Title: PLATFORM SYSTEM FOR GREENHOUSE ROOF

Abstract: A platform system useful for constructing, maintaining, or repairing greenhouse roofs comprises a platform section providing a working area surface formed with removable treads supported on left and right platform rails. The platform section is supported by downwardly projecting upper and lower support bases appointed to rest on structural members of the roof, thereby providing a clearance between the working area surface and the roof beneath. Guardrails extend along the sides of the platform section between guardrail posts attached at the upper and lower ends of the platform rails. The system is light-weight, minimizing the loading imposed on the roof and permitting it to be readily positioned by a small work crew. The support base may include retractable rollers that permit it to be slid upward across the eaves and onto the roof. A deployment assist cart may be used to erect, support, and access the platform system.
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TITLE
PLATFORM SYSTEM FOR GREENHOUSE ROOF

CROSS-REFERENCE TO RELATED APPLICATION

FIELD OF THE INVENTION
The present invention relates to a platform useful for safely constructing, maintaining, and repairing the roofs of greenhouses and other like building structures, which are relatively fragile and cannot sustain excessive loads.

TECHNICAL BACKGROUND
Greenhouses have long been used to provide a controlled climate for growing plants. Typically a greenhouse includes a skeletal structure made of metal (or possibly wood) supporting a roof formed of a material that is transparent to light but impervious to the passage of air or precipitation. Glass and plastic or polymeric materials are commonly used. Often the same materials are used to construct some or all of the walls of the greenhouse.

Light from the sun incident on a greenhouse includes radiation in both visible and infrared (heat) wavelengths. Some of this light passes through the walls and roof and is absorbed, heating the interior of the greenhouse and its contents. The walls and roof provide a closed construction that minimizes loss of that heat through unwanted circulation of the interior air to the exterior. Plants grown in a greenhouse can thus be kept warmer than they would be if simply situated in ambient air. Sometimes natural light is supplemented by artificial light. The inside air can also be heated and/or cooled and may be circulated by fans.

Greenhouses are used worldwide for a number of purposes, including their use to extend the typical growing season at both ends for plants and to permit plants to be cultivated in a given climate zone in which they otherwise could not be sustained. For example, in temperate climates, plants can be started from seed much earlier in the spring and may continue to produce flowers or fruit much later into the fall than they otherwise would. Many greenhouses are used to raise plants on a commercial scale that are either ornamental or produce edible fruits or vegetables. Greenhouses are also used to raise exotic or tropical plants for display in botanical gardens or to provide such plants to florists, and for horticultural and other botanical research projects.
Greenhouses are found in many configurations. For some, such as those in botanical parks and other public spaces, aesthetic appeal is a paramount design factor, so architects have included intricate, multi-planar or curvilinear roof shapes. On the other hand, utilitarian factors such as efficiency and minimizing costs of construction, operation, and maintenance govern the vast majority of designs for commercial greenhouses. The smallest sizes are sometimes built with a simple metal frame structure covered with a flexible film of material such as polyethylene. However, this construction has limited durability and resistance to wind and precipitation (rain, snow, hail, etc.), so roofs of larger commercial structures are commonly built with simple shapes having a limited number of large, planar surfaces formed with rigid panels of glass or comparable plastic materials.

For example, a common greenhouse structure is depicted generally at 10 in FIG. 1. Greenhouse 10 has side supporting walls 20 and end or gable walls 21. The roof configuration shown is frequently termed a pitched or sloped roof; it includes two large, planar, sloped sides 12 that join at an apex 14 to form a configuration having the shape of an inverted vee, when viewed from an end wall. A skeletal structure includes a series of rafters 16 that extend on both sides between a ridge beam 18 and eaves 19, which are formed at the junction of roof side 12 and the corresponding side supporting wall 20. Wall supports 17 are included in both side and end walls 20, 21. One or more cross members 22 run transverse to, and are supported by, rafters 16. Often, some or all of rafters 16 form part of a truss structure (not shown) as required to support a preselected design load. Ordinarily, the design load accounts for: the static structure of the building and its appointments; wind and snow loading; and incidental loading (often termed "live loading"), such as that resulting from workers servicing the roof.

The horizontal spacing between adjacent rafters 16 is ordinarily governed by the size of glass panels 26 that can be effectively supported just at their lateral edges 30 at the selected roof pitch. In a common configuration, the glass panels are installed in a shingled fashion, beginning from the eaves upward toward the ridge, with each successive ascending panel being lapped slightly over its lower predecessor to minimize the intrusion of precipitation and wind. The glass panels may be secured using a technique apparent in the detailed, cross-sectional view of FIG. 2. The lateral edges 30 of panels 26 are received in channels of an elastomeric, compliant gasket structure or caulking 36. The gasketing in turn is sandwiched between a rafter (here shown as a box beam 34) and a glazing bar 32 mounted above, and running parallel to, beam 34. Together, the box beam 34 and the attached glazing bar 32 are frequently termed a purlin. A fastener, such as screw 40 with a corresponding elastomeric sealing washer 42, secures the glazing bar 32 and
the glass panels 26. The glazing bars 32 can be readily removed to allow
replacement of glass panels 26.

Frequently a ridge vent (not shown) is created at or near the ridge beam 18; it
may be selectively openable to permit adjustment of the ventilation in the building. In
some designs, some or all of the glass panels adjacent the ridge are mounted in
openable frames to provide the ventilation. Additional glass panels elsewhere in the
roof may also be made openable for additional ventilation. The structural members
are almost always metal, although wood or other materials could be used.

Larger greenhouses are sometimes constructed by joining additional pairs of
roof sections that alternate in slope, a form sometimes termed “ridge and furrow.”
For example, a configuration having the shape of an inverted letter “W” (as seen in
door view) could be formed using four planar sections. Such construction provides a
structure having increased width, while maintaining the slope angle of the individual
sections, but without increasing the overall height, as would be required for a single

It will be understood that the term "glass" is used herein to refer either to
conventional glass panels of the types used ubiquitously in construction or to other
frangible, transparent or translucent panel materials such as poly(methyl
methacrylate) (e.g., PLEXIGLAS®) and polycarbonate (e.g., LEXAN®) that are also
commonly used. Greenhouses are commonly constructed with ordinary soda-lime
window glass, but more advanced tempered and laminated safety glasses are
sometimes used. These advanced glass and plastic materials typically cost more but
afford some advantages of improved safety and durability.

Society has increasingly recognized the importance of providing safety
systems and equipment to mitigate or prevent injury to workers during building
construction, operation, and maintenance. The prevalence of injuries in the past has
prompted industry to voluntarily improve its own standards and practices. Regulations
have also been imposed by governmental agencies. In general, safety
practices that address these requirements are known and relatively easy to
implement in many conventional construction and later maintenance and repair
operations. However, the extensive use of frangible materials like glass in
greenhouse roofs presents significant challenges that go beyond what is
encountered with other, more common building types. For example, the hazard of
falling off a roof is common to all buildings, but a worker on a greenhouse is
additionally vulnerable to falling through a glass roof panel and being lacerated by
broken glass or injured by hitting internal structural members or a hard ground
surface attendant to the fall below. An even greater potential for serious, even life-
threatening, injury is apparent.
Inevitably, glass roofs are vulnerable to damage during construction and during their ordinary use, whether resulting from inadvertent human actions or from external causes, like hail or other falling objects. Post-construction repairs often must be done quickly and under adverse conditions, which typically heighten the likelihood of accidents.

Repairs are sometimes made from a suitably positioned cherry picker crane that provides a worker access from a platform suspended above a work area. However, implementing this approach is typically costly, and a suitable ground location for the cherry picker close enough to the roof area may not be available.

Thus, workers often resort to planks or ladders placed directly onto the roof structure to form a makeshift working surface from which a worker can perform required repairs. However, these approaches do not afford acceptable safety, as safety equipment and precautions effectively used for conventional buildings are inadequate, inapplicable, or inoperable.

For example, fall protection is ordinarily required for persons such as roofers working more than a few feet off the ground. In some instances, railing systems associated with scaffold platforms or ladders are adequate, but often, workers must have mobility that makes these systems difficult or impossible to implement, so other approaches are needed.

