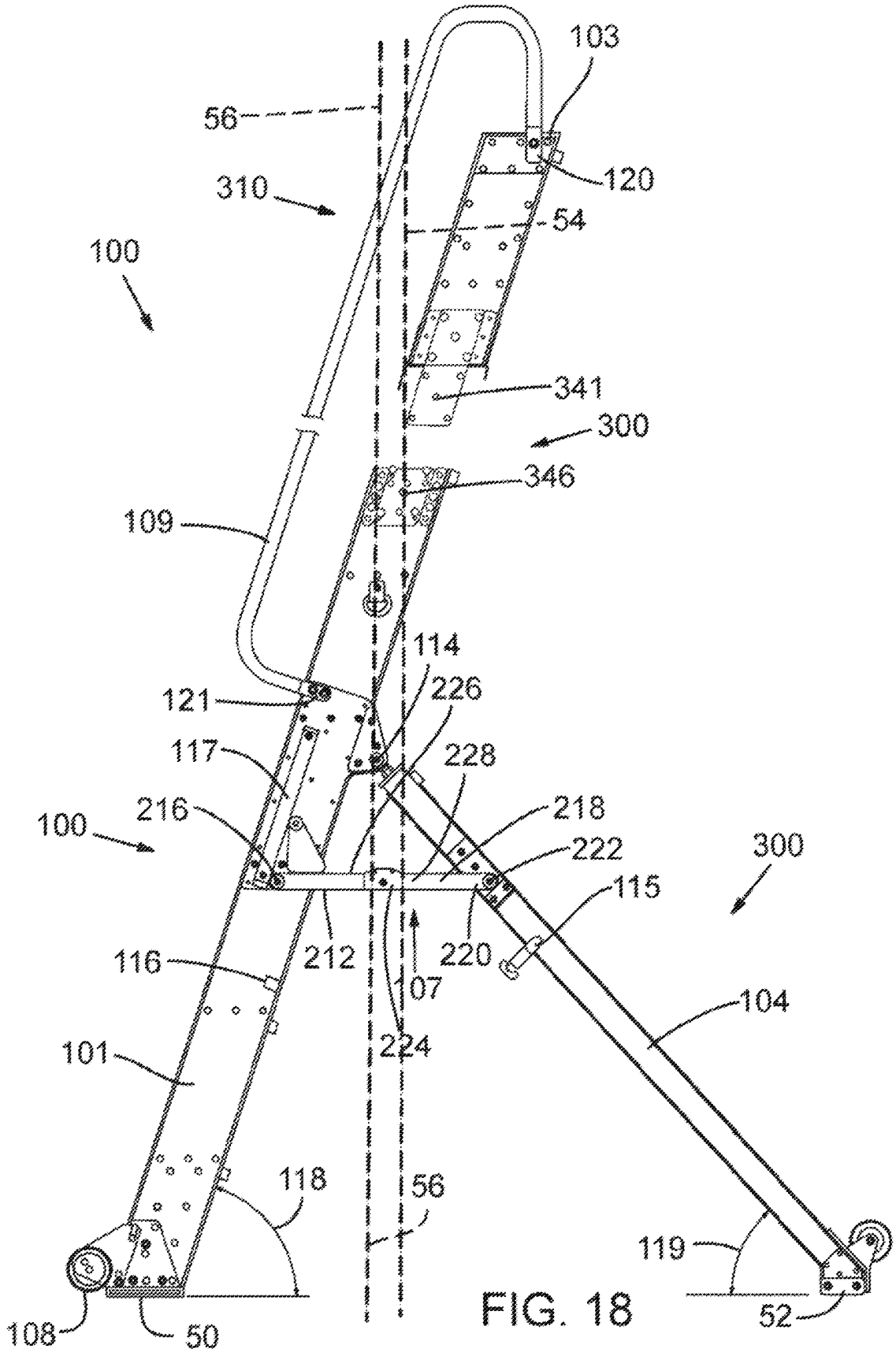
FIG. 17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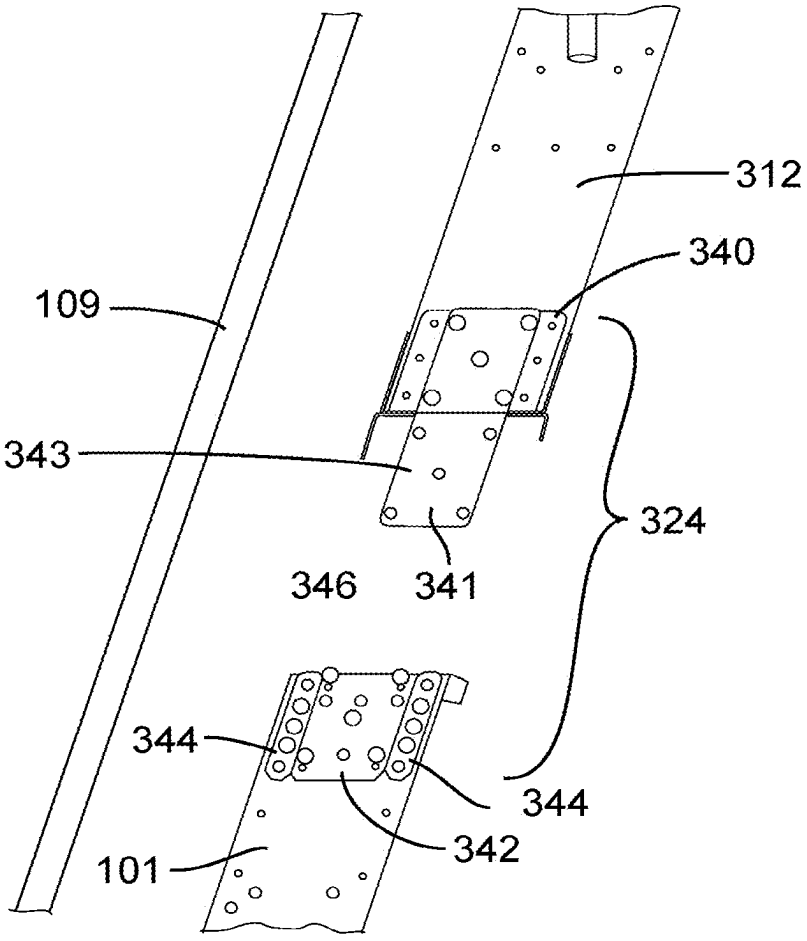

FIG. 19

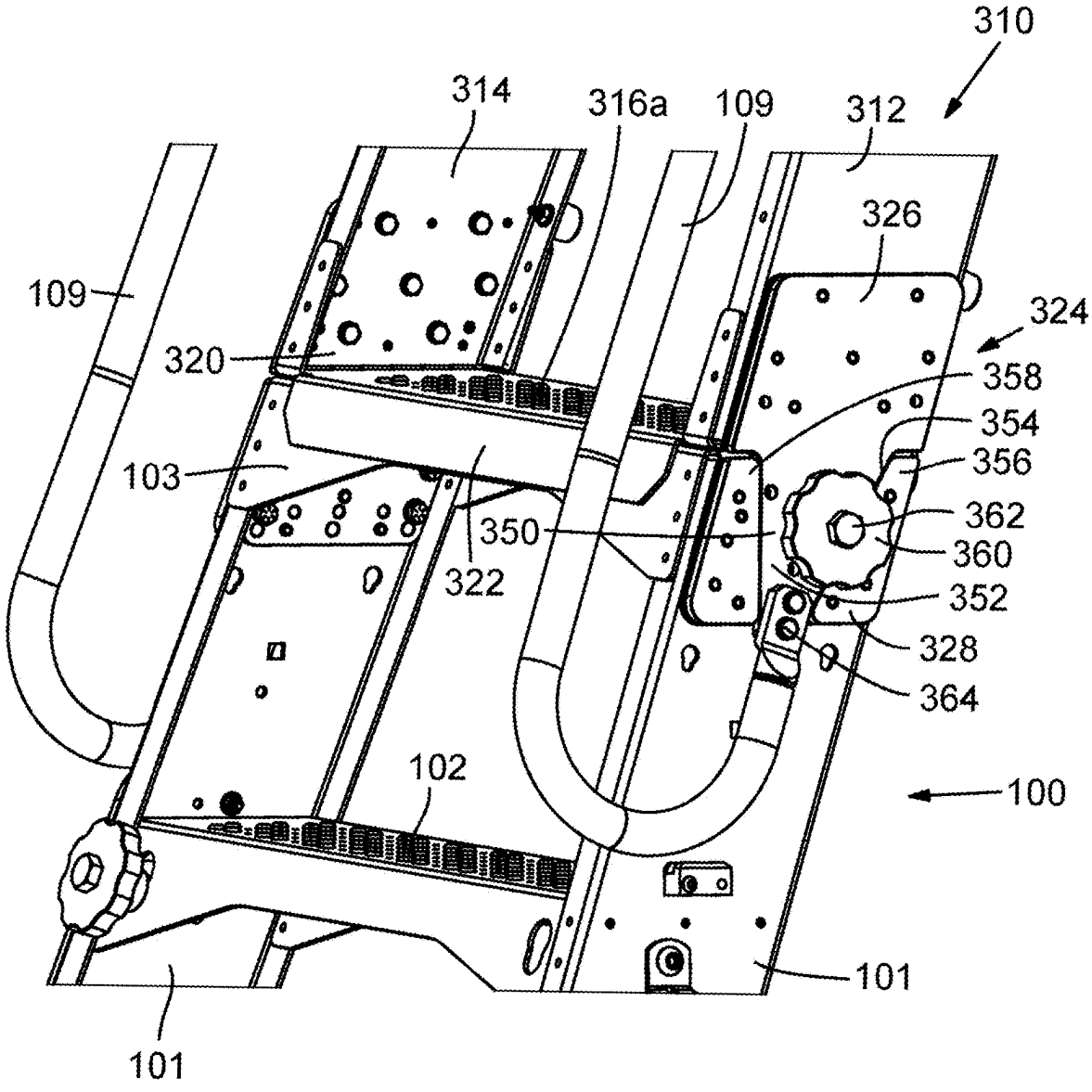
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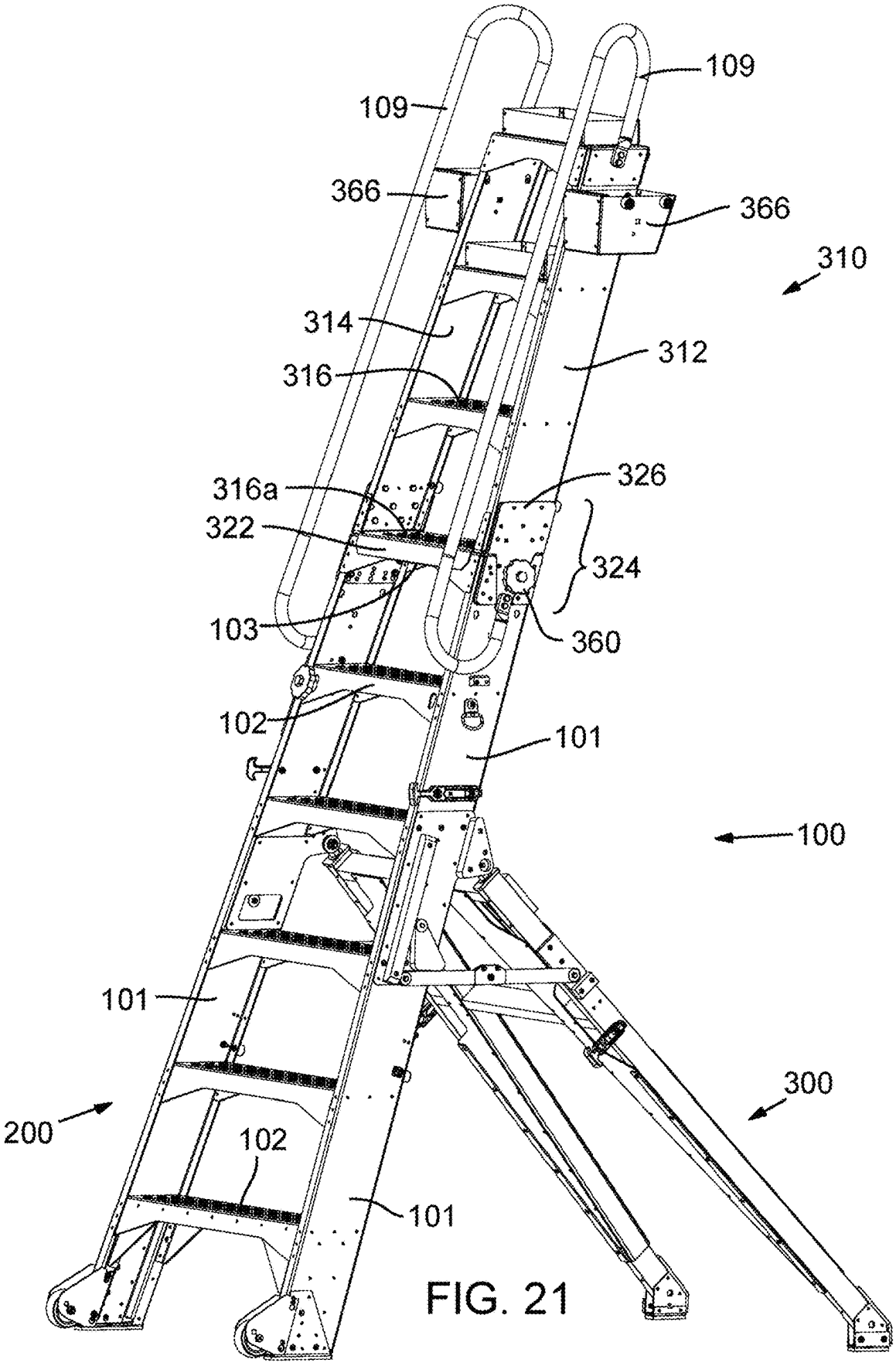
FIG. 20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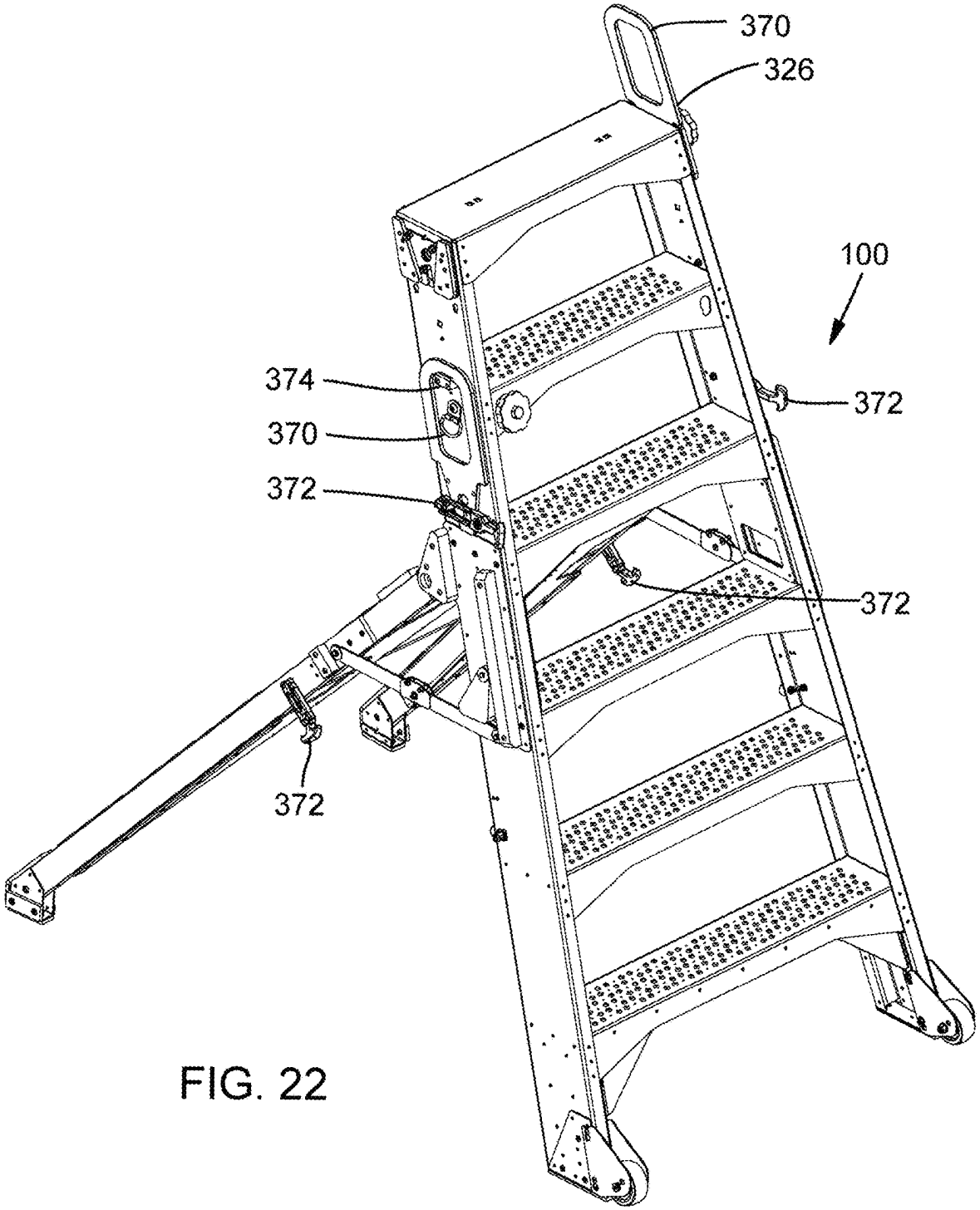