Although various safety equipment and methods are known, including those described above, there nevertheless remains a need for systems that facilitate construction and repair of roofs of greenhouses and other buildings.

SUMMARY OF THE INVENTION

An aspect of the invention relates to a platform system elongated along a platform length direction between a lower end and an upper end and having opposing left and right sides separated along a platform width direction, the platform system being configured for placement on a roof structure and comprising:

(a) left and right upper-end guardrail posts and left and right lower-end guardrail posts;

(b) a platform section that extends along the platform length direction for a platform length and comprises:

(i) left and right platform rails that are disposed in spaced-apart, parallel relationship and extend horizontally along the length of the platform section between the upper and lower ends of the platform system, the upper-end guardrail posts and the lower-end guardrail posts being attached to the respective platform rails,

(ii) a plurality of platform treads disposed along at least a portion of the platform length, each tread having left and right edges and
spanning the left and right platform rails and being removably secured thereto, the treads collectively defining a working platform area having a platform width sufficient to accommodate a worker and a preselected working length defined by the number of treads present, and

(iii) left and right guardrails that extend horizontally along the respective sides of the platform system for substantially the platform length, are attached to the respective left and right platform rails through the lower and upper guardrail posts, and are situated at a preselected height above the platform area;

(c) an upper support base proximate the upper end and comprising an upper horizontal member; and

(d) a lower support base proximate the lower end and comprising a lower horizontal member, and

wherein the upper and lower support bases project downward from the platform section and are configured to rest on the roof structure to support the platform system and maintain a clearance between the roof structure and the platform section.

In some implementations, the present platform system is modularized, comprising a plurality of constituent parts or subassemblies that may be assembled and disassembled repeatedly. Modular construction facilitates convenient transportation and storage of the system, and permits the platform system to be adapted so it can be used to access roofs of different sizes and configurations.

Another aspect provides a platform erection system wherein the present platform system is used in conjunction with a deployment assist cart that comprises:

(a) a platform base section;

(b) a deployment support upstanding from the platform base section;

(c) deployment rails connected to the deployment support and configured to receive the platform system for deployment on the roof structure.

In an implementation, the deployment rails are rotatable between a loading position configured to accept the platform system and a deployment position configured to permit the platform system to be maneuvered from the deployment rails onto a surface of the roof structure. The deployment assist cart is beneficially employed in any of the transportation, erection, and support and stabilization of the platform system on a roof structure.

A further aspect provides a kit that comprises parts that, when assembled, are capable of forming the platform system of the present disclosure. In another implementation, the kit further comprises parts that, when assembled, are capable of
forming the present deployment assist cart, which is configured to receive the platform system for deployment on a roof structure.

A still further aspect provides a method that provides access to a structure that may, without limitation, be a greenhouse roof structure. The method comprises providing the platform system of the present disclosure and disposing the platform system on a flat or sloped area of the structure, whereby access is provided to the area.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The present disclosure will be more fully understood and further advantages will become apparent when reference is made to the following detailed description of certain of the preferred embodiments and the accompanying drawings, wherein like reference numerals denote similar elements throughout the several views and in which:

FIG. 1 depicts in perspective view a schematic form of a conventional greenhouse having a pitched roof;

FIG. 2 depicts in a detailed, cross-sectional view (taken at 2—2 in FIG. 1) a conventional attachment of glass roof panels to a supporting rafter using a glazing bar;

FIG. 3 depicts in perspective view a schematic form an implementation of the present platform system;

FIG. 4 depicts in side elevation view a tread attachment used in an embodiment of the present platform system;

FIGS. 5A - 5B depict details of one possible tread attachment employed to secure platform treads to the platform rails of an embodiment of the present platform system; FIG. 5A is a top plan view of a portion on the left side of the platform system and FIG. 5B is a cross-sectional view taken at 5B—5B in FIG. 5A;

FIGS. 6A - 6B depict in perspective view a roller assembly that includes a spring mechanism employed in an embodiment of the present platform system, with the roller depicted in its retracted and extended positions in FIGS. 6A and 6B, respectively;

FIG. 7 depicts an inclined platform tread included in an embodiment of the present platform system, taken in side elevation view;

FIG. 8 depicts in perspective view a modular platform system of the present disclosure;

FIG. 9 is an enlarged perspective view of a portion of FIG. 8, showing schematically the connection system used to join the modular components of the FIG. 8 platform system embodiment;

FIG. 10 depicts in perspective view the modular assembly of multiple platform
subsections to form a platform system in accordance with an aspect of the present
disclosure;

FIG. 11 depicts in perspective view a deployment assist cart used in
accordance with an aspect of the present disclosure; and

FIGS. 12A - 12C depict in side elevational view stages of the erection of the
platform system onto a roof using the deployment assist cart of FIG. 11.

DETAILED DESCRIPTION

An aspect of the present disclosure addresses the need for a platform
system that allows a worker to construct and maintain roofs safely and conveniently,
including especially the sloped roofs of greenhouses and like structures that are
constructed of glass or other fragile materials. Embodiments of the platform system
have a configuration that is adaptably sized and can be placed onto the roof, with the
loading supported on appropriate structural members of the roof system. The
platform system can be configured to permit a worker to easily access specific glass
panels of a greenhouse roof for repair or replacement while providing a greatly
improved level of security and protection.

Generally stated, embodiments of the present platform system include one or
more of: (i) a platform section comprising a working surface having an adjustable
working length; (ii) a railing system on one or both sides of the platform that protects
a worker from inadvertently falling off the platform; (iii) support bases that allow the
platform system to be supported with a clearance maintained between the working
surface and the underlying roof; and (iv) anchorage points to which a worker's fall
arrest system can be reliably secured. The platform system ordinarily is disposed on
a sloped roof with its lower end approximately at the eaves of the roof and with its
length direction extending along a line toward the roof ridge. It facilitates convenient
and immediate access to any desired area of a roof structure underneath the platform
system or adjacent to it.

The platform system is described herein with principal reference to its use in
constructing and repairing glass-roofed greenhouses. However, it will be understood
that embodiments of the platform systems provided herein are equally useful with
roofs constructed with other fragile materials (e.g., slate or terra cotta tile) not
capable of sustaining significant loads by themselves. More generally, the platform
system and the optional deployment assist cart herein could be used beneficially in
any other situation in which access to a horizontal or sloped area of a structure is
desired but it is preferred, or probably necessary, that the loading that results be
applied only in defined points or regions outside that immediate horizontal or sloped
area.
The present platform system beneficially includes removable platform treads. They are ordinarily installed beginning at the lower end, with the total number of treads being preselected to provide access and define a working surface that extends just up to the roof area to be serviced, without obscuring it. Thus, the platform system provides great flexibility, with the working surface appointed to allow a worker to walk or crawl to gain access to the area of interest, and to sit, kneel, or lie close enough to carry out required activities in that area safely, conveniently, and comfortably. In an embodiment, the platform area and the associated platform treads are approximately 30 inches (75 cm) wide to afford easy passage and positioning of the worker, but other dimensions are also possible. Although not required, the platform system is typically constructed in sections that are at least 5 feet (1.5 m) long, but sections constructed in any convenient length, such as 10, 15, or 20 feet (3, 4.5, or 6 m) or more are also possible, especially if fabricated with lightweight materials that facilitate easy handling, as described in more detail below.

The terms "horizontal" and "vertical" are used herein to describe, in the conventional sense of those terms, the orientation of certain structural members of the present platform system when it is resting on a level, flat surface. Vertical members are thus ones that extend in a direction perpendicular to the plane of the level surface; horizontal members extend parallel to the plane of the level surface, and include ones oriented along either the platform length direction (e.g., platform rails 56 and guardrails 58 shown in FIG. 3) or the platform width direction (e.g., platform treads 78 and horizontal members 60, 61 of FIG. 3). (Of course, when the platform system is placed on a sloped roof (also termed a "pitched roof"), the horizontal components that extend along the platform length direction become inclined at an angle that generally conforms to the angular pitch of the roof and the vertical components are oriented in a direction generally perpendicular to the plane of the roof.)

The present platform system and the working area provided thereby are described as elongated, meaning that they extend horizontally along a platform length direction with a platform length dimension that is ordinarily greater than a corresponding horizontal width dimension measured across the platform working area in a platform width direction perpendicular to the platform length direction. Hence, the platform system and certain components thereof are described as having "upper" and "lower" ends, which refer to the respective ends that are higher and lower in elevation when the system is disposed with its length extending generally along a direction between the eaves and the ridge of a sloped roof structure. Of course, other placements on a roof are also possible. Unless otherwise specified, "left" and "right" are used in reference to the sides of the platform system when viewed along
the length direction from the lower end. As used herein, the term "working area" refers to the area of the present platform system that is accessible and configured to permit a worker to walk, stand, sit, kneel, or the like in the ordinary course of using the system. In general, the working area is provided by removable platform treads, though there may also be ancillary or peripheral areas that provide some additional amount of accessible space but are not covered with removable treads. The "full working area" is defined as the working area afforded when platform treads are installed in all available positions between the ends of the platform rails, whereby worker access is provided along the entire length of the platform system.

The present platform system and its various components may be constructed of any suitable structural materials that afford the requisite strength and other mechanical properties. Certain embodiments employ lightweight materials to minimize the loading imposed on structures on which the platform is situated during its ordinary use.

One possible embodiment of the present platform system is depicted by FIG. 3. Platform system 50 includes a platform section 52, which comprises left and right platform rails 56 that extend substantially the full length of the platform section, left and right guardrails 58, upper-end guardrail posts 68, and lower-end guardrail posts 70. In the embodiment of FIG. 3, the guardrail posts 68, 70 are attached to platform rails 56 through intervening structural members included in upper and lower support bases 79, 80. Other configurations that provide attachment of the guardrail posts to the platform rails, either directly, or indirectly through intervening members, are also contemplated.

One or more platform treads 78 span the left and right platform rails. In the FIG. 3 implementation, the treads are supported at each side by flanges 57 that project inwardly from the respective platform rails 56, as also depicted for one possible embodiment by FIG. 5B. Alternatively, platform rails 56 might be configured to provide support and anchorage for treads 78 directly. It is preferred that the platform rails be situated at the left and right sides of the platform section, with the platform treads therebetween. However, in other embodiments, the platform rails might be displaced inwardly from the sides of the platform section, provided adequate stability can be maintained.

FIG. 3 depicts the guardrail posts 68, 70 as being vertical (i.e., perpendicular to the surface of the platform treads). In other embodiments (not shown), the guardrail posts are angulated, so that they become approximately vertical with respect to the ground after the platform system is disposed on a sloped roof. Guardrails 58 are disposed horizontally at a preselected height above the surface of platform treads 78 and supported at their ends by lower and upper guardrail posts.
Although the guardrails may be situated at any convenient height, they typically are positioned in accord with recognized design guidelines or regulatory standards for worker protection. Ordinarily, the height is such that each guardrail can function both as a handrail for a worker traversing the platform system and to inhibit the worker from falling off the side. The guardrails additionally can provide sites for anchorage points for worker fall protection equipment, as described in more detail below.

The guardrail system in some embodiments of the present platform system further comprises a sidewall to afford additional protection, inter alia, by inhibiting a prone worker from rolling off the side of the platform system through the space between the working surface and the guardrails. For example, the sidewall may be provided by screening or by one or more midrails that extend horizontally from the lower to upper guardrail posts and are located intermediate the working surface and the guardrail. Other implementations include optional bracing members in the guardrail system. For example, and without limitation, the sidewall in the embodiment of FIG. 3 includes cross braces 66 and middle support posts 72 that further connect guardrails 58 and platform rails 56. These bracing members both enhance the structural integrity of the platform system and help obscure the opening between the platform surface and guardrails 58 to further inhibit a worker from falling off the platform system.

Embodiments may also include toerails located contiguous to the working area. In the FIG. 3 embodiment, toerails 74 project perpendicularly upward from platform rails 56 and extend along the platform length. Toerails enhance safety, both by inhibiting a worker walking on the platform from stepping off the edge and by reducing the likelihood that items on the platform surface, such as tools, equipment, or supplies, would fall from, or be kicked off, the platform sides. In some embodiments, toerails 74 (as well as other portions of the structure) include holes (such as holes 76) to reduce overall platform weight. Toerails may be anchored in any suitable way, including without limitation direct attachment to either the guardrail posts, the platform rails, or the treads. Alternatively, as can be appreciated by reference to FIG. 5B, the need for separate toerails might be reduced or eliminated by employing a platform rail 56 that is tall enough above support flange 57.

The guardrail system, including the midrails and toerails if present, extends substantially the platform length, meaning that the railing coverage along the left and right sides of the platform system is sufficient to afford fall protection for a worker present anywhere on the working surface. In most embodiments, the guardrails extend continuously between guardrail posts that are attached to the platform rails at or near their respective opposite ends.
In some embodiments, the guardrail system is prepared as a unitary assembly, meaning that each horizontal guardrail and its associated upper and lower guardrail posts, and possibly other components, are formed as a single-piece assembly, such as by welding or otherwise permanently joining multiple components to form the single piece; by bending a single elongated member at its ends to form guardrail posts perpendicular to an intermediate guardrail section; or by any other suitable manufacturing process. A unitary guardrail assembly may also incorporate midrails, cross bracing, middle support posts, toerails, or other desired structural members. Alternatively, separate guardrail and guardrail post members may be connected in a non-unitary assembly by any suitable form of mechanical attachment, including, without limitation, bolted tube and socket connectors.

The present platform system can readily be equipped with suitable anchorage points for a personal fall arrest system. Such systems typically include a body belt or harness fitted to a worker and tethered by at least one rope, cable, chain, webbing strap, or the like to a suitable anchorage point. Once in the appointed working location, the worker attaches the tether to the anchorage point with a releasable locking clip, such as a carabiner or snap hook. However, the practical efficacy of any fall arrest system is completely dependent on having a conveniently positioned and anchorage point.

A functioning fall arrest system greatly reduces the likelihood of a serious injury to a worker from in the event of a fall, and may allow timely rescue and removal of the worker to safety. Many industry and governmental standards now require this or comparable protection for workers at elevated locations.

Adequate safety protection is particularly challenging for workers on a glass-panel greenhouse roof. The solid decking of many conventional roof constructions means a worker ordinarily is in danger only of falling only at the side or edge, whereas a worker on a greenhouse roof can also fall through the glass panels, with the potential of both lacerations from a broken panel and trauma from hitting structure on the way down and/or the floor or ground below. Suitable anchorage points readily be established on a conventional roof, e.g. by attachment to normal structural members or the roof deck itself, but are ordinarily unavailable or difficult to access on a glass roof.

An embodiment of the present platform system provides one or more anchorages for the tethers of a personal fall arrest system. Typically, these anchorages can be provided by any structure to which a locking clip, such as a carabiner or snap hook, can be removably attached. Ideally, the anchorages are adequate to sustain the load that might reasonably be expected in a fall or other like foreseeable emergency. In various embodiments, the anchorages of the present
platform system comprise one or more discrete anchorage points that provide an aperture configured to render it capable of engaging a locking clip. Useful forms of such discrete anchorage points include, without limitation, eyebolts, and secured free rings having round, oval, d-ring, or other similarly functional shapes. They may be located at any accessible point. In a particularly convenient embodiment, the platform system comprises a plurality of discrete anchorage points disposed along both guardrails, thereby providing a worker using the platform system one or more anchorage points located in proximity to the working area with any possible tread configuration. FIG. 3 depicts a plurality of discrete anchorage points in the form of inwardly-projecting eyebolts 59 that are spaced along guardrails 58. Alternatively, anchorage points might be placed on the toerails, midrails, or platform treads, or at any other suitable location. Fall arrest systems could also be anchored directly to the guardrail or to a free rope separately secured at both ends, e.g. to the guardrails.

The structural integrity of the platform system shown in FIG. 3 is even further enhanced by structure at the platform ends, including upper and lower support bases 79, 80. In a representative intended use, the platform system is configured to be placed so that at least its upper support base, and possibly its lower support base as well, engage load-capable structural members of a sloped, glass-paneled roof system. The platform system and its full load are thus situated on the roof and supported so that a clearance is maintained underneath at least the working area and a worker has access to glass panels and other elements in a desired region of the roof structure. In the FIG. 3 configuration, the support bases 79, 80 respectively comprise upper horizontal member 61 and lower horizontal member 60, which are directly connected to platform rails 56. In other embodiments, the connection between the horizontal members and the platform rails is made indirectly through other intervening members. The FIG. 3 structure further comprises side braces 62 and gusset braces 64 attached to the horizontal members 60, 61 and the guardrail posts 68, 70. The selection, sizing, attachment, and placement of the various end and side bracing members included in the FIG. 3 embodiment are done in a manner consistent with the desired capabilities and requisite strength of the platform system.