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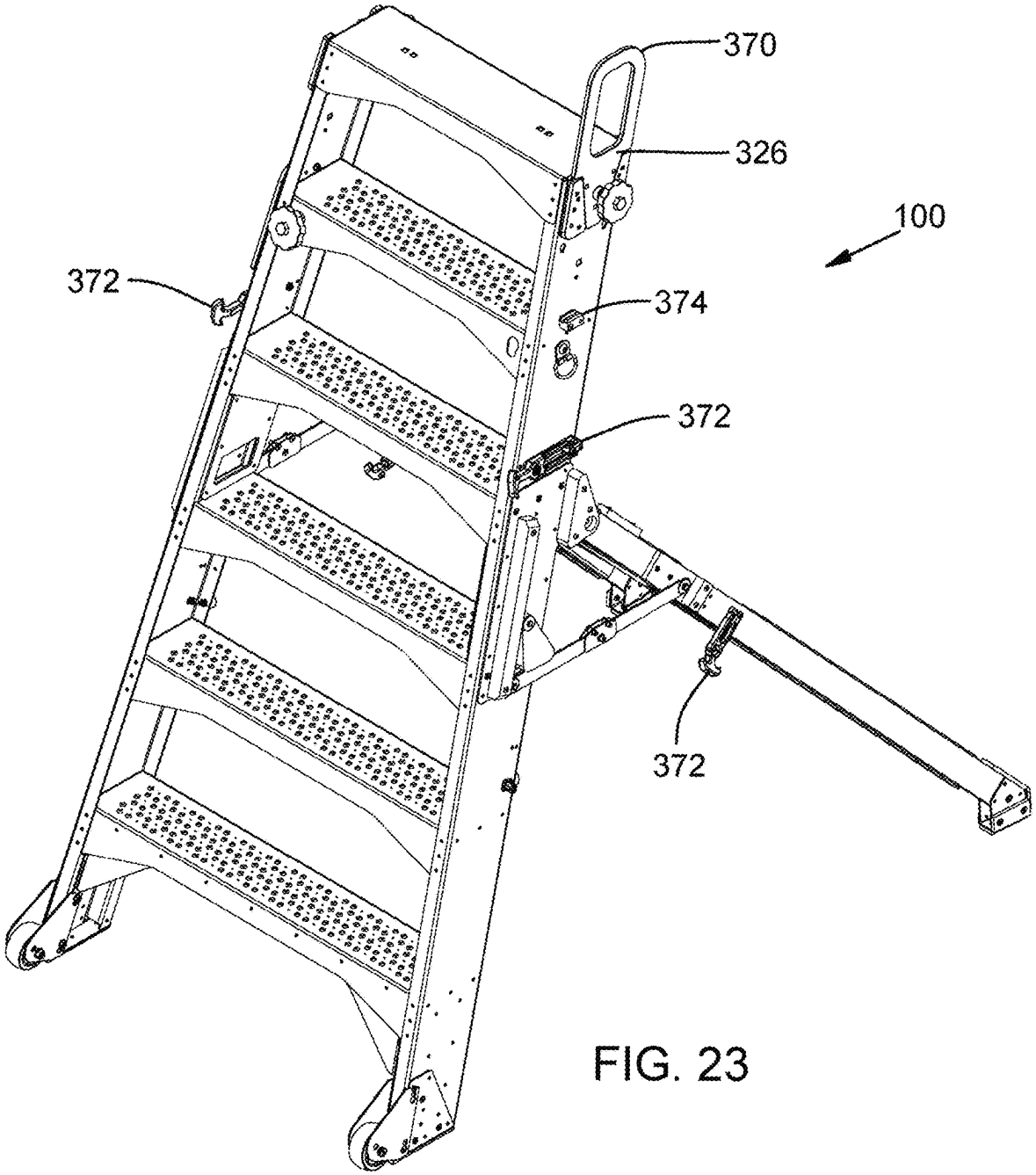

FIG. 23

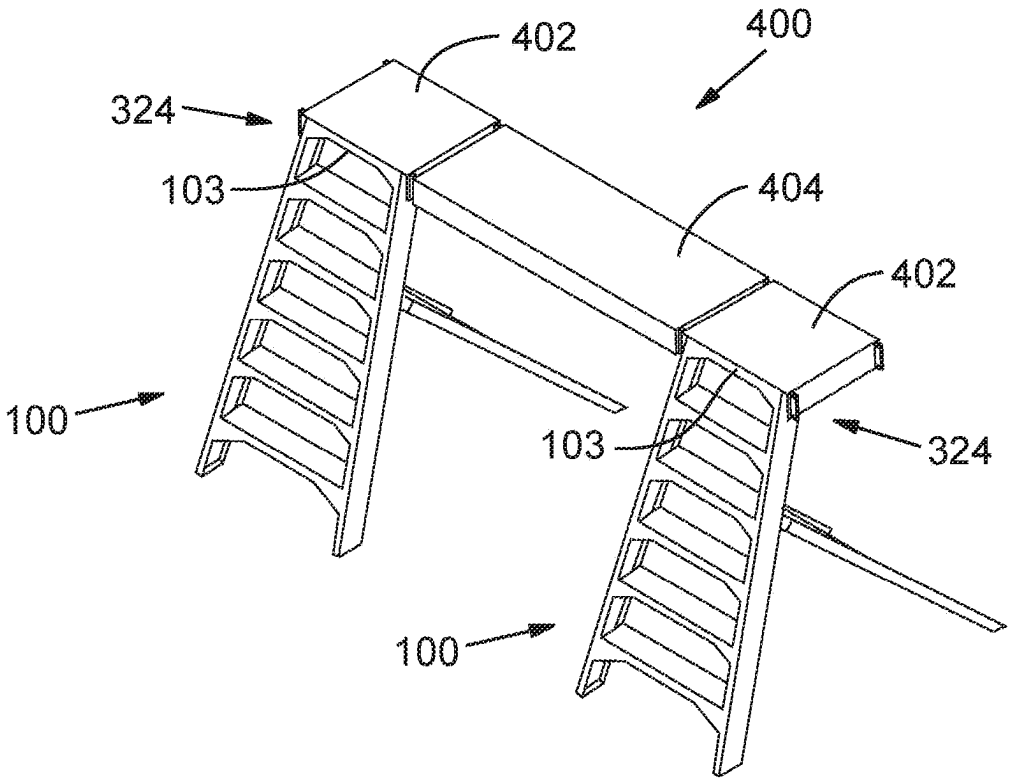

FIG. 24

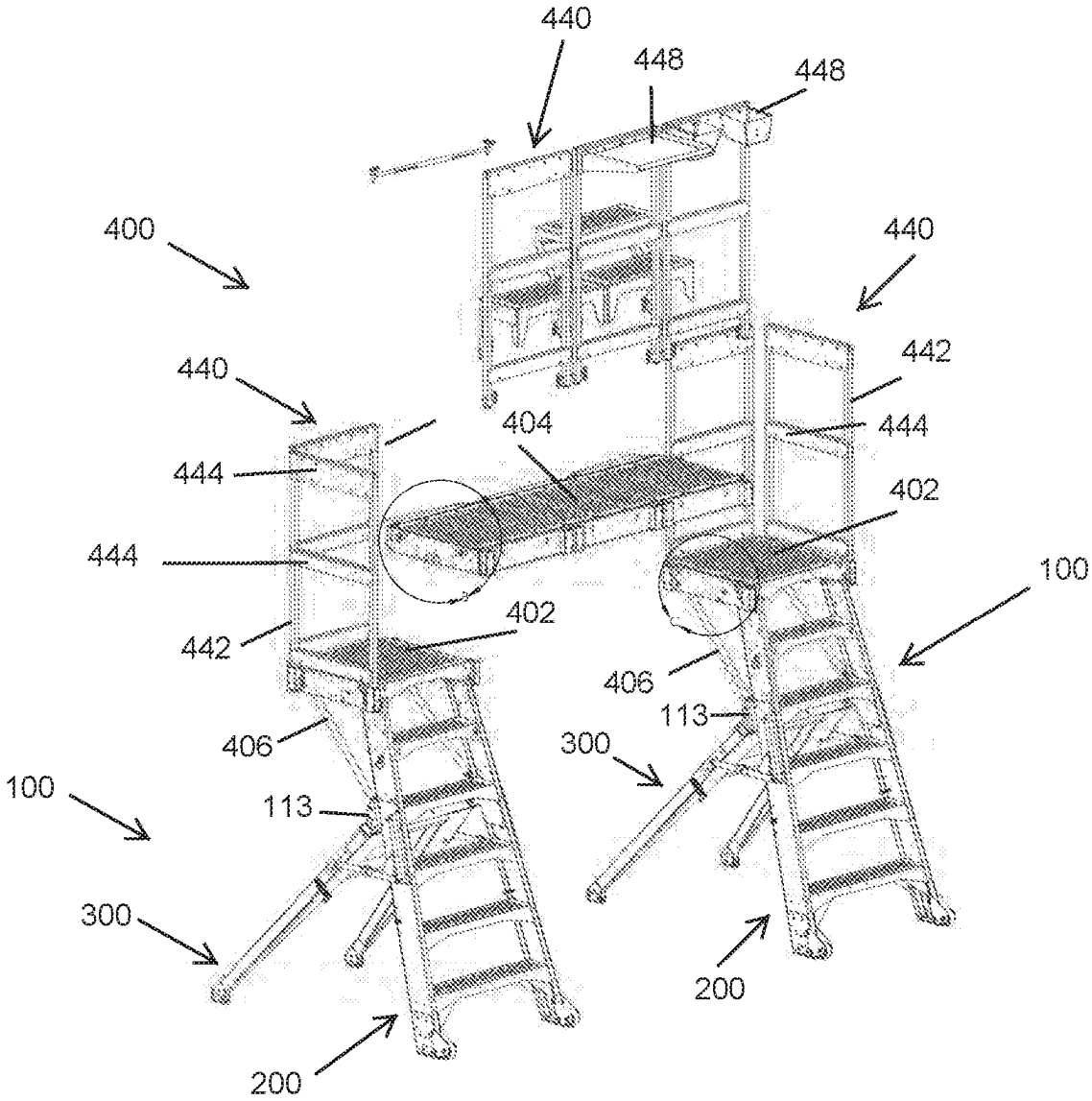
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Fig. 25

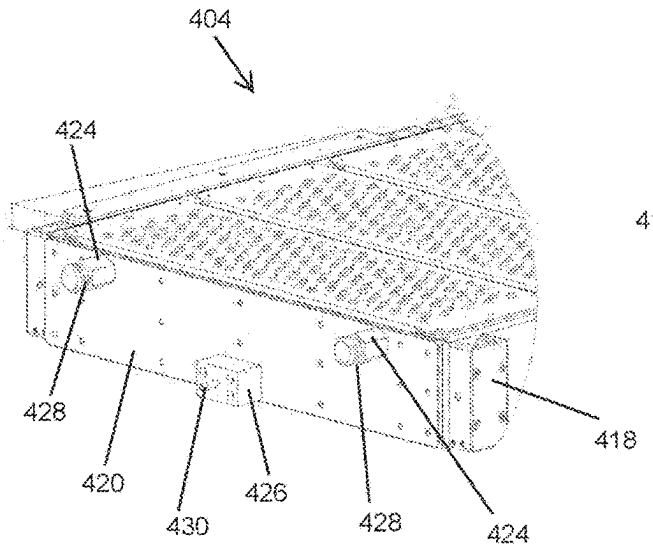
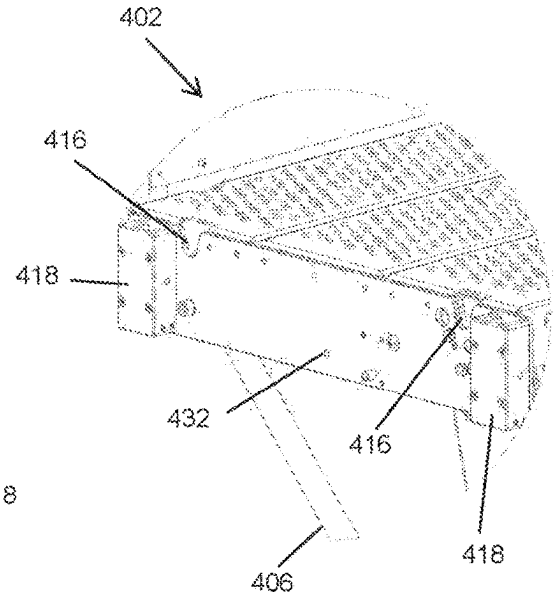


Fig. 25A



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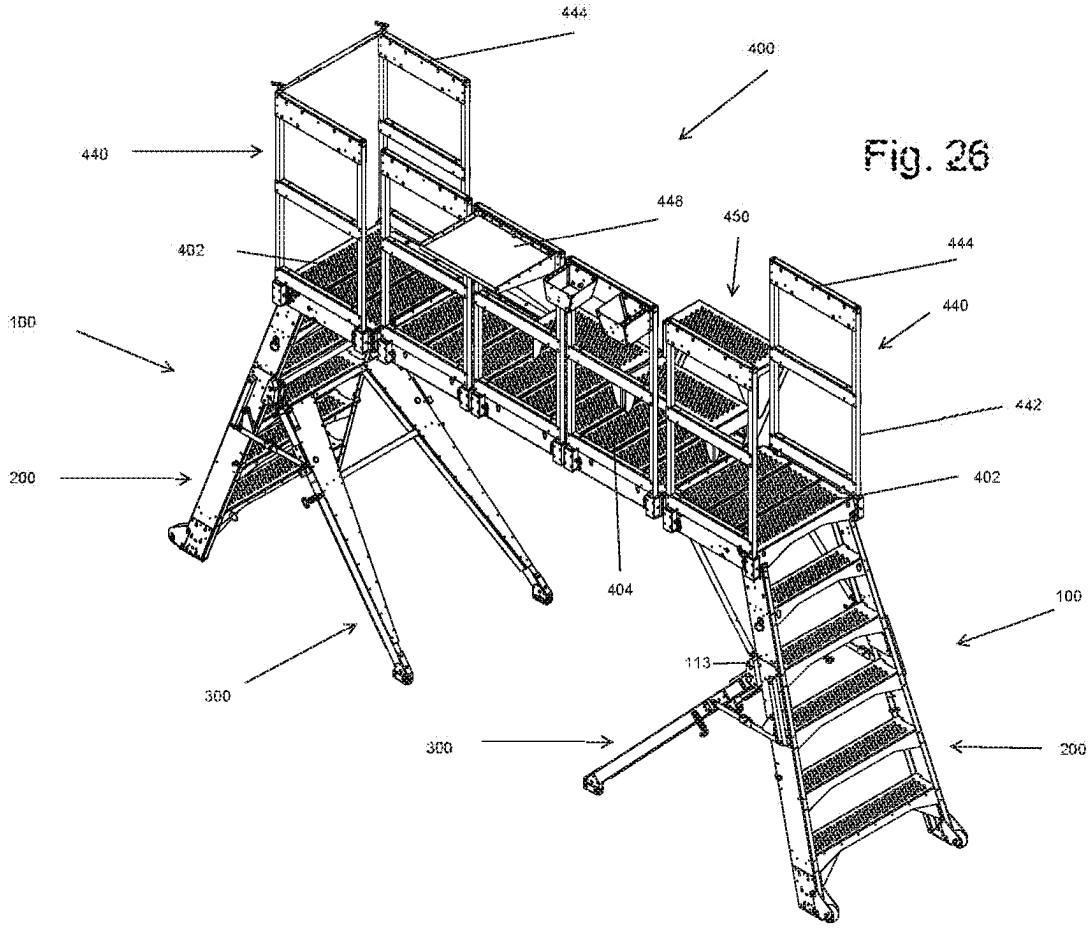
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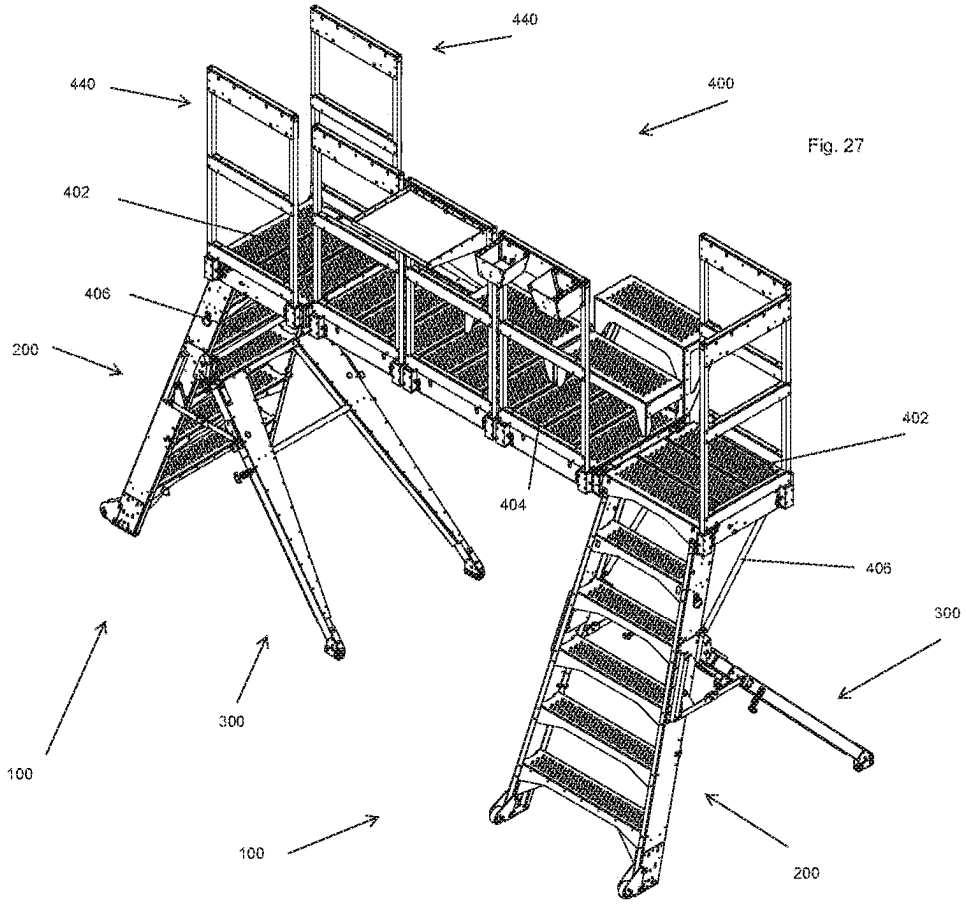
Fig. 26