In various embodiments, the support bases 79, 80 also include optional upper and/or lower support pads that extend below the horizontal members, of which support pads 86, 87 in FIG. 3 are representative.

FIG. 3 shows the support bases being located at the upper and lower ends of the platform system, but in other implementations one or both are located somewhat away from the ends, displaced along the length direction toward the center by any distance that still permits adequate stability to be maintained. One such configuration is depicted by FIG. 10, wherein lower support base 80 is located at the lower end of
the platform section, but upper support base 79 is displaced somewhat below the upper end.

The lower and upper horizontal members 60, 61 in FIG. 3 are structured as outriggers that extend laterally to a width greater than the width of the platform area itself. Increasing the effective lateral extent of the horizontal members improves the stability of the platform system against tipping to the side, both while it is being positioned and when it is in use and supporting personnel and materiel. Widening the outriggers also distributes the loading imposed on the roof structure, due to the weight of both the platform system itself and the personnel and materiel it carries, over a larger area. However, too high an outrigger span limits the placement of the platform system near the edge of a roof, e.g. at the gable end of a typical sloped roof. In the case of the FIG. 3 embodiment, the effective width at the upper end of the platform system in use is established by the point at which the pair of support pads 86 and/or rollers 82 rest on underlying roof structural members. Optionally, the lateral positioning of the pairs of support pads relative to the platform system (and thus the corresponding pad spacing) is adjustable to accommodate different roof configurations. For example, the point at which support pads 86 are attached to the outrigger portion of upper horizontal member 61, as depicted in FIG. 3, might be made adjustable.

The present platform system employs platform treads that are removably secured to the platform rails. For clarity of illustration, FIG. 3 depicts only two platform treads 78, one installed onto the platform rails 56 and a second one positioned to be installed. Treads 78 rest on support flanges 57 that project inwardly from platform rails 56. It will be understood that any desired number of platform treads 78 may be installed sequentially along platform rails 56 to create the requisite access path, beginning at the lower end of platform section 52 and extending toward the upper end for a preselected distance. The distance is selected so that a worker can easily position himself for convenient access to service a desired section of the roof over or beside which the platform system is situated. Platform treads 78 are preferably sized to permit the length of the access path to be selected in convenient increments. Preferably, platform treads 78 are installed with only a minimal gap between adjacent treads to minimize a tripping hazard for a worker ascending the path and to prevent tools, supplies, debris, or the like from falling through, but some amount of gap is possible.

Any suitable form of tread attachment may be used to removably secure the platform treads. At least one attachment should be provided proximate the left and right edges of each tread, but two or more attachments may be used on each side to improve the stability and secure positioning of the attachment. In one simple form,
the tread attachment comprises a threaded fastener system such as a bolt and nut arrangement, with the treads and platform rails having alignable apertures through which the fasteners can be passed and secured. Self-aligning arrangements are preferred for ease of configuration and assembly in the field.

For example, each platform rail may provide a U-shaped channel having an inwardly-facing opening sized to accept and support platform treads of a desired type. In this configuration, the treads either are slid in from the top or bottom end or are placed at the requisite level and rotated from an oblique orientation with respect to the platform length into horizontal orientation to effect engagement on both sides with the U-channel. Attachment can also be made using threaded fasteners such as a bolt and engaging nut or expanding toggles.

Another tread attachment method (shown in FIG. 4) employs U-shaped step brackets 102 spaced regularly along flanges 57 of the opposing platform rails 56 and oriented with their open ends toward the upper end of the platform system. Suitable treads 78 are dropped into slots provided by the open ends of step brackets 102. Apertures 106 in the top portion of each tread 78 are configured to engage studs 104 upstanding from platform rail 56. FIG. 4 depicts one tread already in position and a second tread inserted in its bracket and ready to be lowered over its corresponding stud. Optionally, studs 104 are threaded, so a nut (not shown) can be attached after placement of the tread to improve the security of the attachment. Other arrangements for securing the treads are also contemplated.

Still another form of self-aligning tread attachment is depicted in FIGS. 5A and 5B. For clarity of illustration, FIG. 5A shows a single attachment point proximate the left edge of representative treads 78a, 78b, but it will be understood that the treads are similarly attached on both sides, and preferably at two or more points on each side, to provide greater stability and security of attachment. This form is particularly convenient and reliable, because it permits treads to be installed and removed quickly and without the need for tools or separate fasteners.

In the implementation depicted, each platform rail 56 comprises an inwardly-projecting support flange 57 configured to support the peripheral edges of platform treads 78a, 78b. In FIG. 5A, tread 78b is shown in full engagement, while tread 78a is depicted as it is being installed, prior to its final engagement in the position indicated by dotted lines 119.

Still referring to FIGS. 5A and 5B, a plurality of upstanding studs 108 are attached at regular intervals along the support flanges 57 on both sides of the platform. Each stud 108 includes an enlarged, terminal head 110 portion and a smaller-diameter shank 112 portion. Each platform tread includes a keyhole-shaped slot 114 having a small-diameter portion 116 extending in the platform length
direction upwardly away from large-diameter portion 118. Slot 114 is configured for locking engagement with stud 108.

Head 110 has a diameter such that it can pass through large-diameter portion 118 but not small-diameter portion 116 of slot 114, while shank 112 can slide through portion 116. Tread 78a is shown as being placed so that the large-diameter portion 118 of its keyhole-shaped slot 114 is oriented toward the lower end of the platform and with head 110 protruding through slot portion 118. Thereafter, tread 78a is secured by sliding it downward in the direction D into the position defined by dotted lines 119, so that shank 112 becomes located in portion 116. Tread 78b is shown in the resulting, fully-engaged configuration. FIG. 5B shows in cross-section the full engagement of a stud 108 in a slot 114.

The platform treads are fabricated from any suitable material that provides sufficient strength, stiffness, and durability. Safety is promoted by a non-slip top surface on the treads, such as one that is suitably patterned, textured, or roughened. A gritty surface is especially beneficial for using the platform system in adverse weather. Metal or wood treads can be used, but strong, lightweight composite materials beneficially reduce weight. For example, a lightweight, non-skid platform tread can be fabricated using a KEVLAR® para-aramid-carbon fiber composite.

Some implementations of the present platform system include an inclined top platform tread as the uppermost tread. As depicted in FIG. 7, such an inclined top platform tread 120 is inclined by an angle \( \phi \) with respect to the platform horizontal direction, so that when the platform system is erected on a roof sloped upward by approximately the same angle \( \phi \), the surface 122 of the top platform tread 120 is approximately parallel to the plane of the ground and a floor of the greenhouse or like structure. This surface 122 thereby provides a level area on which a worker can safely and comfortably stand, kneel, or lie while performing required tasks. Surface 122 is supported by riser 124, which extends from base section 126 to surface 122. The same attachment means used to secure the running platform treads can also be used to secure the inclined top platform tread to the platform rails at the desired point along its length. For example, the FIG. 7 configuration is shown with keyhole-shaped slots 114 of the same type as seen in FIGS. 5A and 5B. It is preferred, but not required, that an inclined top platform tread be longer than the remaining platform treads 78 so that its flat surface 122 is large enough so that a worker can safely stand, sit, or kneel thereon.

In another variant, some or all of the running platform treads may have an inclined configuration, so that the platform has the general appearance of a staircase and the platform treads function as stair steps on which the worker can ascend to the
desired level, instead of walking up on an inclined, but generally planar, platform path.

The present platform system is appointed to be supported over a roof system in a manner that permits it to be used by a worker servicing an area of the roof beneath. Typically, one or both of the ends of the system are configured so that they may bear on capable structural members of the roof, such as the purlins depicted in FIGS. 1 - 2. Optionally, the lower end may be configured to engage either structure at the eaves 19 of roof side 12, if available, or, alternatively, a ladder or scaffold or the like positioned next to side wall 20, e.g. an engagement effected using one or more clamps.

For example, the lower end of the FIG. 3 embodiment includes clamps 77 attached to the platform system, e.g., to lower horizontal member 60. Clamps 77 are configured to engage structure that may be available at the eaves of some greenhouses. The upper end includes upper support pads 86 that project downwardly from the upper horizontal member 61. Together clamps 77 and upper support pads 86 permit platform system 50 to be secured with its lower end at the eaves and to extend upwardly along the greenhouse roof with at least its upper support base bearing on the roof's structural members. The platform system is thereby supported, so that a slight clearance is maintained between it and the underlying roof. Thus, a worker is enabled to access a desired portion of the greenhouse roof for construction, maintenance, repair, or like operations. It will be understood that clamps 77 may be configured in any form needed to ensure a secure connection to available support structure, whether part of the greenhouse structure itself, an independent scaffold, the deployment assist cart discussed below, or other like structure. Preferably, clamps 77 are attached to the platform system by any suitable removable connection, such as bolts, to make the system more versatile.

The present platform system optionally, but preferably, includes one or more retractable roller assemblies that facilitate rolling it into a desired position on a roof surface. The roller assemblies ordinarily provide for rolling motion along the platform length direction, but may permit lateral motion also. Various configurations are possible for the rollers, consistent with maneuverability and stability of the platform system.

In an implementation, the roller assembly comprises one or more retractable rollers having a retracted position and an extended position. The roller assembly is configured such that when the platform system is disposed on a roof structure with the rollers in the retracted position, at least one support base is in contact with the roof structure and the body of the platform system remains elevated above the roof structure; in the extended position, the rollers are in contact with the roof structure.
and bear against structural members (e.g., at least two of the glazing bars 32 shown in FIG. 2) and not the glass portion. In an embodiment, the design is such that the platform system is stable against tilting while it is being moved.

For example, the exemplary embodiment of FIG. 3 provides a roller assembly that incorporates rollers 82 associated with both upper support pads 86. With these rollers 82 thus situated on its left and right sides, platform system 50 can readily be manipulated into position and thereafter stably secured by attaching clamps 77 to suitable support structure at its lower end and retracting rollers 82 to bring upper support pads 86 into contact with structural members of the roof. FIGS. 6A - 6B (discussed in more detail below) depict one possible type of roller assembly.

As noted above, some greenhouses do not include structural members at the eaves to which the lower end of the present platform system can be secured. In such configurations, the lower end of the system can be secured to an external, temporary support such as a ladder, scaffold, or the deployment assist cart described below.

Alternatively, the system can be configured with a lower support base 80 intended (like the upper support base 79) to rest on the roof itself. Such embodiments preferably include lower support pads and one or more rollers associated therewith, which are similar to upper support pads 86 and upper rollers 82. Of course, the platform system can employ both a lower support base and any suitable anchorage to an external support for added security.

Some roller assembly implementations employ a single, relatively wide roller at one or both ends of the platform system. For example, such a roller may extend laterally to at least the full width of the system, and preferably wider, so that the platform system itself is stable against tipping laterally and can be moved readily.

Alternatively, at least two rollers, such as separate rollers included at both sides on of the one or both ends, are configured to provide similar stability.

In the FIG. 3 configuration, both the rollers 82 and upper support pads 86 to which they are attached are laterally displaced from the main platform area and deployed on outriggers. As indicated above, this spacing beneficially improves stability against tipping, both when moving the system and when it is supporting a worker during its intended use. Ideally, the one or more rollers on each side are sufficiently wide to be able to engage structural members whose spacing can vary widely between different roof designs. Alternatively, the lateral span between the rollers in a multi-roller configuration is adjustable. FIG. 3 depicts rollers 82 and upper support pads 86 as being conjoined and thus in close proximity, so they can both engage the same roof support structure. In other arrangements, the two need not be attached, and may be separated and adapted to engage different structural
members. It is also contemplated that the lateral spacing of one or both of the rollers and support pads may be adjustable.

In any of these embodiments, each roller is ordinarily rotated on an axle supported at one or, preferably, both ends. In some implementations, the axle is supported by a fork having two prongs dependent from a central strut, with the ends of the axle attached to the respective prongs. Alternatively, one, or preferably both, ends of the axle are supported by independent struts. It is preferred, but not required, that the axle be in a fixed orientation along the width direction of the platform system.

A variety of actuation mechanisms can be employed to move the rollers between the extended and the retracted positions. In one option, the axle support mechanism is hingedly connected to some member of the platform structure, so that the roller assembly can be moved between the extended position and the retracted position. Various hinging arrangements are possible, including ones in which the roller assembly can be tilted downwardly from, and along the length of, the platform system (e.g., from a horizontal base member), or outwardly (e.g., from the platform rails). In another option, a lead screw or gear arrangement can be used to drive the axle support mechanism between the extended and retracted positions.

In still another option, the actuation relies on a spring mechanism associated with each roller. The spring mechanism urges the roller into the extended position, and may include a latching arrangement permitting the rollers to be locked in either or both of the extended and retracted positions. In other embodiments, the spring mechanism has a compliance such that imposing at least a predetermined weight on the platform system is sufficient to overcome the urging into the extended position and drive the rollers into the retracted position. Typically, the predetermined weight is some appreciable fraction of the expected weight of a worker, so that the rollers of an unloaded platform system are extended, but reliably move into retracted position once a worker mounts the platform.

FIGS. 6A - 6B depict one such roller assembly, wherein a roller (with an associated spring mechanism) is associated with a support pad 86. The FIG. 6 arrangement can be used with the platform system embodiment of FIG. 3 or other embodiments. Roller 82 is disposed for rotation on an axle 84, whose opposite ends are attached to struts 88, which are supported and vertically movable through collinear mating holes 90 in upper and lower axle mounts 92, 93. Upward movement of strut 88 is countered by a compliant member, such as spring 94 compressed between upper axle mount 92 and spring mount 95 attached to strut 88. The spring constant of springs 94 is selected so that loading of the platform system with more than a predetermined weight overcomes the downward urging of rollers 82 by springs
94, so that support pads 86 rest on the underlying roof structure. FIG. 6B shows roller 82 in its extended position below the bottom of upper support pad 86, while FIG. 6A shows roller 82 in its retracted position, with spring 94 compressed and strut 88 moved upward from the FIG. 6A configuration.

In a related embodiment (not shown), a retractable roller assembly such as that of FIGS. 6A - 6B is associated with one of the support bases, while the other support base includes one or more non-retractable rollers. For example, platform system 50 of FIG. 3 might be modified to have retractable roller assemblies of the FIG. 6 type attached to support pads 86 on both sides of upper support base 79, but rollers fixed in an extended position on support pads 87 of lower support base 80, along with clamps 77 as shown. In use, this form of the platform system could rely on being clamped at the roof eaves. Thus, the load of the platform system would be distributed, with some carried through the upper support pads 86 and the rest through the clamping of the lower end.

In the embodiment depicted in FIG. 3, the upper and lower support bases 79, 80 are permanently connected to platform section 52. In an alternative construction, the system is modularized, meaning that it is configured to be assembled from a kit comprising a plurality of subcomponents and disassembled again at will, such as on a job site. The mating subcomponents that are to be connected during the assembly are joined in any convenient but secure and reversible manner.

One possible modularized implementation is shown in FIG. 8, wherein upper and lower end assemblies 98, 99 are separably joined to the platform section 100 (which includes platform rails 56, guardrails 58, treads 78, and associated bracing components) by any form of secure, locking connection, such as a pin and socket attachment. In this implementation, end assemblies 98, 99 comprise support bases 79, 80, which also include horizontal members 60, 61 and optional support pads and roller assemblies that are operable in a manner that is apparent from FIGS. 3 and 6. Respective guardrail posts 68, 70 are also incorporated in end assemblies 98, 99. The end assemblies are formed by joining together the various components by any suitable means providing adequate structural integrity. In alternative modularized configurations, the guardrail posts are instead included as part of the platform section.