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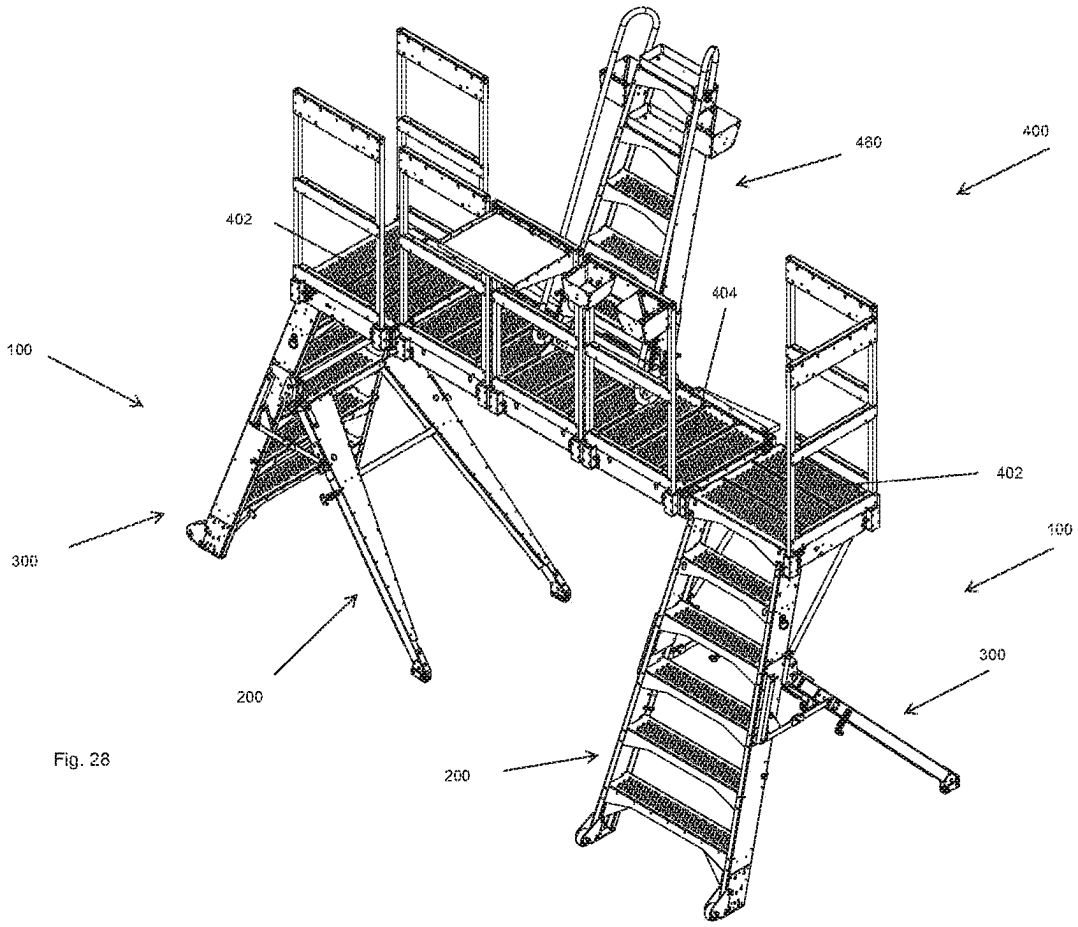

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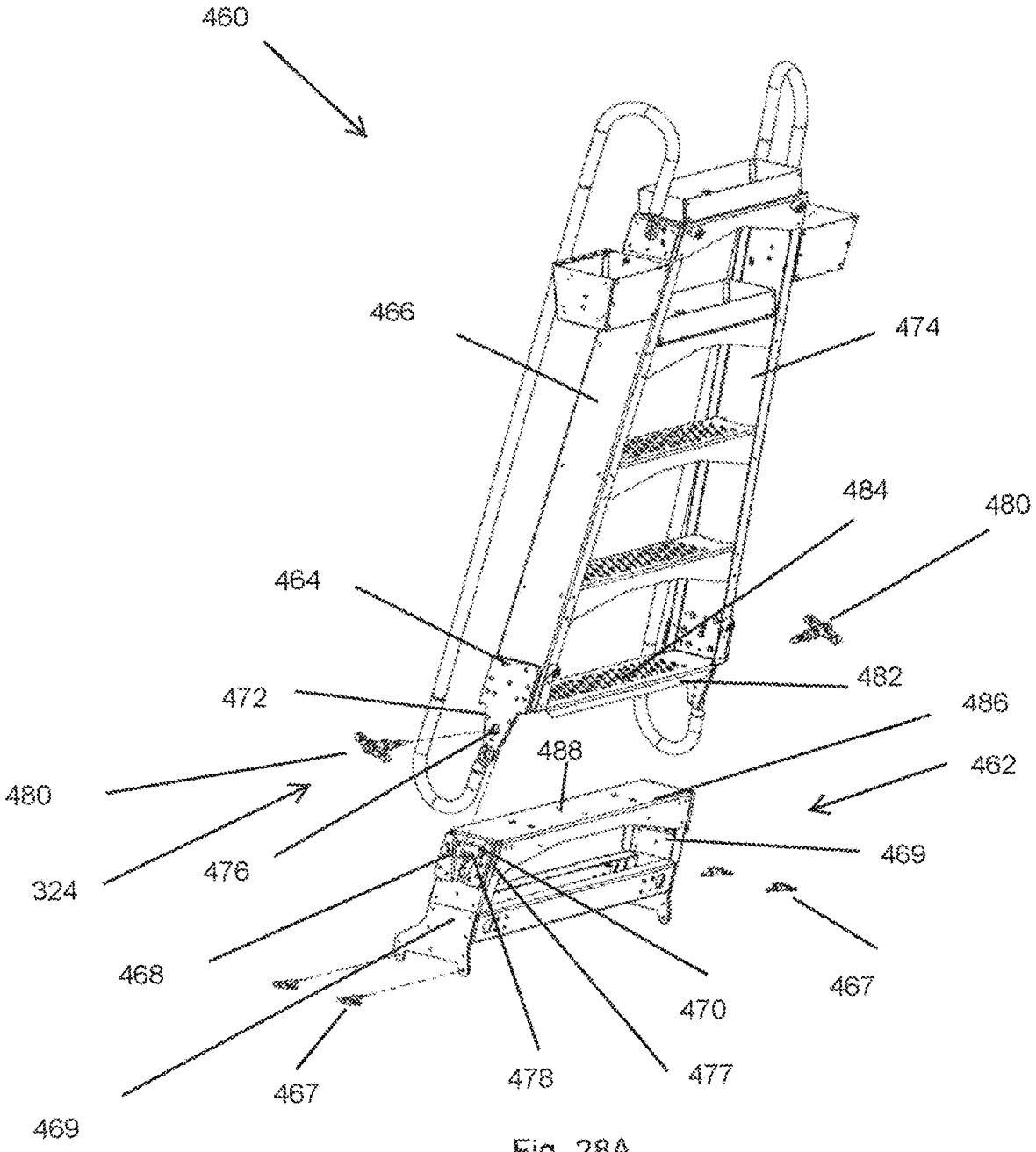
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Fig. 28A

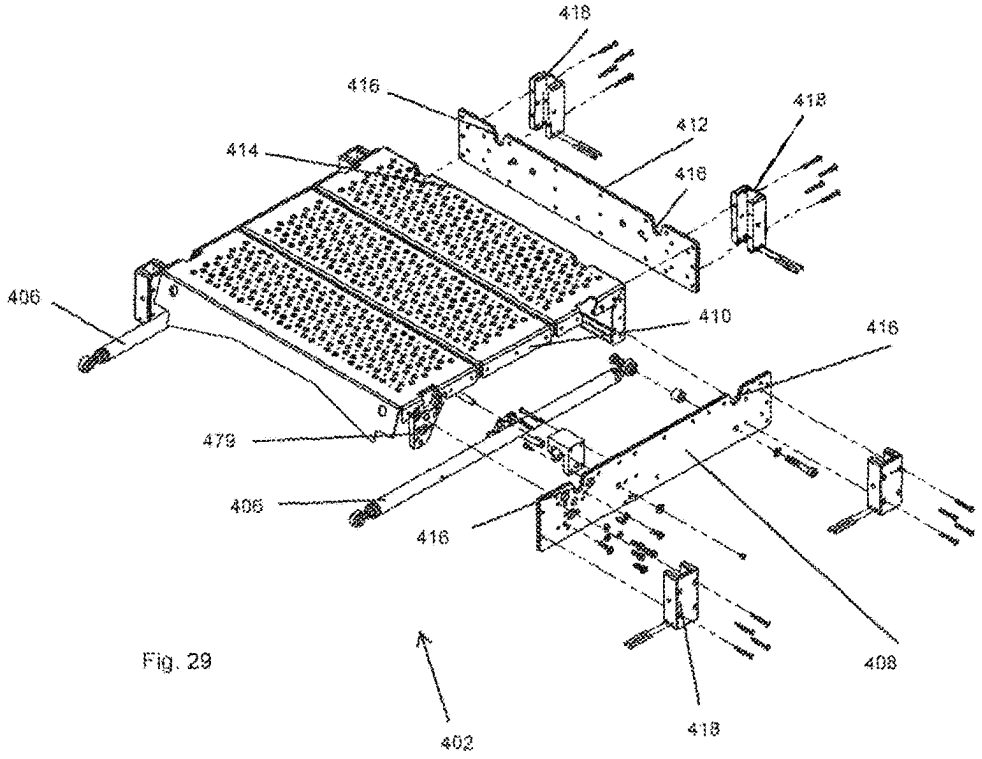
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Fig. 29

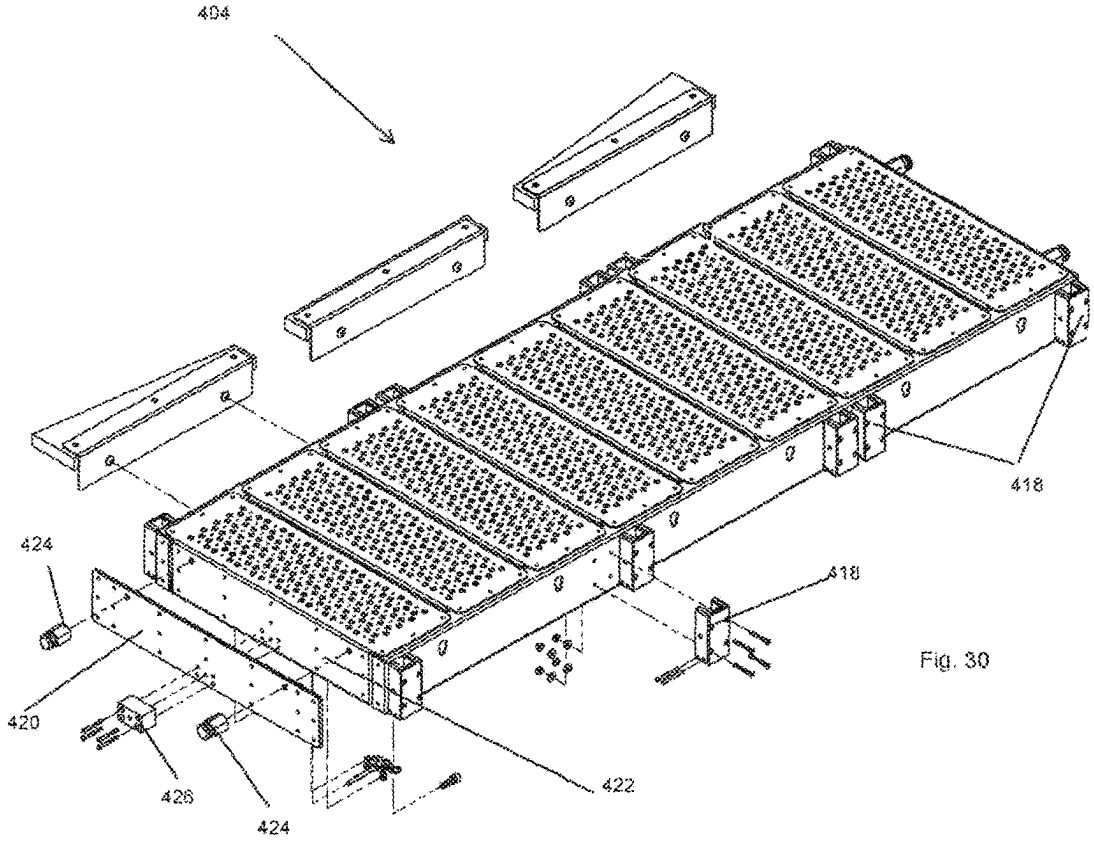
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Fig. 30

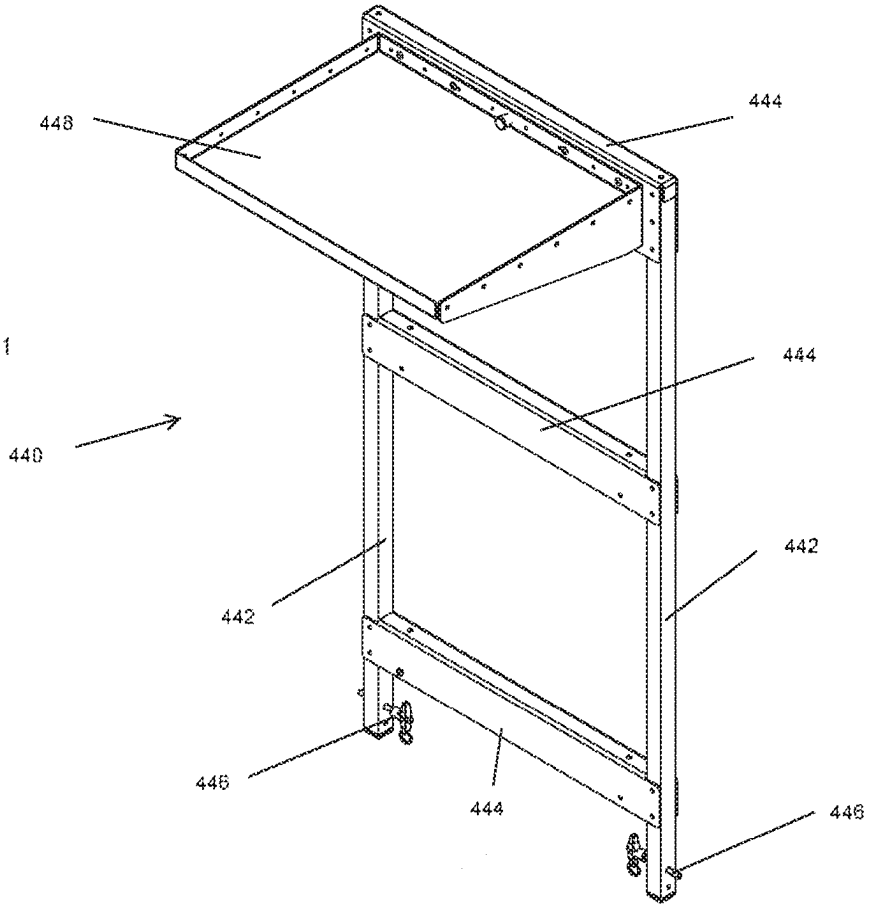


Fig. 31

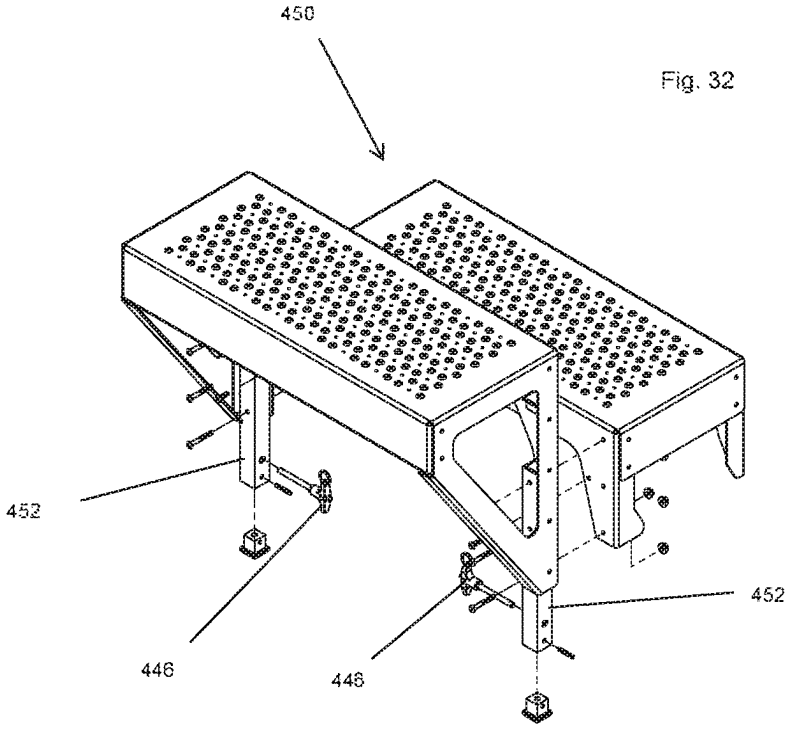


Fig. 32

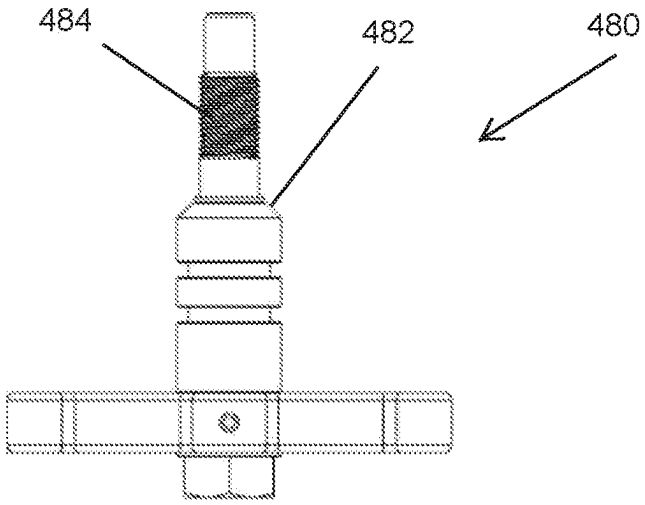
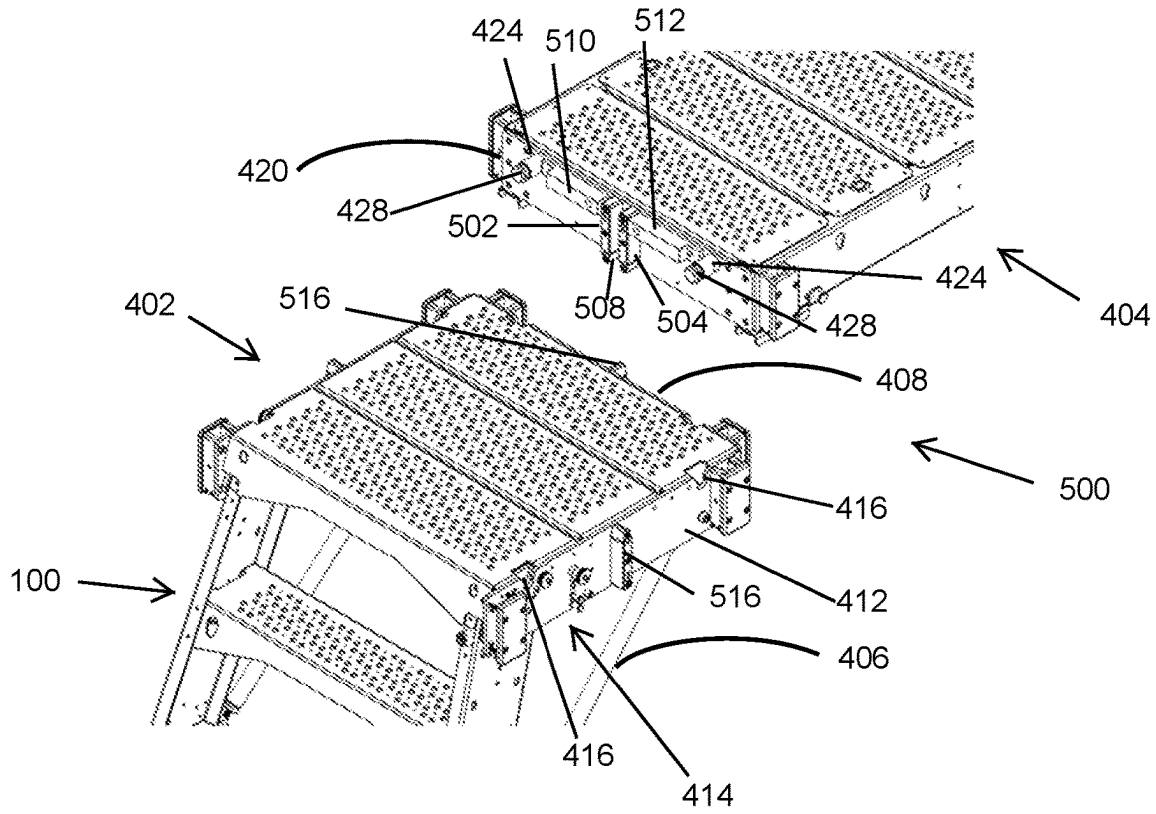


Fig. 33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414

Fig. 34

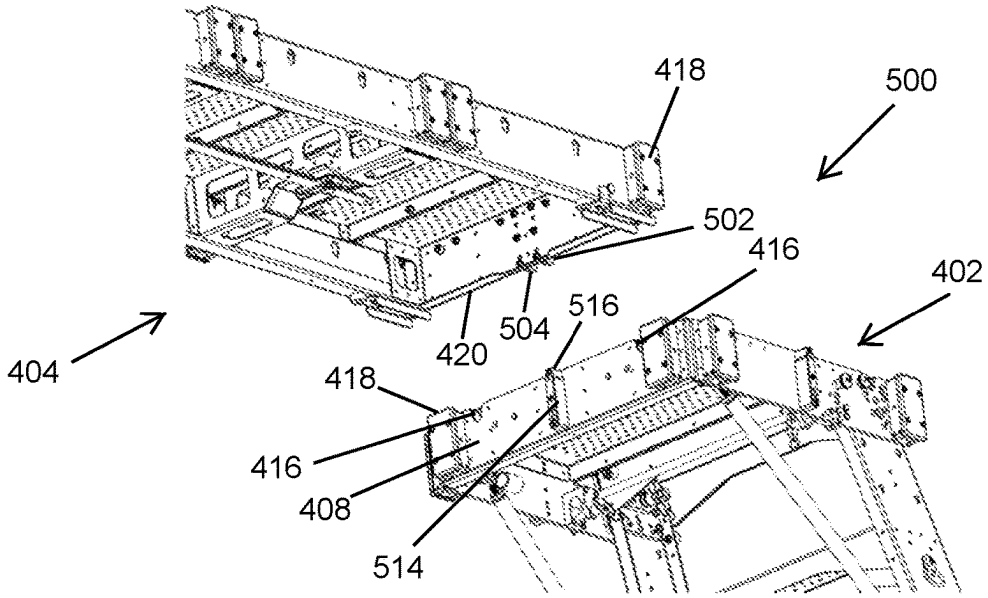
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Fig. 35

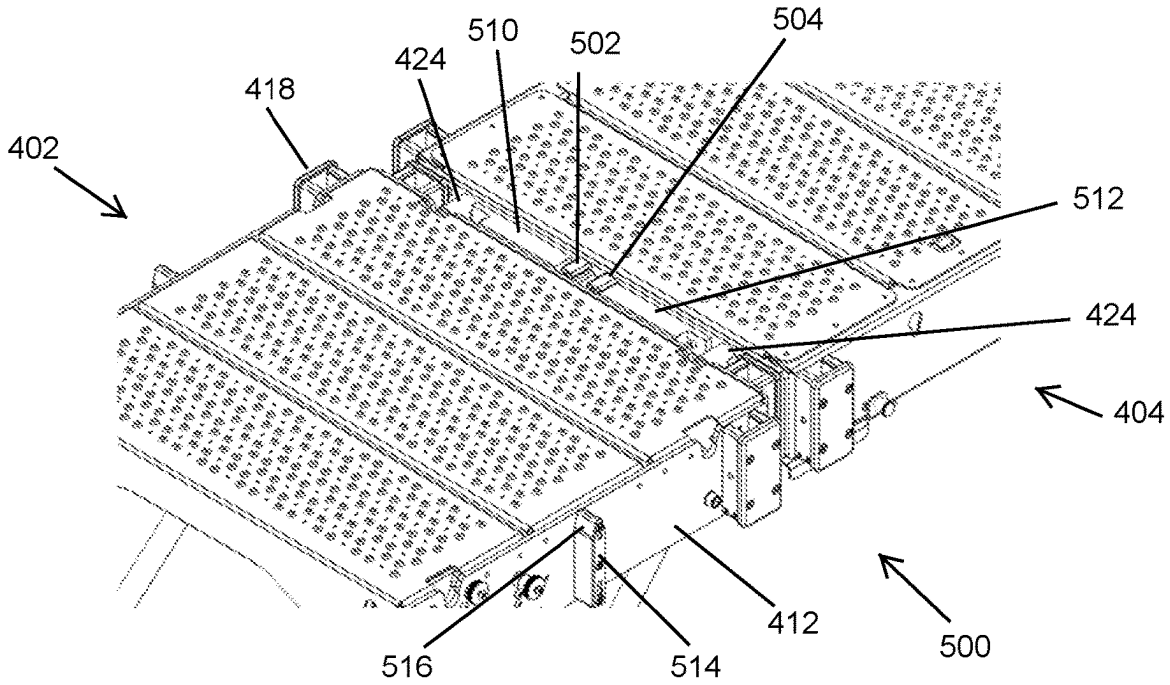
510
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Fig. 36

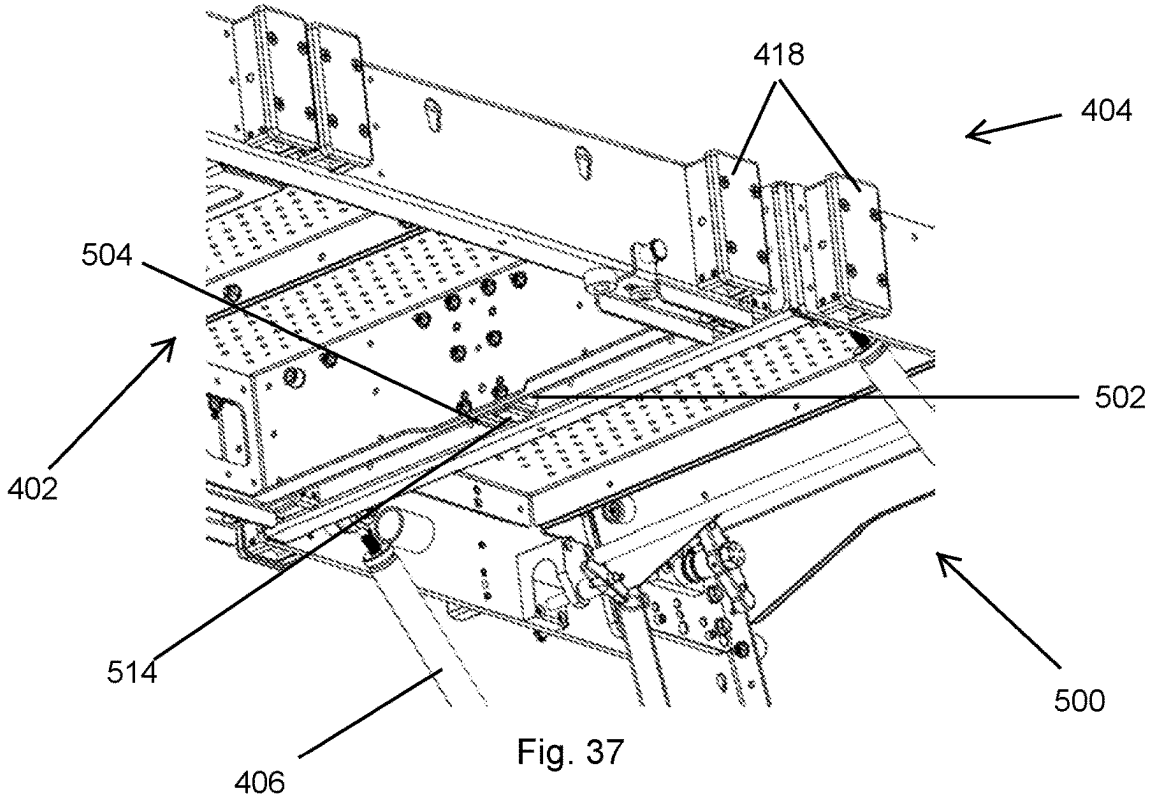
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Fig. 37

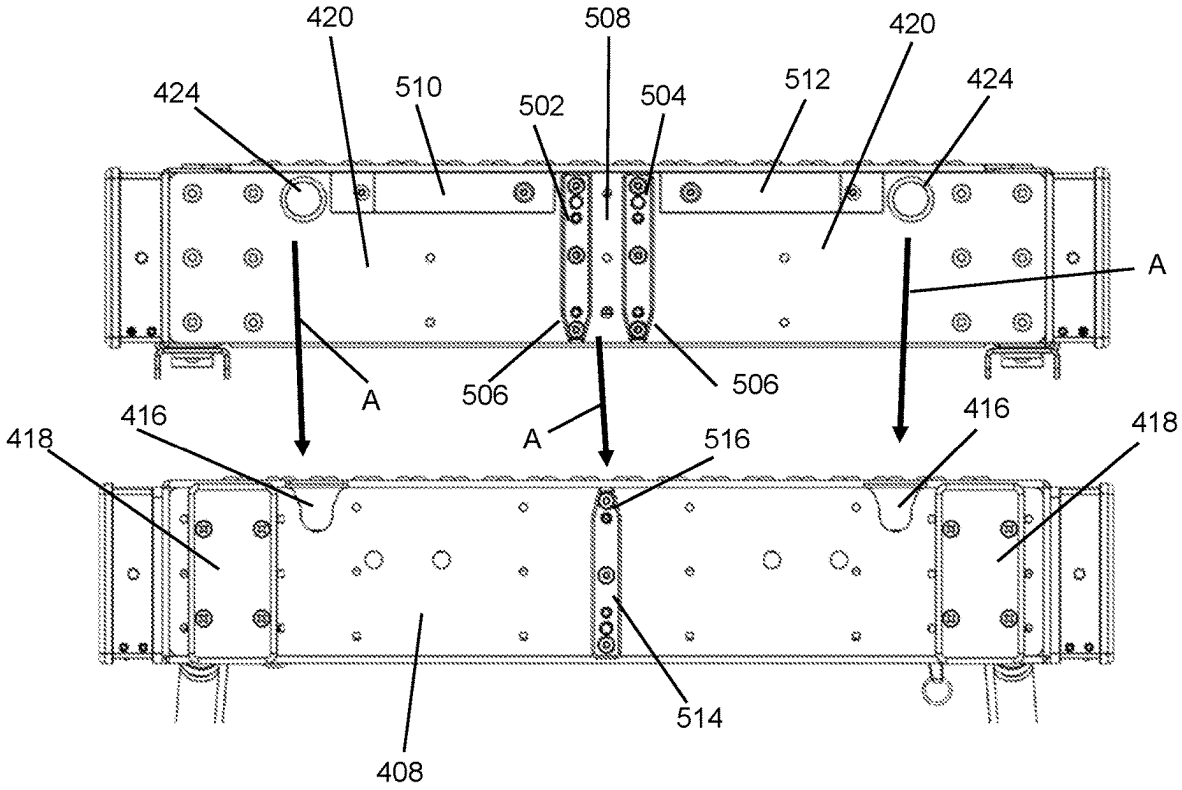
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Fig. 38

STABILIZATION AND ANTI-ROTATION APPARATUS FOR SCAFFOLDING SYSTEM

FIELD OF THE INVENTION

The present inventions are generally directed to light-weight moveable safety ladders and work platforms and more specifically to ladders and platforms that can be placed in close proximity to helicopters, aircraft and other vehicles or equipment in order to provide human workers with a safe and stable means of accessing, inspecting or servicing those and similar machines. More specifically, the inventions are defined by cantilevered ladders that are paired with scaffolding work platforms that attach to and extend between ladders, and an apparatus to stabilize and prevent rotation of the scaffolding work platforms relative to the ladders.