The locking connection is provided by connector arrangements that are disposed at each point of engagement between the end assemblies and the guardrails and platform rails. The FIG. 8 implementation provides four points of engagement at each end of the platform system, i.e., two at the engagement between the respective left and right guardrails 58 and the respective guardrail posts
68 and 70 and two at the engagement between the left and right platform rails 56 and the horizontal members 60 and 61.

Generally stated, each connector arrangement comprises a first connector element attached to an end of the respective platform rail or guardrail, a second connector element attached to a respective one of the end assemblies, and a locking means. Typically, one of the connector elements is a connector pin; the other connector element is a socket having a complementary, mating shape adapted to receive the connector pin. The first and second connector elements are configured to be joined in mating relationship, with a locking pin securing the mutual engagement of the elements.

The detailed view of FIG. 9 representatively depicts one suitable form of the connector arrangement with reference to the joint at the top of right upper guardrail post 68 in FIG. 8. Guardrail connector pin 96a projects horizontally from upper guardrail post 68 and is configured to be received in socket 96b in guardrail 58. After the components are assembled, a through aperture is formed by aligned apertures 96d in guardrail 58 and 96e in connector pin 96a. The locking engagement is completed by passing locking pin 96c through these aligned apertures in a direction perpendicular to the commonly aligned axes of pin 96a and socket 96b. In an alternative locking arrangement, connector pin 96a might include a spring-loaded pin adapted to project transversely from the pin axis to engage an aperture, as depicted at 96d, in socket 96b.

Similar locking connections are made at each of points of engagement seen in FIG. 8, wherein guardrail connector pins 96a attached to guardrail posts 68, 70 are adapted to be received in corresponding sockets 96b provided in guardrails 58 and platform rail connector pins 97a (also attached to guardrail posts 68, 70) are adapted to be received in corresponding sockets 97b provided in platform rails 56. Each connection is secured by locking pins (not depicted in FIG. 8). Preferably, each of the locking pins is further secured in position by any suitable means known to a skilled designer, including without limitation a cotter pin or by using a threaded form of locking pin secured by a mating nut.

Locking engagements of the respective platform frame elements are readily implemented by using tubular members having round or rectangular internal passages to construct the guardrails and platform rails, with the connecting pins being of complementary size and shape. Other implementations are also suitable, including without limitation ones in which the respective disposition of the connector pins and sockets on the rails and end assemblies is reversed. In still another alternative, pins 96a and 97a are omitted and instead, sockets on the end
assemblies are configured to directly receive the guardrails and platform rails with a locking connection.

The modular system of FIG. 8 can easily be disassembled into its component subassemblies (e.g., end assemblies 98, 99; two side sections, each comprising a platform rail 56, a guardrail 58, cross braces 66, and middle support posts 72; and a requisite number of platform treads 78, along with needed hardware). Disassembly greatly reduces the bulkiness of the platform system for transportation and storage before subsequent re-use. In addition, the platform section can be used fitted with different forms of the end sections that are adapted to different greenhouse constructions.

In most modularized embodiments it is not intended that the components within the end assemblies be disassembled during ordinary operation of the platform system. Hence, the techniques used to assemble the end-assembly components can include welding, gluing, or other permanent methods, as well as other less permanent joining methods such as bolting the components together to permit repair or replacement of damaged parts. The guardrail and bracing elements of each side rail are ordinarily not intended for routine disassembly, and so are joined by similar methods.

In a further aspect, the modular concept of the FIG. 8 embodiment can be extended to provide platform systems of varying lengths by connecting multiple subsections. One representative embodiment is depicted generally in FIG. 10, wherein the platform section is divided into two subsections 100a, 100b. Specifically, the platform rails 56 and guardrails 58 shown in FIGS. 3 and 8 are divided into platform rail subsections 56a, 56b and guardrail subsections 58a, 58b that are connected through coupling support assembly 130, which has a configuration with features generally similar to those of end assemblies 98, 99 shown in FIG. 8. Assembly 130 comprises: a middle support base 132 having a middle horizontal member 134 and middle support pads 136 depending downward therefrom; left and right middle guardrail posts 138 connected to middle support base 132; and connector arrangements at the top and bottom of the left and right middle guardrail posts that secure the facing platform rail and guardrail subsections in collinear relationship. As depicted, the individual connector pins 96a of FIGS. 8 and 9 are replaced by pairs of oppositely directed connector pins 140a configured to engage mating sockets 140b in the facing ends of the platform rail subsections 56a, 56b; likewise connector pins 97a are replaced by pairs of oppositely directed connector pins 141a configured to engage mating sockets 140b in the facing ends of guardrail subsections 58a, 58b. The connections effected using these mating pins 140a, 141a and sockets 140b, 141b join the platform rail and guardrail subsections together.
collinearly in a secure, locking connection to form the respective platform rails and guardrails. However, intermediate connector arrangements that lack any one or more of these components are also contemplated, as long as they provide a secure connection between the platform rail subsections of the respective platform subassemblies and ensure that a secure and adequately supported guardrail system protects the entire platform. For example, the middle support base might be omitted, with pins alone used to join subsections 100a and 100b. The FIG. 10 embodiment optionally includes roller assemblies (not shown) associated with each of the support assemblies. The roller assemblies may be of the type depicted in FIGS. 6A - 6B or other suitable design.

Implementations such as that of FIG. 10 beneficially facilitate the servicing of large greenhouses, because the platform system can be erected on the roof in stages, instead of having to lift an entire system into final position in a single operation. For example, two platform subsections (e.g. subsections 100a, 100b seen in FIG. 10) might be needed to provide adequate length. Such a platform system can be erected by first placing onto the roof at the eaves a first subassembly comprising upper end assembly 98, platform subsection 100a, and coupling support section 130. Then a second subassembly comprising platform subsection 100b and lower end assembly 99 can be lifted to the eaves and coupled onto the first. The combined subassemblies can then be rolled up the roof till the lower end assembly 99 reaches the eaves and is secured to the desired support structure associated therewith. Modular platform systems comprising more than two subsections are also contemplated herein. Use of individual subsections that are as long as possible, consistent with a handleable weight, is generally beneficial, since the number of joints can be minimized and the overall structure is more rigid and less subject to flexure at each joint.

In a still further aspect of the present disclosure, a deployment assist cart is used in conjunction with the platform system to provide a platform erection system. Such a cart may be used to facilitate the erection of the platform system onto a greenhouse roof. The cart may include wheels or tracks, so it can be moved to a desired site adjacent to a roof structure to be serviced. Preferably the cart is also used to transport the platform system components. It optionally provides a stable and secure attachment for the lower end of the platform system, since many greenhouses do not have a suitable structure to which the lower end can be secured.

FIG. 11 depicts a representative embodiment, including cart 160 having wheels 162 that permit it to be easily maneuvered and locked into a convenient position. Once the cart is positioned, outrigger stabilizers 164 are projected downwardly, e.g. by a reversible jackscrew mechanism (not shown), so that the
weight of the cart and whatever load it supports are transferred off the wheels and onto support pads 165 of stabilizers 164. Cart 160 is optionally provided with suitable handles to permit it to be maneuvered into position by a worker. Alternatively the cart may be transported by attaching it to a vehicle through a hitch (not shown).

Cart 160 is equipped with deployment support 168, which upstands from platform base section 169, and ordinarily is braced either by an optional access ladder 166 as shown in FIG. 11 or by other suitable bracing structure. Support 168 may be oriented either exactly perpendicular to base section 169 or at a preselected angle away from the vertical direction. In the FIG. 11 embodiment, access ladder 166 and deployment support 168 are stabilized by securing their respective bases to the platform base section 169 of cart 160 and joining them at a point above the platform base section, preferably at or near their tops. Optionally, access ladder 166 and deployment support 168 are removable for ease of transport. In another variant (not shown), ladder steps are incorporated directly in deployment support 168, so a separate access ladder is not needed. Deployment support 168 may also include clamps or other like fixturing to provide stable and secure anchorage for the lower end of the platform system after it has been deployed on a roof, as mentioned above.

Cart 160 further includes deployment rails configured to facilitate the erection of the platform on a roof. In a representative use, the cart is first positioned at the desired location. Then the platform system is staged on the deployment rails and thereafter deployed onto the adjacent roof. The entire system may be erected in one operation; alternatively, sections of a modular system may be positioned in a series of steps. The rails beneficially may be equipped with rollers, guides, slides, or the like that engage the platform components while they are being erected. (For clarity of illustration, the deployment rails are omitted from FIG. 11.) It is preferred that the deployment rails, if present, be tiltable, but embodiments wherein the rails are fixed at an inclination angle suitable for positioning the platform system are also possible. The cart and deployment rails may include a winch, hydraulics, or other like actuation system to assist in elevating the deployment rails and/or sliding the platform system onto the roof structure.

Referring now to FIGS. 12A - 12C, the stages of a representative and typical use of deployment assist cart 160 are depicted. For convenience of illustration, the cart is shown as being used to erect a single-section platform system, such as the embodiment 50 depicted by FIG. 3, on a sloped greenhouse roof surface 12. A pair of tiltable deployment rails 170 are rotatably articulated at or near the top of deployment support 168. In some embodiments, the point of articulation of rails 170 and/or the height of deployment support 168 can be adjusted. The articulation
permits the rails to be elevated between a loading position 171a and a deployment position 171b (shown by dot-dash lines in FIG. 12A). A suitable mechanism (not shown) is preferably provided to permit the deployment rails to be locked at one or more requisite elevations.

In a first configuration shown in FIG. 12A, cart 160 is situated on the ground near the eaves 19 where the platform is to be erected, the cart being secured by deploying its outrigger stabilizers 164. Platform section 50 is placed against rails 170 in loading position 171a. Then rails 170 and platform section 50 secured thereon are rotated downwardly to an elevation approximately parallel to the plane of the sloped roof, e.g. to deployment position 171b, with the top ends of the rails possibly resting upon the eaves (FIG. 12B). Platform section 50 is then maneuvered, e.g. by sliding or rolling it upward on rails 170 and onto the roof structure (FIG. 12C). Once in place, platform section 50 is secured, e.g. by clamping its lower end to either part of the roof structure at or near eaves 19 or to any convenient structural member of cart 160. A worker may ascend ladder 166 to access the platform structure. If needed, a gangplank can be used to bridge any gap between the ladder and the platform itself.

Alternatively, the rails 170 might be disposed initially in deployment position 171b and then platform section 50 placed thereon, bypassing the rotation connecting the FIG. 12A and 12B configurations.

It will be apparent that the cart embodiment seen in FIGS. 11 and 12 can also be used to erect a multi-section platform system by a sequence of steps, wherein separated subassemblies of the platform system are elevated one by one and assembled as they are moved into position on the roof. For example, the first subassembly 100a of FIG. 10 can be erected in a manner comparable to that described above, by sliding it up rails 170 and temporarily securing it on the roof so that coupling support section 130 is proximate the eaves. Then rails 170 are rotated back to loading position 171a to receive a second subassembly comprising platform subsection 100b and lower end assembly 99. The rails are then raised again into deployment position 171b, along with the second subassembly, which is joined onto the first subassembly using the connector arrangements associated with coupling support section 130. The combined subsections can then be slid upwardly into position on the roof, with the bottom end of the second subassembly being secured either to structure at the eaves or to a ground-positioned support such as vertical ladder support 168 or other structural member of cart 160, or to a conventional ground-situated ladder, scaffold, or the like. A similar process can be used to erect a platform having more than two subassemblies by sequentially repeating pertinent ones of the foregoing steps. The platform may be removed by reversing the foregoing steps.
It is desirable that the platform system be strong enough to accommodate the weight of a single worker and a desired payload of tools, equipment, and supplies needed for typical maintenance or repair operations. However, it is further preferred that the platform system be strong enough to support a second person, for example to assist or rescue the first worker in an emergency situation.

In certain embodiments, the present platform system beneficially has a strong but lightweight construction. Minimizing the platform's weight makes it easy to transport, assemble, and situate on a roof, while also reducing the load that is imposed onto the roof system during its use. Ideally the platform weight is a small fraction of the aggregate weight of a worker and their payload. It is further desirable that a platform system be light enough that a small work crew can readily erect and maneuver it into position, all without damaging a glass roof. Systems that can be handled by a two-person crew are beneficial, especially if the platform system can be erected on the roof without a crane or an elaborate or specialized hoist system.

In an embodiment, a platform system in accordance with the present disclosure is constructed with materials having high specific strength and stiffness. These characteristics are most readily attained with advanced composite materials, however it is to be understood that any structural material (e.g. metals) can also be employed in one or more components of low-weight embodiments. Suitable lightweight materials include, without limitation, composites with one or more of glass, carbon, or other polymers or polymeric fibers. Embodiments fabricated with members composed of a composite with KEVLAR® para-aramid/carbon fiber reinforcement in an epoxy matrix provide a beneficial combination of the required high specific strength and stiffness. Such composites can be manufactured in various shapes useful in constructing the present system, including without limitation round, square, and rectangular tubular forms and flat, planar panels. The various components can be joined using any suitable technique or joint hardware.

Certain embodiments of the present platform system are capable of supporting a rated load of at least 500 pounds or 200 kg while being light-weight. Such a platform system having an unloaded weight "W" (i.e., including a complete set of platform treads but excluding workers and other payloads) and a full platform working area "A" is considered to be light-weight if a value of the ratio W/A is at most 3, 4, 5, 6, 7, 8, 9, or 10 pounds per square foot of working area.

The load of the platform system and its payload is supported over a roof area that may be larger than the platform working area, particularly for embodiments wherein the support bases include outrigger supports. The effective support area is at least as large as the area of a polygon having vertices defined by each of the points on which the platform system rests atop a roof or like structure. For example,
the configuration depicted by FIG. 3 may be supported over a rectangular effective support area defined by the four support pads 86, 87. Alternatively, if the FIG. 3 configuration is clamped at its bottom end by clamps 77 attached to a rail structure (not shown) at the eaves of a greenhouse, the effective support area might be defined by a trapezoid having vertices at clamps 77 and upper support pads 86.

For example, a representative platform system embodiment of the form depicted by FIG. 3 might have a full working area 16 feet (-4.9 m) long and 30 inches (-75 cm) wide and be supported by upper and lower support bases that are located at the platform system's upper and lower ends and have outriggers that extend to a width of 10 feet (-3 m). Such an embodiment can be constructed with KEVLAR® para-aramid/carbon fiber reinforced composite members and platform treads, and be strong enough to support a rated load of at least 500 pounds (-227 kg or 2230 N). Platform treads spanning the 30 inch platform width and extending about 12 inches (-30 cm) along the platform length would weigh about 4 pounds (-1.8 kg or 17.8 N) each. This platform system, with a full set of platform treads installed along its length, would have a total weight of about 230 pounds (-104 kg or 1023 N), corresponding to about 5.75 pounds per square foot of working area (275 N/m²).

The 230 pound weight of the platform system and treads of this embodiment is supported over an effective support area on the roof of 160 square feet (10 foot outrigger span x 16 foot length), corresponding to an effective roof loading of about 1.44 pounds per square foot (69 N/m²) of effective support area. Even with a worker, tools, and materiel, the system thus imposes a roof loading far less than the building code requirement that a greenhouse in the Delaware location of the inventors must be capable of withstanding a snow loading of 20-25 pounds per square foot (-958-1197 N/m²). In representative embodiments, the present platform system, including a full set of platform treads but without a user or any other payload, imposes an effective roof loading of at most 1.2, 1.4, 1.6, 1.8, 2, or 2.5 pounds per square foot of effective roof support area.

It is noted that design standards in the ladder and scaffold industries typically presume a safety factor of at least 5, meaning the device would be presumed able to withstand a loading of five times the rated nameplate load. The safety factor thus accounts for variations in strength of the actual device as constructed and possibly degraded during its lifetime and the need to support an additional worker who may be forced to aid the primary user in the event of an injury, medical emergency, fire, or other unforeseen circumstance.

Having thus described various embodiments of the invention in rather full detail, it will be understood that this detail need not be strictly adhered to but that further changes and modifications may suggest themselves to one skilled in the art,
all falling within the scope of the invention as defined by the subjoined claims. For example, certain materials are identified herein as suitable for constructing components of the present platform system, but other materials known to a skilled artisan may also be used. Various structural configurations and assembly methods that are suitable are also known to the artisan.