BACKGROUND INFORMATION

Aircraft, and most especially helicopters, require regular inspection and maintenance by trained mechanics. In order to gain close access to surfaces, parts or areas higher than can be reached while standing upon the ground, it is necessary to use a ladder or work platform of adequate height.

When work must be performed in the field, on the flight-line or elsewhere where no dedicated stationary platform is available, the mechanic will use a portable platform or ladder. Most frequently a conventional hinged aluminum folding-ladder is used. Such ladders are light in weight, can be carried by a single person and placed adjacent to the helicopter as required. Such ladders, however, are not stable. They can be hazardous when used correctly and dangerous when used incorrectly or when a mechanic is struggling to lift a heavy part or tool.

Furthermore, a conventional folding ladder cannot be positioned relative to the curved body of a helicopter in a manner so that the mechanic is positioned in close proximity to the aircraft. Whether placed parallel to or at an angle to the body of a helicopter, the poor fit of the ladder to the aircraft compromises the ability of the mechanic to perform his work and creates a hazardous condition when he is forced into awkward or unstable positions.

Lightweight, portable ladders or platforms that are truly safe, stable and which may be positioned so as to provide the kind of uncompromised access a mechanic requires are not known in the art. One product that is on the market is called the Aircraft MRO Pylon Ladder manufactured by Lock-N-Climb LLC (http://lockclimb.com/pylon-ladder/). This is a light-weight cantilevered aluminum stepladder that may be used for aircraft maintenance, but which fails to provide a truly safe and stable platform. This ladder is a conventional stepladder to which shortened support rails have been attached at about the mid-point of the stepped rails. To partially compensate for the shortness of the support rails, angled extensions have been affixed to the top end of those rails. It is apparent that the support legs will not fold flat against the stepped legs, thus making the ladder excessively bulky when in its folded position. The support legs are, of necessity, braced and cross-braced such that they cannot straddle the cross-tubes of a helicopter's skid assembly and would be unusable in many applications. Furthermore, because the support legs of the Pylon Ladder do not extend beyond the bottom of the stepped legs when the ladder is in the folded position and do not make a more acute angle to the ground than do the stepped legs when the ladder is in its open, operational, position, the Pylon Ladder would be expected to provide less than optimal resistance to forward tipping.

Folding step ladders are required by regulatory standards to have a locking mechanism on each side of the ladder that will prevent the spreader arms from articulating when the ladder is in use. More specifically, the purpose of this locking mechanism is to ensure that the ladder does not fold up when a worker is standing on the ladder rungs. The most conventional form of a locking mechanism is defined by the well-known braces that extend between the stepped side of the ladder and the support side of the ladder. The braces typically have a first elongate arm that is pivotally attached to a rail of the stepped unit, a second elongate arm that is pivotally attached to the support unit, and one-way locking hinge mechanism interconnecting the two elongate arms. In use, as the support unit is articulated away from the stepped unit to move the ladder to its open position, the braces are locked by pushing down on the one-way hinge mechanism. Doing so causes the spreader arms to align end-to-end or causes them to move into a slightly over-centered configuration. While no actual locking occurs at the brace mechanism, there is a frictional jamming that occurs and which is sufficient to ensure that the ladder will not collapse when stood upon.

The conventional spreader arm locks just described generally meet regulatory safety requirements and prevent an open ladder from closing when stood upon. These locks, however, do not engage automatically, and they require that the user push down the lock to fully engage the locking hinge mechanism when the ladder is opened. Failure to perform this action negates this safety feature and the ladder can accidentally collapse when in use. Moreover, the spreader arms may be inadvertently moved away from the locked position when the ladder is jostled and jarred as it is moved from one position to another. This has the potential of causing a dangerous condition where the spreader arms collapse when a user climbs the steps.

Additionally, most folding ladders have a fixed length. There are many known types of extension ladders, and there are known examples of folding or step ladders that have the ability to be extended. For example, some manufacturers have combined the structures of conventional extension ladders with folding step ladder design. But since many ladder users require ladders of varying lengths (as evidenced by the popularity of conventional extension ladders), there is a need for folding ladders that are able to be of multiple lengths and which are safe for the users.

SUMMARY OF THE INVENTION

It is an object of the invention to devise a portable ladder that can be manipulated by one person and be placed in close proximity to a helicopter, an aircraft or to another piece of equipment.

It is an object of the invention to devise a portable ladder than can closely nest with the curved body of a helicopter, aircraft or equipment and by so doing, provide ready access to a variety of surfaces and areas.

It is an object of the invention to have the ability to clear, straddle or otherwise avoid interference with portions of the aircraft or other equipment to which the ladder is being placed adjacent.

It is an object of the invention to provide enhanced access to the upper portions of otherwise difficult to access parts, such as to the rotor assembly of a helicopter.

It is an object of the invention to provide enhanced stability in comparison to conventional step ladders.

It is an object of the invention to provide stepped rungs upon which a person can stand that are cantilevered with respect to the attachment point of the supporting legs.

The ladder described in this invention has two pairs of legs (commonly known as "rails"). Typically, one pair of rails is longer than the other. The longer pair is interconnected with rungs or steps and designed to be stood upon. The shorter pair of rails is interconnected with bracing and designed to provide stability. The longer pair of rails when connected with steps or rungs is hereafter referred to as the 'stepped unit'. The shorter pair of rails when connected with bracing is hereafter referred to as the 'support unit'.

The two units are attached to each other at a hinge-point located some distance below the top of the stepped unit. The two units are further attached to each other by a brace which can retract when the ladder is in the folded position and can extend to hold the ladder in the open position.

When in the folded position, the two units are ostensibly parallel and in close proximity to one another. In the folded position, the lower portion of the support unit extends beyond the lowest portion of the stepped unit.

When unfolded and locked in place by the side braces, the two units are held at different angles with respect to the ground. The angle of the stepped unit is typical of a conventional folding ladder. The angle of the support unit is more acute.

The hinge point is typically located within about the middle third of the stepped unit. The upper portion of the stepped unit is thus cantilevered with respect to the hinge point. The ladder is constructed of materials sufficient to permit a person to stand one or more rungs above the hinge point.

When the ladder is placed at approximately right angles to the aircraft, the curved body of the aircraft fits within the space defined by the stepped and support units. By selecting appropriate rail lengths and an appropriate attachment point location, ladders can be tailored to fit specific aircraft profiles.

Another object of the present invention is to provide a mechanism that physically locks the spreader arms so that they are prevented from articulating inadvertently when the ladder is being stood upon.

Objects of the invention include locking the spreader arms so they are prevented from articulating when the ladder is tilted back toward the operator and the support rails are lifted into the air and to physically lock the stepped rails and the support rails at a fixed distance apart, a distance that will not increase when the operator stands upon the ladder.

Yet another object of one aspect of the invention is to provide a fully automatic mechanism for locking the spreader bars relative to one another.

In another aspect of the invention, an object is to provide an extension module that may be securely coupled to the ladder of the invention to effectively increase the working height of the ladder.

In yet another aspect of the invention, an object is to provide apparatus for stabilizing a work platform such as a scaffolding platform that is interconnected between two ladders according to the invention, and to prevent rotation of the work platform as loads are applied to the platform.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features of the invention will be apparent from the following, more particular descriptions of exemplary embodiments of the invention, as illustrated in the accompanying drawings. Like reference numbers indicate identical or functionally and/or structurally similar elements.

FIG. **1** is a perspective view of a first embodiment of the present invention in which the support unit is hinged to the stepped unit within about the middle third of the length of the stepped unit.

FIG. **2** illustrates an embodiment of the portable ladder according to an embodiment of the invention with the ladder nested in close proximity to a helicopter.

FIG. **3** is an isometric view of an embodiment of the support unit according to the invention braced such that it can straddle objects between the support rails.

FIG. **3***a* is an enlarged perspective view of the rod end ball joint used as a hinge mechanism in the embodiment shown within FIG. **3**.

FIG. **4** is a side elevation view of an embodiment of a portable ladder according to the invention in an open position where the angle measured between the ground and the stepped unit is greater than the angle between the ground and the support unit.

FIG. **5** is a side elevation view of an embodiment of a portable ladder in a folded position in which the support unit extends beyond the bottom of the rails of the stepped unit.

FIG. **6** is a close up side elevation view of a brace locking mechanism according to the present invention, illustrating the mechanism in the locked position when the ladder is in the open, working position.

FIG. **7** is a side elevation view of the brace locking mechanism shown in FIG. **6**, illustrating the mechanism being moved out of its locking position to an open position so that the ladder may be folded into its storage position; in FIG. **7** the ladder is shown in an intermediate position between the open, working position and the folded, storage position.

FIG. **8** is a side elevation view of the brace locking mechanism shown in FIGS. **6** and **7**, and is a sequential step showing the mechanism as the ladder is moved fully into the storage position.

FIG. **9** is an upper perspective view of one embodiment of a ladder according to the invention, showing the ladder in the working position; the ladder shown in FIG. **9** incorporates structures that allow extension modules to be attached to the ladder.

FIG. **10** is an upper perspective view of one embodiment of a ladder according to the invention, showing the ladder in the working position, with an extension module juxtaposed adjacent the ladder in exploded view.

FIG. **11** is a close up perspective and exploded view of the upper end of the ladder shown in FIG. **10**, showing in exploded view a first embodiment of a coupling mechanism according to the invention for secure attachment of an extension module to the ladder.

FIG. **12** is a close up, perspective and exploded view the close-up circle of FIG. **11** to illustrate the coupling mechanism.

FIGS. **13** through **15** show three different ladders according to the invention in which extension modules of different lengths have been securely coupled to the ladder in order to extend the working length or height of the ladder. Specifically:

FIG. **13** is an upper perspective view of one embodiment of a ladder according to the invention, showing the ladder in the working position, wherein the ladder shown has an extension module of a first length secured in place.

FIG. **14** is an upper perspective view of another embodiment of a ladder according to the invention, showing the ladder in the working position, wherein the ladder shown has an extension module of a second length secured in place.

FIG. **15** is an upper perspective view of another embodiment of a ladder according to the invention, showing the ladder in the working position, wherein the ladder shown has an extension module of a third length secured in place.

FIG. **16** is a perspective and partially exploded view of a ladder according to the invention and illustrating a second embodiment of a coupling mechanism that may be used to secure an extension module to the ladder base.

FIG. **17** is a close up, perspective and exploded detail view of area A FIG. **16**.

FIG. **18** is a side elevation view and partially exploded of a ladder according to the present invention in which an extension module is shown in a position ready to be secured to the ladder base.

FIG. **19** is a close up and side elevation view of the portion of FIG. **18** that is shown in a close-up circle, illustrating the coupling mechanism for securing the extension module to the ladder base is illustrated.

FIG. **20** is a close up perspective view of an alternative embodiment of a coupling mechanism for securing an extension module to a ladder.

FIG. **21** is a perspective view of a ladder having an extension module secured thereto using the coupling mechanism shown in FIG. **20**.

FIG. **22** is a perspective view of a ladder according to the invention that is adapted to use the coupling mechanism illustrated in FIG. **20** but in which one component of the coupling mechanism is modified to be also used as a hand hold.

FIG. **23** is a perspective view of the ladder shown in FIG. **22**, illustrating the opposite side of the ladder from that shown in FIG. **22**.

FIG. **24** is a perspective and schematic view of a pair of cantilevered ladders according to the present invention used to support and interconnect a work platform.

FIG. **25** is a perspective and exploded view of a pair of cantilevered ladders according to the present invention illustrated with a work platform that defines a scaffolding system, in which the two ladders are oriented relative to one another such that they are facing the same direction.

FIG. **25**A is a perspective view of one end of the scaffolding work platform shown in the close up circle of FIG. **25**.

FIG. **25**B is a perspective view of one end of the primary platform shown in the close up circle of FIG. **25**.

FIG. **26** is a perspective view of another embodiment of a pair of cantilevered ladders according to the present invention illustrated with a work platform that defines a scaffolding system, and in which the two ladders are oriented to face one another.

FIG. **27** is a perspective view of yet another embodiment of a pair of cantilevered ladders according to the present invention illustrated with a work platform that defines a scaffolding system, and in which the two ladders are oriented such that one ladder is rotated by 90 degrees relative to the other ladder.

FIG. **28** is a perspective view of the embodiment of a pair of cantilevered ladders shown in FIG. **27**, and including a ladder extension attached to the work platform.

FIG. **28**A is an exploded view of the ladder extension illustrated in FIG. **28**, showing the ladder extension and its attachment in isolation.

FIG. **29** is a perspective and exploded view of the primary platform that attaches to the top step of the ladder.

FIG. **30** is a perspective and exploded view of the work platform.

FIG. **31** is a perspective view of a support tray for use with the scaffolding system according to the present invention.

FIG. **32** is a perspective view of steps adapted for use with the scaffolding system according to the present invention.

FIG. **33** is an elevation view of a bolt adapted for use with the present invention.

FIGS. **34** through **38** are views of a scaffolding stabilization and anti-rotation apparatus according to the present invention. More specifically,

FIG. **34** is an upper perspective view of a primary platform illustrated juxtaposed adjacent to a work platform, prior to connecting the two structures and illustrating the scaffolding stabilization and anti-rotation apparatus according to the present invention.

FIG. **35** is a lower perspective view of the primary platform and work platform shown in FIG. **34**, taken from a different perspective, namely, approximately 180 degrees opposite of the view of FIG. **34**.

FIG. **36** is an upper perspective view of a primary platform and a work platform interconnected.

FIG. **37** is a lower perspective view of the primary and work platforms shown in FIG. **36**, taken from a different perspective, namely, approximately 180 degrees opposite of the view of FIG. **36**.

FIG. **38** is a side elevation view of the plates that are attached to the primary platform and the work platform, with the views juxtaposed relative to one another to illustrate the structural elements that interact when the two platforms are interconnected to stabilize the scaffolding system and to prevent rotation of the work platform relative to the primary platforms.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

Exemplary embodiments are discussed in detail below. While specific exemplary embodiments are discussed, it should be understood that this is done for illustration purposes only. Persons skilled in the relevant art may recognize that other components and configurations may be substituted without parting from the spirit and scope of the invention. It is to be understood that each specific element includes all equivalents that operate in a similar manner to accomplish a similar purpose.

Referring now to FIG. **1**, a lightweight, portable, safety ladder and work platform **100** according to the first embodiment of the present invention is shown. The ladder is comprised of two pairs of rails. To one pair of rails **101** steps **102** and a top plate **103** are attached. This combination of rails, steps and top plate will be referred to as the 'stepped unit' **200**. The other pair of rails **104** are braced **105** to each other as can most clearly be seen in FIG. **3**. The combination of braced rails will be referred to as the 'support unit' **300**. The support unit is attached to the stepped unit with hinges **106** and foldable braces **107**. The length of the support rails and the location of the hinge attachment point or points along the stepped unit are variables which can be optimized for use with specific aircraft and helicopters. The bottom ends of the stepped rails **101** and the support rails **104** are fitted with pads **108** that assist in preventing the ladder from slipping. Attached to the stepped unit is a pair of handrails **109**. In this embodiment, the stepped rails are further apart where they touch the ground than where they are joined at

the top plate. Similarly, the support rails are further apart where they touch the ground than where they are joined to the stepped unit at the two hinge points.

FIG. **2** illustrates an embodiment of the present invention in close proximity to an aircraft ready to be used for its intended purpose.

FIG. **3** depicts an isometric view of an embodiment of the safety ladder such that the support unit **300** is clearly visible. The support rails **104** are shown with internal bracing **105** that rigidly holds the two members and provides the structural strength necessary to meet the load requirements of the ladder. The bracing is constructed so as to leave the space between the rails empty, thus permitting the unit to fit over obstacles such as the helicopter skid cross tubes seen in FIG. **2**.

The ladder depicted in FIG. **3** is fitted with wheels **110** on upward facing edges of the support rails **104** and wheels **111** the backward facing edges of the stepped rails. Such wheels can be of assistance in transporting the ladder to the work area and in positioning the ladder in proximity to the aircraft.

The stepped unit **200** and support unit **300** are interconnected through the use of two rod end ball joints **112**. These rod end ball joints are better seen in the enlarged view provided in FIG. **3***a*.

In FIG. **3***a* the rod end ball joint **112** is securely attached to the top end of the support rail **104**. Two brackets or plates **113** are securely attached to the stepped rail **101** in the area where the support unit and stepped unit will be joined. A securing bolt **114** passes through corresponding holes in those plates and through the eye of the rod end ball joint, thus completing the hinge assembly.

FIG. **4** depicts a side view of an embodiment of the ladder in its open position. A latching strap **115** is secured to the stepped rail **104** and a corresponding latching hook **116** is secured to the support rail **101**. When the ladder is in the closed position, the latching strap and latching hook may be joined to secure the stepped unit **200** to the support unit **300**. A protective bumper **117** is affixed to the stepped rail. When the ladder is in the closed position and laid on the ground upon its side, the bumper acts to protect the folding side braces **107**.

In FIG. **4**, it can be seen that the angle measured between the ground and the stepped rail **118** is greater than the angle measured between the ground and the support rail **119**. Moreover, in FIG. **4** it may be seen that when the ladder **100** is in the open, working position, the top plate **103** is located beyond the hinge axis that is defined by securing bolt **114** (see FIG. **3***a*; the securing bolt is also referred to as the "hinge axis **114**"). In the side elevation view of FIG. **4** the foot of the stepped unit **200** is identified with reference number **50** and the foot of the support unit **300** is identified with reference number **52**. If a triangle is defined by the lines interconnecting the hinge axis **114**, foot **50** and foot **52**, then the horizontal location of top plate **103** is to the right of hinge axis **114** and to the left of foot **52**. Stated another way, when the ladder **100** is in the open position and located on a horizontal ground plane, then a vertical line drawn from the top plate **103** to the ground plane intersects the line extending from the foot **50** to the foot **52** at a position intermediate between the intersection of a line extending from hinge axis **114** to the line extending from the foot **50** to the foot **52**. These two vertical lines are illustrated in phantom lines in FIG. **4**, labelled with reference numbers **54** and **56**, respectively. This geometric orientation is distinctive and important.

FIG. **5** depicts a side view of an embodiment of the ladder in its closed position. In this depiction, the latching strap **115** is secured to its corresponding latching hook **116** thus holding the stepped and support units together for ease of transport. In this closed and latched position, the support rails **101** are in a close and substantially parallel orientation with respect to the support rails **104**, thus minimizing the space requirement for storing or transporting the ladder. The handrails **109** are secured to the stepped unit with removable bolts at attachment points **120** and **121**. The handrails may be detached from the ladder by removal of the bolts, further minimizing the space requirement for storing or transporting the ladder.

In FIG. **5**, it can be seen that the support legs **104** extend beyond the bottom of the stepped rails **101** and below the friction pads **108** secured to the end of those rails.

Materials, Design Considerations and Operation

Based upon the foregoing description of the elements, their configuration and interconnection, one skilled in the art would be expected to be able to construct a lightweight portable ladder that provided the advantages possessed by described embodiments of the present invention. Described here are additional details related to the material used, design considerations and operation of the ladder.

Because safety and stability are characteristics of paramount importance, design consideration can augment the suitability of the ladder for its intended purpose. In FIGS. **1**, **2**, **3** and **6** embodiments of the ladder are depicted with both the support rails **104** and the stepped rails **101** being spaced wider apart at their bottom end than at their top end.

With respect to the stepped rails **101** of the stepped unit **200**, the wider stance at the friction pads **108** provides additional stability. The shortening of the steps **102** which occurs as one traverses up the ladder serves to centralize the mass and to provide additional stability through those means. The narrowed stance at the upper steps further serves to bring the handrails **109** into a more convenient position to be gripped by the person standing upon the ladder.

With respect to the support rails **104** of the support unit **300**, the wider stance at the friction pads **108** provides additional stability which is further enhanced owing to the fact that the support rails **104** are longer than the stepped rails as measured from the hinge point **106**. Because the angle of flare is ostensibly the same for the rails of both the support unit and the stepped unit, the added length of the support rails results in the friction pads **108** of the support unit being spread still further apart. These more widely spaced foot pads act as if they were outriggers and provide enhanced stability in the lateral direction.

With further respect to the support rails **104** of the support unit, it should be apparent to those skilled in the art that their extended length provides increased resistance to tipping forward, thus allowing the ladder to support heavier loads being applied higher above the hinge point **106**. In order to accommodate these higher loads and forces, the support rails **104** and support rail bracing **105** must be constructed using appropriately strong materials. High tensile strength aluminum tubing has proven to be suitable for this purpose. Various other metals, alloys, fiberglass and composites might also prove suitable.

With further respect to the issue of safety and stability, in the embodiment depicted in FIGS. **1**, **2** and **3** the rails **101** and steps **102** are oversized compared to those found in conventional stepladders. These larger steps better facilitate the safety ladder and work platform functions of the present invention giving the mechanic a stronger and larger platform

upon which to stand. The presence of handrails **109** further add to the safety features of this ladder.

Persons skilled in the art understand that step ladders can be constructed using a variety of hinge mechanisms **106**. Any number of hinged mechanisms that would permit the stepped unit to smoothly swing relative to the support unit could be used to construct a ladder that shared many of the advantages of the present invention. For example, a continuous hinge (commonly called a 'piano' hinge) could be used such that one flap is affixed to the backside of a step **102** and the other flap is affixed to bracing **105** connecting the top ends of the support rails **104**. An obvious limitation of using this arrangement would be that that there are a discrete number of steps thus a limited number of structurally appropriate attachment points.

Because it is desirable to construct a helicopter maintenance ladder with optimized angles, it is important to be able to locate the hinge points wherever the design requires. It is further desirable for those hinges to operate smoothly without binding and with a minimum of free play which, if present, would permit the ladder to wiggle or shake. The limitation described for the embodiment using a continuous hinge can be overcome by using a pair of rod end ball joints **112** or functional equivalents such as spherical rod end ball joints, race linkage rod ends or rod end bearings. Such joints may be affixed to the top ends of the support rails **104** and corresponding attachment means affixed to the rails **101** of the stepped unit wherever the design requires. Alternately, attachment means may be affixed to the top end of the support rails **104** and corresponding rod end ball joints affixed to the rails **101** of the stepped unit. Such flexibility facilitates the construction of a ladder having angles optimized for its intended use. Another advantage of using paired rod end ball joints in this application is that paired joints permit ostensibly zero motion in any direction other than the desired axis of rotation. When used as the hinge element in the construction of embodiments of the present invention, rod end ball joints contribute greatly to the production of safety ladders that are exceptionally stable and secure.

With respect to moving the ladder from where it may be stored to where it will be employed, the ladder may be found to be light enough to be carried by one person. Alternatively, the ladder, preferably in its closed position as seen in FIG. **5**, can be rolled to the work site using attached wheels **110** or **111**. The safety hand rails **109** provide a convenient handle when pushing or pulling the ladder upon either pair of wheels.

In operation, the ladder is brought into its fully open position by pivoting the rails **101** and **104** upon the hinge mechanism **106** until the folding braces **107** are fully extended. Once extended, the folding braces lock the ladder into its operational position. Once so locked the ladder is moved into its ultimate work position either by manually lifting, or tilting and then rolling it upon wheels **111**, or by dragging, or by rocking it upon the friction foot pads **108** and/or by combinations thereof. As most clearly seen in FIG. **2**, in order to place the ladder in its optimal work position, it may be necessary to clear, straddle or otherwise avoid contact with various portions of the aircraft or helicopter. A properly constructed embodiment of the present invention will have taken into consideration the nature and location of those obstacles and will integrate well with the aircraft for which it was designed.

To further enhance the utility of the present invention as a work platform for the maintenance of aircraft, helicopters and other machinery, the ladder may be fitted with additional accessories such as trays, tool and part holders, cup holders and the like. These accessories may be permanently attached, hung from the ladder, or attached by temporary or removable means. In an embodiment of the current invention not shown in any of the figures, the ladder is fitted with receptacles sized to receive a quart-sized can of motor oil mounted on the outboard surfaces of each of the two stepped rails **101** near the top plate **103**. These receptacles provide convenient repositories for the placement of small parts when the ladder is in use and further serve as protective bumpers when the ladder is laid upon either side.

Reference is now made to FIGS. **6** through **8**, which illustrate a brace locking mechanism **210** according to the present invention. The purpose of brace locking mechanism **210** is to lock the foldable braces **107** when the ladder **100** is in the open position. With returning reference to the basic structural components of ladder **100** described previously, and for example, as shown in FIG. **1**, the brace locking mechanism of FIGS. **6** through **8** is used with a ladder **100** that has a stepped unit **200** and a support unit **300**. The foldable brace **107** extends between the stepped unit and the support unit. More specifically, foldable brace **107** is a spreader bar system that is defined by a first elongate arm **212** that has its first end **214** pivotally attached to rail **101** of stepped unit **200**, for example, with a bolt **216**. Foldable brace **107** further is defined by a second elongate arm **218** that has its first end **220** pivotally attached to rail **104** of support unit **300** with a bolt **222**. A conventional one way hinge **224** interconnects the respective, facing ends **226** and **228** of elongate arms **212** and **218**. The foldable brace **107** just described is conventional and of course there is a foldable brace **107** interconnecting the rails on both sides of the ladder **100**. As with known foldable braces, the one way hinge **224** is operable to limit and stop relative pivotal movements of elongate arms **212** and **218** when the support unit **300** is fully moved into the open position.

Brace locking mechanism **210** comprises a lock block **230** that is pivotally attached to rail **200** with a bolt **232**. In FIGS. **6** through **8** the lock block **230** is illustrated as generally triangular in shape with the bolt **232** extending through an upper apex of the triangle, but it will be appreciated that other geometric shapes will have equivalent functionality. It will be appreciated that the major mass of lock block **230** is below the bolt **232** and the lock block will naturally swing under the force of gravity about the bolt **232** toward the position shown in FIG. **6**. This is the "locked position" where the ladder **100** is in its fully open, working position. In this position the foldable brace **107** is fully extended and the base leg **234** of triangular lock block **230** is in an abutting relationship with the elongate arm **212** of foldable brace **107**. When the lock block **230** is in the position shown in FIG. **6**, the base leg **234** physically abuts the elongate arm **212** to thereby prevent the arm from pivoting about bolt **216**. Said another way, when lock block **230** is in the locked position of FIG. **6** the foldable brace **107** cannot be moved out of the fully extended and locked position.

To move the ladder **100** out of the open position the lock block **230** is pivoted in the counterclockwise direction (in the view of FIG. **6**, and as shown in the view of FIG. **7**) about bolt **232**. Movement of lock block **230** in the counterclockwise direction disengages the abutting relationship between base **234** of the lock block **230** and elongate arm **212**; once the block **230** has been rotated sufficiently that the base **234** has been moved away from arm **212**, the foldable brace **107** may be pivoted in a conventional manner about its respec-

tive ends, which of course allows the support unit **300** to be pivoted toward the stepped unit **200**, out of the work position and into a storage position.

FIG. **7** is the next sequential step in the movement of the ladder **100** from the fully open position to the storage position. As may be seen, as the support unit **300** is moved partially toward the stepped unit **200** so that the ladder **100** is in an intermediate folded position between the fully open and fully closed positions. Elongate arm **212** pivots about bolt **216** and the elongate arm makes contact with the lock block **230** and pushes on the lock block as the ladder is moved toward the closed position, thereby causing the lock block to continue rotation about bolt **232** as the ladder is moved toward the storage position. The rounded corner **236** of lock block **230** eases the rotation of the lock block by the pushing contact of the elongate arm. An elongate blocking member **238** is bolted to rail **101** and is position such that the blocking member **238** prevents over rotation of lock block **230** when the ladder is fully closed—the blocking member **238** may be provided in multiple pieces as shown in FIG. **7**, or in a single piece, which is not illustrated. The purpose of the split, multi-piece blocking member **238** shown in FIG. **6** is to allow attachment of a handrail to bores **70** and **72** in the rails, as detailed below.

FIG. **8** further illustrates the brace locking mechanism **210** described above. Sequentially, in FIG. **8** ladder **100** is in the full storage position and it may be seen that brace locking mechanism **210** does not interfere with the stepped and storage units in this position.

It will be appreciated that when ladder **100** is moved to its open position (FIG. **6**) from the storage position (FIG. **8**), the brace locking mechanism **210** automatically moves into the locked position when the ladder is fully open because the lock block **230** is, relative to the pivot point defined by bolt **232**, bottom weighted. Specifically, when the support unit **300** is pivoted about hinge axis **114** and fully away from the stepped unit **200** in the working position, and such that foldable brace **107** is in its engaged position (FIG. **6**), the lock block **230** rotates under the force of gravity (in the clockwise direction in FIGS. **6-8**) and into the locked position. Thus, no operator intervention is required to lock the ladder securely in the work position. In the locked position, the ladder **100** may be moved from one position to another, or rolled on wheels from one location to another where the ladder incorporates wheels without disengaging the brace locking mechanism. To fold the ladder into its storage position, the user must affirmatively rotate the lock block **230** away from its locked position and also disengage the one way hinge **224** of foldable brace **107**.

The brace locking mechanism **210** described above may be used with any foldable ladder and is not limited to the cantilevered ladder **100** described herein. In a preferred embodiment a brace locking mechanism is provided on each rail **101**. In another preferred embodiment, only one brace locking mechanism is provided on one of the two rails **101**. Further, it will be appreciated that the lock block described above may be attached to the rails **104** of the support unit **300** to define a functionally equivalent brace locking mechanism.

Although not shown in the drawing, the brace locking mechanism **210** may also incorporate a spring that functions to normally drive the lock block **230** into the locking position. The lock block could be move out of the locking position by rotating it in the counter clockwise direction (of the drawings) against the force of the spring. Further, the locking mechanism **210** may include a safety-type mechanism that secures the lock block **230** in the locked position, such as a ball detent or a locking pin and the like. Those of skill in the art will also recognize that there are numerous structural equivalents to lock block **230** that perform the same function. As a few examples, clevis pins inserted through a bore in rail **101** adjacent or through arm **212**; a spring-loaded clamp oriented either above or below arm **212** such that the clamp secures the arm when the ladder is in the open position.

The present invention further contemplates the use of an extension module that may be attached to the upper end of the stepped unit to increase the usable length of the ladder.

Reference is now made to the drawings of FIGS. **9** through **19**, which illustrate an extension module that is attached to ladder **100** to increase the working height of the ladder and the connecting structures that securely interconnect the extension module with the ladder. A ladder **100** that is designed for use with an extension module **310** defines the base module to which the extension module is attached, and includes cooperatively constructed interconnecting structures on the ladder **100** and the extension module **310** that operate to secure the extension module to the ladder. Different embodiments of these interconnecting structures are described below. In the illustration of FIG. **9**, a ladder **100** is illustrated without an extension module **310** but including one element of an interface connector **324**, that is, the half of the cooperative interface connector that is attached to the upper end of rail **101**. The interface connectors **324** are described in detail below.

With specific reference to FIG. **10** a ladder **100** as described above and includes the stepped unit **200** that is defined by side rails **101** interconnected with steps **102** and a top plate **103**. Ladder **100** further includes the support unit **300**. The extension module **310** is shown juxtaposed relative to and separated from the top plate **103**. Extension module **310** is defined by opposed side rails **312** and **314** that are interconnected by plural steps **316** and top plate **318** in a manner analogous to the analogous components of ladder **100** described previously. The extension module **310** is sized appropriately that it mates with an existing ladder **100** in order to allow the extension module to be securely coupled to the ladder in the manner detailed below. The lowermost step of extension module **310** is labeled as step **316*a*** and is located near the lower ends **320** of opposed rails **312** and **314** so that the lowermost step **316*a*** abuts the top plate **103** of ladder **100** and the rails **312** and **314** align with rails **101** of stepped unit **200**. A flange **322** extends downwardly from step **316*a*** and overlaps with the forward edge of top plate **103** when the extension module is attached to the ladder. An identical flange (not visible in the view of FIG. **10**) extends downwardly from step **316*a*** on the opposite side of the step from that shown in FIG. **10**—and overlaps with the opposite edge of the top plate **103** when the extension module is coupled with the ladder. The handrails **109** are also shown juxtaposed from the ladder **100** shown in FIG. **10**. The handrails are securely attached at their bottom ends to the opposed rails **101** with, for example, bolts or quick release skewers that extend through bores in the handrails and through bores **70** and **72** (see, e.g., FIG. **8**). The upper ends of the handrails **109** are attached to the upper ends of the opposed rails **312** and **314** in a like manner.

It will be noted that the physical spacing between top plate **103** and the closest adjacent step **102** is slightly less than the spacing between other steps **102** of the ladder **100**. When the extension module **310** is mated to ladder **100**, the top plate **103** of ladder **100** is, as noted above, brought into abutting or very close proximity with the lowermost step **316*a*** of the extension module **310**. This abutting relationship between

the top plate **103** and the step **316***a* defines a step spacing that is consistent with the other step-to-step spacing of ladder **100**. This structural arrangement also strengthens and adds rigidity to the interconnection between the extension module **310** and the ladder **100**, thereby contributing to a solid connection between the two units, and the overlap of flanges **322** with top plate **103** effectively transforming the combined step into a fully functional step.

While the abutment of step **316***a* with top plate **103** contributes to the stability of the interconnection between the extension module **310** and the ladder **100**, the primary interconnection between the two is provided by interface connectors, referred to generally with reference number **324**. A first embodiment of an interface connector **324** is shown in the views of FIGS. **10** through **15** and comprises a first plate **326** that is securely attached to the lower end **320** of rail **312** of extension unit **310** such that a portion of the first plate **326** extends beyond the end of the rail **312**. Likewise, an identical first plate **326** is attached in the same way to the lower end **320** of rail **314**. A second plate **328** is securely attached to the upper end of rail **101** adjacent top plate **103**—one second plate **328** is attached to each rail **101**.

The first and second plates **326** and **328**, respectively, include structural features that contribute to a highly secure and stable connection between the extension module **310** and the ladder **100**. With continuing reference to FIG. **10**, first plate **326** has a generally V-shaped notch **330** formed in the lower edge of the plate. Second plate **328** includes a cooperatively formed V-shaped extension **332** facing V-shaped notch **330**. When extension module **310** is connected to ladder **100** the V-shaped extension **332** of second plate **328** is received in the cooperatively formed V-shaped notch **330** of first plate **326**, thereby stabilizing the interconnected first and second plates. Further, a pull-action toggle clamp **334** is attached to second plate **328** and a corresponding latch plate **336** with a hook portion is attached to first plate **326**. When extension module **310** is connected to ladder **100** the arms **338** of the toggle clamp **334** (see FIG. **12**) are extended over the corresponding hook portion of latch plate **336** and the toggle clamp is closed. This further secures the extension module **310** to the ladder **100**, and the pulling action of the toggle clamp **334** adds additional strength to the interconnection. There is a toggle clamp **334** attached to each of the second plates **328** of ladder **100**, and of course, the relative positions of the toggle clamp and the latch plates on first and second plates **326**, **328** may be reversed.

The structure of the second plate **328** is shown in the close up and exploded views of FIGS. **11** and **12**. Each of the second plates **328**—i.e., one plate **328** is attached to each of the rails **101** of ladder **100**—is secured to the upper edge **313** of a rail **101** with plural fasteners such as screws **315**.

The length of extension module **310**—that is, the number of steps **316** that may be incorporated into the extension module, may be varied and the maximum length of the extension module is dictated in large part by the specific dimensions of the ladder **100** to which the extension module **310** is to be coupled. FIGS. **13**, **14** and **15** depict identical ladders **100** with three differently sized extension modules **310** coupled thereto with interface connectors **324** of the type described above. The ladder **100** in FIG. **13** has an extension module **310** with two steps **316** and a top step **318**; the ladder **100** in FIG. **14** has an extension module with three steps **316** and a top step **318**; and the ladder **100** in FIG. **15** has an extension module with four steps **316** and a top step **318**.

Those of skill in the art will recognize that there are numerous structural equivalents that may be utilized to define the interface connectors **324** that couple the extension module **310** to the ladder **100**, in addition to the embodiment described above in respect of FIGS. **9** through **15**. A second embodiment of an interface connector **324** is shown in FIGS. **16** through **19**. In the second embodiment a first plate **340** is securely attached to the lower end **320** of rail **312** of extension unit **310** and a portion of the first plate **340** extends beyond the end of the rail **312** to define a bayonet **341**. An identical first plate **340** is attached in the same way to the lower end **320** of rail **314**. Bayonet **341** may be an integral part of first plate **340**, or may be attached to plate **340** as a separate piece. A second plate **342** is securely attached to the upper end of rail **101** adjacent top plate **103**—one second plate **342** is attached to each rail **101**. Second plate **342** includes shoulders **344** at the opposite lateral sides of the plate to define a channel **346** there between—the shoulders **344** may be formed as an integral part of the plate **342** or attached to the plate as separate pieces. The channel **346** has parallel side walls defined by the shoulders **344** and the width of the channel is adapted to be the same as the width of bayonet **341**. As best seen in the close up view of FIG. **19**, when extension module **310** is mated with ladder **100** the bayonet **341** is slid into the channel **346** and the mating structures help to stabilize the interconnected components. Further security between the extension module and the ladder is provided by securing the bayonet **341** to the second plate **342**, for instance, with fasteners such as screws or threaded bolts that connect the two or with a latch similar to toggle clamp **334** described above, and more particularly with a bolt threaded through the aligned bores **343** and **345** in first plate **340** and second plate **342**, respectively.

When an extension module **310** is coupled to a ladder **100** as described above the stepped base unit has support legs that are of sufficient length to support a step ladder of substantially greater length than the height of the base unit itself and the added height is provided by the extension module. In conventional step ladder designs, the stepped unit and the support unit are angled symmetrically and assume the shape of an isosceles triangle when the ladder is in its open position. But in the design of the present invention the angle measured between the stepped unit and the ground is greater than the angle measured between the support unit and the ground and when the ladder **100** is folded into its storage position the lower portion of the rails of the support unit extend beyond the feet of the stepped unit. Accordingly, this combination of structural features allows the ladder **100** to provide a footprint that is larger than footprint of a convention ladder, assuming isosceles triangle construction. In this way the ladder **100** with the extension module with its added steps securely coupled to the stepped unit will exhibit stability comparable to or greater than that of a conventional step ladder of similar height.

Further, as may be seen in FIG. **18** and as noted above in respect of FIG. **4**, it may be seen that when the ladder **100** is in the open, working position, the top plate **103** and the interconnection with extension module **310** is located beyond the hinge axis **114**. In the view of FIG. **18**, the triangle defined by the lines interconnecting the hinge axis **114**, foot **50** and foot **52**, the horizontal location of top plate **103** is to the right of hinge axis **114** and to the left of foot **52**. Accordingly, when the ladder **100** is in the open position as shown and located on a horizontal ground plane, then a vertical line drawn from the top plate **103** to the ground plane intersects the line extending from the foot **50** to the foot **52** at a position intermediate between the intersection of

a line extending from hinge axis **114** to the line extending from the foot **50** to the foot **52**. These two vertical lines are illustrated in phantom lines in FIG. **18**, labelled with reference numbers **54** and **56**, respectively.

In addition to the interface connectors **324** that are described above, other suitable methods of securely attaching an extension module **310** to the ladder **100** include hinged connections, tapered joints with cooperative tapered receivers, finger joints, dovetail joints, wedge plates and others. Similarly, there are numerous ways to attach the interface connector components, including for example bolts and screws, pit pins, claims, hand wheels, etc.

Reference is now made to the alternative embodiment of an interface connector/coupling mechanism **324** for securing an extension module **310** to a ladder **100** as shown in FIG. **20**. In the embodiment of FIG. **20** the first plate **326** is securely attached to the lower end **320** of rail **312** (with fasteners such as screws) and includes a downwardly oriented and substantially triangular extension **350** that has its apex **352** oriented at the lower end of the plate **326**. The second plate **328** is securely attached to the upper end of rail **101** of ladder **100**, adjacent top step **103** as shown and defines a cooperative structure for receiving the triangular extension **350** in a mating relationship. More specifically, second plate **328** forms a V-shaped notch **354** into which the triangular extension **350** is received. The second plate may be formed from two mirror image halves such as halves **356**, **358** (as shown in FIG. **20**), or alternately, the second plate **328** may be fabricated from a single plate of material.

When the extension module **310** is assembled onto a ladder **100** as shown in FIG. **20** the triangular extension **350** is received in the V-shaped notch **354** such that the sides of the extension align with and abut the facing sides of the notch. This in itself provides a stable and secure interconnection between the extension module and the ladder. However, a fastener is always provided to attach the extension **350** to the ladder **100** and in the instance of the embodiment of FIG. **20**, a hand wheel **360** with a threaded bolt **362** extending therethrough is extended through a bore in the triangular extension **350** (the bore is not shown because it is blocked in the view of FIG. **20** by the hand wheel) and is screwed into an aligned threaded bore in rail **101** of ladder **100** (the treaded bore also is blocked in the view of FIG. **20**). The hand wheel **360** and bolt **362** provide additional security for attaching the extension module **310** to ladder **100**, and of course there is an identical coupling mechanism **324** associated with the rails on the opposite side of the ladder from that shown in the view of FIG. **20**. As also seen in FIG. **20**, the end **364** of handrail **109** in the embodiment of FIG. **20** is secured to the triangular extension **350** with a pair of bolts **364**.

A ladder **100** having an extension module **310** secured to it with the coupling mechanism **324** as shown in FIG. **20** is illustrated in FIG. **21**. A tool tray **366** is attached to each of the rails **312** and **314** in positions that allow a user to conveniently store tools and the like. The tool trays may be relocated wherever the user finds convenient with appropriate fasteners.

It will be appreciated that the embodiments of the coupling mechanisms **324** shown in, for instance, FIGS. **13**, **19** and **20** provide very secure and stable interconnections between the ladder **100** and the extension module **310**. The cooperative geometric configurations of the first plates and the second plates of the coupling mechanisms provide a primary stabilizing and securing modality, and secondary stabilizing and securing modality is provided by the attachment mechanisms defined by, for instance, the toggle **334** (FIG. **12**), the interconnecting bolt (FIG. **19**) and the hand wheel **360** (FIG. **20**).

Finally, the ladder shown in FIGS. **22** and **23** is yet another embodiment of a ladder **100** that is adapted for attaching an extension module **310**. However, the first plate **326** is adapted for use as a handle **370** rather than as a securement mechanism for attaching an extension module to the ladder. More specifically, as best seen in FIG. **23**, the lower end of first plate **326** is identical to that described above in respect of FIG. **20**, with a downwardly projecting triangular extension **350** that is received in the V-shaped notch **354** in second plate **328**. However, the upper part of the first plate **326** is formed into the handle **370**. As seen in FIG. **22**, the handle **370** that is defined by the first plate **326** may be stored on rail **101** with appropriate mechanisms to secure the handle on the rail for storage, such as a strap **372** and bracket **374**.

A ladder according to the present invention may also include, in place of the extension module described above, a standing platform that is attached to the top plate of the ladder in the same manner as the extension module, and which would include hand rails that extend appropriately to the standing platform. Additionally, two ladders according to the invention described herein can be located spaced apart from one another, in either parallel or perpendicular relative orientations, and a scaffolding-like work platform may be used to interconnect the two ladders. Reference is made to FIGS. **24**, **25**, **26**, **27** and **28** in which two ladders **100** of the type described herein are used to support a work platform or scaffolding system **400**. Shown generally in FIG. **24**, the two outer ends of the work platform **400** are defined by primary platforms **402** that directly attach to the top plate **103** of the ladders, and which include appropriate components of the coupling mechanism **324** to interconnect the primary platforms to the ladders. A work platform **404** interconnects the two primary platforms **402** with appropriate coupling mechanisms to define a complete, stabile scaffolding structure. Additional bracing may be added extending from the platform **400** to the ladders if desired for added strength, and hand rails may be added to the platform as necessary for safety considerations.

Turning to FIGS. **25**, **26** and **27**, the scaffolding system **400** is shown in greater detail. The two ladders **100** are cantilevered ladders of the type described above according to the invention. The ladders **100** may be oriented relative to one another in different positions. For example, in FIG. **25** the ladder **100** on the left and the ladder **100** on the right are in the same positions relative to one another so that both are facing the same direction. In FIG. **26** the two ladders **100** have been positioned such that the support units **300** of each ladder are facing one another—that is, both ladders have been rotated 90 degrees toward one another relative to the positions shown in FIG. **25**. And in FIG. **27** one ladder **100** (the one on the right in the illustration) has been rotated 90 degrees from its position in FIG. **26** so that, relative to the ladder **100** on the left, the two ladders are oriented at right angles relative to one another. As detailed below, the modularity of the components of scaffolding system **400** allow the varying ladder orientations shown in FIGS. **25**, **26** and **27** in order to accommodate using the system in varying on-the-ground situations. For purposes of clarity, when a ladder is said to be "facing" in any given direction the facing direction is the direction from the stepped unit **200** toward the support unit **300**. Using this naming convention, the two ladders in FIG. **25** are facing in the same direction; the two ladders in

FIG. **26** are facing one another; and the two ladders in FIG. **27** are facing in directions that are 90 degrees different.

The scaffolding system **400** according to the invention comprises a pair of ladders **100**, a pair of primary platforms **402**, one attached to the top step of each ladder **100**, and a work platform **404** that interconnects the two primary platforms **402**. Together, the two primary platforms and the work platform define a stable work space on which workers can move about. The primary platforms **402** are connected to the ladders **100** with interface connectors **324** of the type described above with respect to FIGS. **10** and **20**, and as shown in FIG. **28**A. Thus, as described previously with respect to FIGS. **10** through **20**, the primary interconnection between a ladder **100** and a primary platform **402** is provided by the interface connectors **324** such as a first plate **326** (see, e.g., FIG. **29**) that is securely attached to the lower end **320** of rail **312** of extension unit **310** such that a portion of the first plate **326** extends beyond the end of the rail **312**. Likewise, an identical first plate **326** is attached in the same way to the lower end **320** of rail **314**. A second plate **328** is securely attached to the upper end of rail **101** adjacent top plate **103**—one second plate **328** is attached to each rail **101**. In addition, to the primary connections defined by the coupling mechanisms, the primary platforms **402** are supported with a pair of support struts **406** that extend angularly from the outer, lower edges of the primary platforms to the brackets **113** that join the support unit **300** and stepped unit **200**. The brackets **113** are modified to accept the lowermost ends of the struts **406**. The support struts **406** provide strength to the primary platform and it will be appreciated that the struts may be configured other than that shown to obtain the same strength. As an example, a single strut or a strut with a Y-configuration may be used but in all instances at least one strut is necessary for stability and strength.

The structures utilized to connect the work platform **404** to the two primary platforms **402** are shown in greater detail in FIGS. **29** and **30**, and in the close-up circles of FIGS. **25**A and **25**B. With reference to FIG. **29**, a primary platform **402** is shown with the components exploded. A first plate **408** is attached to lateral side **410** of the platform **402** with appropriate fasteners such as bolts. A second plate **412** is attached to the adjacent side **414** of platform **402**. The plates **408** and **412** have two spaced apart notches **416**, the purpose of which is detailed below, and plural receptacles **418** are attached to the outer-facing surfaces of the plates. The receptacles **418** are used to receive upright posts that are used for safety rails and the like and are located on three sides of the platform to allow for modularity in the manner that the ladders are oriented relative to one another, and the positions in which safety rails are attached. The work platform **404** is shown in an exploded view in FIG. **30** and it may be seen that an end plate **420** is attached to the outer end **422** of the platform (an identical end plate is attached to the opposite outer end but is not visible in FIG. **30**). Two connecting posts **424** and a locating block **426** are attached to plate **420**. Each connecting post **424** has a circumferential slot **428**, as best shown in FIG. **25**A.

Referring now to FIGS. **25**A and **25**B, the assembled work platform **404** and primary platform **402** are illustrated. With the primary platforms **402** securely attached to two ladders **100** and with the ladders spaced apart from one another by an appropriate distance (and oriented as desired relative to one another) the work platform **404** is connected to the two primary platforms **402** by inserting the connecting posts **424** on work platform **404** into the notches **416** on the primary platforms **402** with the notches **416** engaging the circumferential slots **428**. The receptacles **418** are captured between the plates **420** and **408** (or **412**, depending upon the relative orientation of the two ladders **100**) and thus function as both stand offs to ensure the proper spacing between the plates and as stabilizing structures between the connected platforms. The locating block **426** includes a protruding locator pin **430** that is received in a bore **432** formed in plate **408**. The manner of connecting the primary platforms **402** to the ladders **100**, and the work platform **404** between the two primary platforms defines a very strong and stable scaffolding platform. Because in an embodiment the ladders **100** are cantilevered, when the two ladders **100** are oriented as shown in FIG. **25** the scaffolding platform may be oriented very close to, for example, a helicopter as shown in FIG. **2**, thus allowing mechanics to easily access components that require servicing.

Since the scaffolding platform just described is elevated above the ground level the scaffolding system **400** includes safety equipment. For example, modular guard rails **440** are defined by upright posts **442** and interconnecting rails **444**. The upright posts **442** are spaced apart from one another by the same spacing between adjacent receptacles **418** so that the lower ends of the posts may be inserted stably into the receptacles, and optionally secured in place with, for instance, pins **446** as shown in FIG. **31**. Plural receptacles **418** are spaced around the primary platforms **402** and work platform **404** so that the modular guard rails **440** may be located as appropriate for any particular work situation, and according to the orientation of the ladders relative to one another, as illustrated in FIGS. **25**, **26**, **27** and **28**.

Scaffolding system **400** is configured to allow addition of a number of different accessories such as a work trays **448** of different types (FIGS. **25**, **31**), and modular step ladders **450** such as those shown in FIGS. **25**, **26**, **27** and **32**. Each modular step ladder **450** includes support posts **452** that are spaced apart from one another by the same spacing as adjacent receptacles **418** so that the posts **452** may be inserted into receptacles **418** and secured with pins **446**.

Finally, turning to FIGS. **28** and **28**A, a ladder **460** may be connected to work platform **404**. The connection between the ladder **460** and platform **404** must be strong enough to support a worker on the ladder and this secure connection is accomplished with an interconnection between the ladder **460** and the platform with a ladder support module **462** that is secured to the platform **404** and which has opposed sides **469** that correspond to and are adapted to form a connection with the opposed side rails **466**, **474** of the ladder **460**. An interface connector **324** (as described in detail previously with respect to, for example, FIGS. **10** and **20**) has a first plate **464** that is securely attached to the lower end of side rail **466** of extension ladder **460**. A second plate **468** is securely attached to and is part of the ladder support module **462** at one side **469**, which is secured to the platform **404** with appropriate fasteners such as pins **467**. Second plate **468** defines a generally V-shaped notch **470** and the first plate **464** defines a V-shaped extension **472** that is cooperatively formed to fit into the notch **470**. The opposite rail **474** of ladder **460** includes identical components and it will be appreciated that the interface connector **324** shown in FIG. **28**A is identical to that described above in respect of FIG. **20**. When ladder **460** is connected to support module **462** the V-shaped extension **472** of plate **464** is received in the cooperatively formed V-shaped notch **470** of second plate **468** of support module **462**. At this point a bore **476** in the V-shaped extension **472** aligns with a threaded bore **478** in a backing plate **477** in the support module **462** and a bolt **480** is threaded through bore **476** and into bore **478** and is tightened to thereby stabilize the ladder **460** relative to the

platform **404**. When the ladder **460** is attached to the support module **462** as described, a flange **482** extends downwardly from the lowermost step **484** and overlaps with the mating edge **486** of the top plate **488** of the extension module **462** in the manner described above with respect to, for example, FIG. **20**. An identical flange (not visible in the view of FIG. **28**A) extends downwardly from step **484** on the opposite side of the step from that shown in FIG. **28**A—and overlaps with the opposite edge of the top plate **488** when the ladder extension module is coupled to the extension module.

In a preferred embodiment, the dimensions of the V-shaped extension **472** and the mating V-shaped notch **470** are engineered to increase the strength of the connection provided by the interface connector **324**. Specifically, the bore **476** in the V-shaped extension and the threaded bore **478** in the backing plate **477** are slightly offset from one another when the V-shaped extension is received in the V-shaped notch so that the bores overlap but the axial centerlines through the respective bores, that is, bore **476** and threaded bore **478**, are not coaxial and such that the axial centerline through the bore **476** is slightly above the axial centerline through threaded bore **478**. With reference to FIG. **33**, the bolt **480** is adapted with a conical shoulder **482** along the length of the bolt. The outer peripheral edge of bore **476** has a conical edge **479** that is configured to mate with the conical shoulder **482** (see, for example, FIG. **29**). When bolt **480** is inserted into the mis-aligned bores **476** and **478**, the differences in the axial offset is slight enough that the threaded portion **484** of the bolt engages the threads of threaded bore **478**. As the bolt is tightened and moves inwardly in the bores, the conical shoulder **482** of the bolt begins to mate with and seat against the conical edge **479** of the bore. As the bolt is further tightened, the V-shaped extension **472** is drawn downwardly as the conical shoulder and conical edge seat fully against one another. This causes substantial compression between the V-shaped extension **472** and the V-shaped notch **470**, which significantly increases the strength of the connection.

It will be appreciated that the extension module **310** described herein is not limited to use with folding ladders but instead may be used with a rigid ladder that has the appropriated coupling mechanisms such as those detailed herein to attach the extension module to the ladder.

Reference is now made to the series of drawings of FIGS. **34** through **38**, which illustrate a stabilization and anti-rotation system **500** that provides for secure interconnection between the work platform **404** and the primary platforms **402** and prevents relative movement therebetween. The system **500** utilizes the pair of notches **416** that are formed in first plate **408**, as described earlier and as illustrate in, for example, FIG. **25**B, and the connecting posts **424** that are attached to the second plate **420**, as also described earlier and as illustrated in FIG. **25**A. However, in the system **500** the locating block **426** and the locator pin **430** of the embodiment of FIG. **25**A have been replaced with alternative structures as described below.

Continuing with respect to FIGS. **34** and **35**, and as detailed previously, plate **408** is attached to side **410** of the primary platform **402** with appropriate fasteners such as bolts. A plate **412** is attached to the side **414** of platform **402**. The plates **408** and **412** have two spaced apart notches **416**, the purpose of which was explained previously, and as further detailed below, and plural receptacles **418** are attached to the outer-facing surfaces of the plates as detailed above. The receptacles **418** are used to receive upright posts that are used for safety rails and the like and are located on three sides of the platform to allow for modularity in the manner that the ladders are oriented relative to one another, and the positions in which safety rails are attached.

The work platform **404** is shown in an exploded view in FIG. **30** and it may be seen that a plate **420** is attached to the outer end **422** of the platform (an identical plate is attached to the opposite outer end but is not visible in FIG. **30**). Two connecting posts **424** and a locating block **426** are attached to plate **420**. Each connecting post **424** has a circumferential slot **428**, as best shown in FIG. **25**A.

Returning to FIGS. **34** and **35**, pair of spaced apart and vertically oriented guide blocks **502** and **504** are attached on plate **420** of work platform **404**, preferably with the blocks positioned along the lateral length of the plate so that a spaced apart guide slot **508** is at the center of the plate. The guide blocks **502** and **504** at attached to plate **420** with appropriate fasteners. The lower ends **506** of the guide blocks are tapered, as best illustrated in FIG. **38**. Because the guide blocks **502** and **504** are spaced apart, the guide slot **508** is defined between the blocks. A first spacer block **510** is affixed to plate **420** on one lateral side of the plate **420** outwardly of guide block **502**, and a second spacer block **512** is affixed to plate **420** on lateral side of the plate **420** outwardly of guide block **504**.

As shown in FIG. **35**, a single locator, or locating block **514** is attached to plate **410** of primary platform **402** with appropriate fasteners (a similar locating block is attached to the adjacent plates of the primary platforms **402**). The upper end **516** of locating block **514** is tapered. The width of locating block **514** is slightly less than the width of guide slot **508** so that the locating block **514** may be slid into the guide slot **508** with very close tolerances between the sides of the block **514** and the facing sides of the blocks **502** and **504**.

The structures described above are especially well-illustrated in the elevation views of FIGS. **38** and **39**.

The combination of the guide blocks **502** and **504** with locating block **514** function to stabilize the work platform **404** relative to the primary platforms **502** when the work platform is assembled with two primary platforms to detailed above, and prevents rotation of the work platform relative to the primary platforms when, for example, one side of the work platform is loaded with a heavy load.

To assemble a scaffolding system **400** as described earlier using the stabilization and anti-rotation system **500**, the assembled work platform **404** and primary platform **402** as shown in FIGS. **34** and **35** are securely attached to two ladders **100** and with the ladders spaced apart from one another by an appropriate distance (and oriented as desired relative to one another). The work platform **404** is connected to the two primary platforms **402** by moving the work platform downwardly relative to the stationary ladders **100** and such that the tapered upper end **516** of the locating block **514** on plate **408** is inserted into the guide slot **508** between the guide blocks **502** and **504** on plate **420**. As noted, the width of locating block **514** is preferably very slightly less than the width of guide slot **508**. Because the upper end **516** of locating block **514** is tapered, and the lower ends **506** of guide blocks **502** and **504** are tapered, the block **514** slides very easily into the slot **508**. The two spacing blocks **510** and **512** on plate **420** abut plate **410** and thus act as stand-offs that ensure that the work platform **404** and the primary platforms **402** are separated by the ideal distance when the scaffolding system **400** is assembled.

FIG. **38** shows one end of the primary platform situated below one end of the work platform to illustrate how the two are interconnected. Of course, in FIG. **38** the illustration of one of either the primary platform or the work platform is

180 degrees rotated from the position that the rotated platform would be when in actual use, but the illustration shows the interconnection well. More specifically, in FIG. **38** the plate **420** of the work platform **404** is shown vertically above the plate **408** of the primary platform **402**. As the work platform is moved downwardly toward the primary platform, in the direction of the arrows in FIG. **38**, the locating block **514** slides into the slot **508** between the two guide blocks **502** and **504**. The connecting posts **424** on work platform **404** slide into the notches **416** on the primary platforms **402** with the notches **416** engaging the circumferential slots **428**. The receptacles **418** are captured between the primary platforms and work platform and thus also function as stand offs to ensure the proper spacing between the plates and as stabilizing structures between the connected platforms, and the spacing blocks **510** and **512** also act as stand offs to ensure spacing.

The manner of connecting the primary platforms **402** to the ladders **100**, and the work platform **404** between the two primary platforms defines a very strong and stable scaffolding platform. Because the locating block **514** is located in guide slot **508** between blocks **502** and **504** with minimal tolerance between the blocks, the work platform **404** is prevented from axial rotation relative to the primary platforms **402**. As an example, with reference to the scaffolding system **400** as shown in FIG. **26**, which includes a ladder **460** attached to one side of the work platform **404**, the ladder **460** can place a large load along the edge of the work platform that tends to put an axial rotational load on the work platform (axial being along the longitudinal axis of the work platform). The stabilization and anti-rotation system **500** as described and shown in the drawings prevents relative rotation of the work platform relative to the primary platforms and thus increases safety.

It will be appreciated that the ladders **100** that are used as part of a scaffolding system **400** that utilizes the stabilization and anti-rotation system **500** may be oriented relative to one another in any of the orientations described above. It will further be understood that the relative positions of the stabilization components described above may be reversed. For example, the guide blocks **502** and **504** may be located on plate **408** with the locating block **514** located on plate **420**.

It is believed that the present invention as described and its many attendant advantages will be understood by the foregoing description. It is also believed that it will be apparent that various changes may be made in the form, construction and arrangements of the components thereof without departing from the scope and spirit of the invention and without sacrificing all of its material advantages. Thus, the breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments, but should instead be defined only in accordance with the following claims and their equivalents.

The invention claimed is:

1. Apparatus for stabilizing a work platform extending between first and second ladders, comprising:

a first platform attached to a first ladder, the first platform having a first side plate having first and second notches formed therein, each of the notches being vertically oriented and having an open upper end and a closed lower end, and a locating block attached to the first side plate;

a second platform attached to a second ladder, the second platform having a second side plate having first and second notches formed therein, each of the notches being vertically oriented and having an open upper end and a closed lower end, and a locating block attached to the second side plate;

a work platform having opposed first and second end plates, each of the first and second end plates of the work platform having first and second connecting posts extending therefrom, wherein each of the first and second end plates of the work platform further have a pair of spaced apart guide blocks defining a guide slot therebetween adapted to receive a corresponding one of the locating blocks;

wherein the work platform is adapted to be connected to the first and second platforms with the respective first and second end plates of the work platform facing the respective first side plate of the first platform and second side plate of the second platform, the locating blocks configured for sliding downwardly into the guide slots, and ends of the respective first and second connecting posts of the first and second end plates of the work platform sliding downwardly into the respective first and second notches of the first and second plates of the first and second platforms such that the ends of the connecting posts are supported by the closed lower ends of the notches and can be removed therefrom by lifting the work platform and sliding the ends of the connecting posts upward through the open upper ends;

wherein each locating block is received in the corresponding guide slot with sufficiently close tolerance to prevent axial rotation of the work platform relative to the first and second platforms.

2. The apparatus according to claim **1** wherein the first and second ladders are folding ladders.

3. The apparatus according to claim **2** wherein the first and second ladders are cantilevered ladders.

4. The apparatus according to claim **1** in which each locating block is defined by a vertically oriented member having a width and the guide slot is a vertically oriented, and wherein the slot has a width that is greater than the width of the vertically oriented member.

5. The apparatus according to claim **4** in which each vertically oriented member has an upper end that is tapered.

6. The apparatus according to claim **4** in which each of the guide blocks has a lower end that is tapered.

7. The apparatus according to claim **1** in which the first ladder is positioned relative to the second ladder such that both ladders are facing the same direction.

8. The apparatus according to claim **1** in which the first ladder is positioned relative to the second ladder such that the second ladder is rotated by 90 degrees relative to the first ladder.

9. The apparatus according to claim **1** in which the second ladder is rotated by 180 degrees relative to the first ladder.

10. The apparatus according to claim **1** further including at least two spacers on each of the first and second end plates of the work platform.

11. The apparatus according to claim **1** in which the first and second platforms further include receptacles for receiving upright posts.

12. Apparatus for stabilizing a work platform extending between first and secondladders, comprising:

a first cantilevered ladder defined by first and second stepped unit side rails, a top plate interconnecting the first and second stepped unit side rails at an upper end thereof, a support unit defined by first and second support unit side rails, and a primary platform attached

to the first and second stepped unit side rails and extending over the top plate;

a second cantilevered ladder defined by first and second stepped unit side rails each having bottom ends, plural steps interconnecting the first and second stepped unit side rails, a top plate interconnecting the first and second stepped unit side rails at an upper end thereof, a support unit defined by first and second support unit side rails, and a primary platform attached to the first and second stepped unit side rails and extending over the top plate;

a scaffolding platform having a first end interconnected to the primary platform of the first cantilevered ladder and a second end interconnected to the primary platform of the second cantilevered ladder, the first and second ends of the scaffolding platform being interconnected to the primary platforms in a manner that allows removal of the scaffolding platform from the primary platforms simply by lifting the scaffolding platform vertically to slide male connectors upwardly out of vertically oriented receiving notches;

a first anti-rotation assembly associated with the interconnection between the first end of the scaffolding platform and the primary platform of the first cantilevered ladder and a second anti-rotation assembly associated with the interconnection between the second end of the scaffolding platform and the primary platform of the second cantilevered ladder;

the first and second anti-rotation assemblies each comprising

a locating member attached to a selected one of either a primary platform or an end of the scaffolding platform, the locating member defined by a vertically oriented member with a tapered upper end; and

a locator receiver attached to the primary platform or the end of the scaffolding platform to which the locating member is not attached, the locator receiver comprising a pair of spaced apart members defining a vertically oriented guide slot therebetween into which the locating member is received by a vertical sliding motion;

wherein each locating member is received in the corresponding locator receiver with sufficiently close tolerance to prevent axial rotation of the scaffolding platform relative to the primary platforms.

13. The apparatus according to claim **12** wherein the first and second cantilevered ladders are folding ladders.

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