In this specification, unless explicitly stated otherwise or indicated to the contrary by the context of usage, where an embodiment of the subject matter hereof is stated or described as comprising, including, containing, having, being composed of, or being constituted by or of certain features or elements, one or more features or elements in addition to those explicitly stated or described may be present in the embodiment. An alternative embodiment of the subject matter hereof, however, may be stated or described as consisting essentially of certain features or elements, in which embodiment features or elements that would materially alter the principle of operation or the distinguishing characteristics of the embodiment are not present therein. A further alternative embodiment of the subject matter hereof may be stated or described as consisting of certain features or elements, in which embodiment, or in insubstantial variations thereof, only the features or elements specifically stated or described are present. Additionally, the term "comprising" is intended to include examples encompassed by the terms "consisting essentially of" and "consisting of."

Similarly, the term "consisting essentially of" is intended to include examples encompassed by the term "consisting of."

When any amount or other value or parameter is given as either a range, preferred range, or a list of upper preferable values and lower preferable values, this is to be understood as specifically disclosing all ranges formed from any pair of any upper range limit or preferred value and any lower range limit or preferred value, regardless of whether ranges are separately disclosed. Where a range of numerical values is recited herein, unless otherwise stated, the range is intended to include the endpoints thereof, and all integers and fractions within the range. It is not intended that the scope of the invention be limited to the specific values recited when defining a range.

In this specification, unless explicitly stated otherwise or indicated to the contrary by the context of usage, amounts, sizes, ranges, formulations, parameters, and other quantities and characteristics recited herein, particularly when modified by the term "about", may but need not be exact, and may also be approximate and/or larger or smaller (as desired) than stated, reflecting tolerances, conversion factors, rounding off, measurement error, and the like, as well as the inclusion within a stated value of those values outside it that have, within the context of this invention, functional and/or operable equivalence to the stated value.
What is claimed is:

1. A platform system elongated along a platform length direction between a lower end and an upper end and having opposing left and right sides separated along a platform width direction, the platform system being configured for placement on a roof structure and comprising:
   (a) left and right upper-end guardrail posts and left and right lower-end guardrail posts;
   (b) a platform section that extends along the platform length direction for a platform length and comprises:
      (i) left and right platform rails that are disposed in spaced-apart, parallel relationship and extend horizontally along the length of the platform section between the upper and lower ends of the platform system, the upper-end guardrail posts and the lower-end guardrail posts being attached to the respective platform rails,
      (ii) a plurality of platform treads disposed along at least a portion of the platform length, each tread having left and right edges and spanning the left and right platform rails and being removably secured thereto, the treads collectively defining a working platform area having a platform width sufficient to accommodate a worker and a preselected working length defined by the number of treads present, and
      (iii) left and right guardrails that extend horizontally along the respective sides of the platform system for substantially the platform length, are attached to the respective left and right platform rails through the lower and upper guardrail posts, and are situated at a preselected height above the platform area;
   (c) an upper support base proximate the upper end and comprising an upper horizontal member; and
   (d) a lower support base proximate the lower end and comprising a lower horizontal member, and

   wherein the upper and lower support bases project downward from the platform section and are configured to rest on the roof structure to support the platform system and maintain a clearance between the roof structure and the platform section.

2. The platform system of claim 1, further comprising a roller assembly associated with the upper support base, the roller assembly comprising one or more rollers having a retracted position and an extended position, the roller assembly
being configured such that when the platform system is placed on a roof structure: (a) with the rollers in the retracted position the upper support base is in contact with the roof structure; and (b) with the rollers in the extended position the rollers are in contact with the roof structure and the upper support base is elevated above the roof structure, thereby permitting the platform system to be rolled along the platform length direction.

3. The platform system of claim 2, wherein the roller assembly comprises a spring mechanism that is operable to urge the one or more rollers downward into the extended position and has a compliance such that imposition of at least a predetermined weight on the platform system is sufficient to overcome the downward urging and drive the one or more rollers into the retracted position.

4. The platform system of claim 1, further comprising a roller assembly associated with each of the upper and lower support bases, each roller assembly comprising one or more rollers having a retracted position and an extended position, the roller assemblies being configured such that when the platform system is placed on a roof structure: (a) with the one or more rollers in the retracted position the support bases are in contact with the roof structure; and (b) with the one or more rollers in the extended position the rollers are in contact with the roof structure and the support bases are elevated above the roof structure, thereby permitting the platform system to be rolled along the platform length direction.

5. The platform system of claim 4, wherein each roller assembly comprises a spring mechanism that is operable to urge the one or more rollers of the roller assembly downward into the extended position and has a compliance such that imposition of at least a predetermined weight on the platform system is sufficient to overcome the downward urging and drive the one or more rollers of each roller assembly into the retracted position.

6. The platform system of claim 1, further comprising a plurality of tread attachments, at least one of which is disposed proximate each edge of each of the platform treads to removably secure the platform treads to the platform rails.

7. The platform system of claim 6, wherein each tread attachment comprises a stud having an enlarged head and upstanding from one of the respective platform rails, and at least one keyhole-shaped slot is provided proximate each edge of each platform tread, each keyhole-shaped slot being configured for locking engagement with one of the studs.

8. The platform system of claim 1, further comprising a plurality of anchorages, each configured to engage a locking clip of a personal fall arrest system.

9. The platform system of claim 8, wherein the anchorages comprise one or more discrete anchorage points spaced along each of the guardrails and attached
thereto, each anchorage point providing an aperture configured to engage the locking clip.

10. The platform system of claim 1, wherein the upper-end guardrail posts and the upper support base are formed as an upper end assembly and the lower-end guardrail posts and the lower support base are formed as a lower end assembly, and the upper and lower end assemblies are separately joined to the platform section by connections made at points of engagement between the guardrails and the platform rails and the end assemblies.

11. The platform system of claim 1, being capable of supporting a rated load of at least 200 kg and having a ratio of an unloaded weight "W" of the platform system to a full working area "A" that is at most 8 pounds per square foot of working area.

12. The platform system of claim 1, wherein the left and right platform rails and the left and right guardrails are each comprised of a plurality of subsections that are collinearly disposed and separably joined together in a locking connection to form the respective platform rails and guardrails.

13. The platform system of claim 12, further comprising:

a coupling support assembly situated intermediate the upper and lower ends and comprising a middle support base comprising a middle horizontal member and left and right middle guardrail posts connected to the middle support base,

wherein respective subsections of the platform rails and the guardrails are separably joined together through locking connections made using connectors disposed at points of engagement on the coupling support assembly,

and wherein each of the connectors comprises a first connector element attached to an end of the respective platform rail or guardrail subsection, a second connector element attached to the coupling support assembly, and a locking pin, the connector elements being configured to be joined in mating relationship and secured to each other by mutual engagement with the locking pin, the first connector element being one of a connector pin and a mating socket and the second connector element being the other of the connector pin and the mating socket.

14. A platform erection system, comprising the platform system of claim 1 and a deployment assist cart comprising:

(a) a platform base section;
(b) a deployment support upstanding from the platform base section;
(c) deployment rails connected to the deployment support and configured to receive the platform system for deployment on a roof structure.

15. The platform erection system of claim 14, wherein the deployment rails are rotatable between a loading position configured to accept the platform system and a
deployment position configured to permit the platform system to be maneuvered from the deployment rails onto a surface of the roof structure.

16. A method of providing access to a structure, comprising:

(a) providing a platform system as recited by claim 1; and

(b) disposing the platform system on a flat or sloped area of the structure, whereby access is provided to the area.
FIG. 6B
### A. CLASSIFICATION OF SUBJECT MATTER

**IPC(8)** - E04G 3/28 (2015.01)

According to International Patent Classification (IPC) or to both national classification and IPC.

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC (8): E04G 3/28 (2015.01)

CPC: E04G 3/28

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched


Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

- Google (Patents, Scholars); PatBase(AII); search terms: protective platform greenhouse roof work workers glass mobile suspended roofing assembly outrigger extending resting assisted track guided in boom jack rollers rolling wheels sitting static attached placed stage scaffold hoist rooftop displacing movable.

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
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<tr>
<td>A</td>
<td>EP 0 950 779 A1 (HOONDERT) 20 October 1999 (20.10.1999) entire document, especially Fig 1-4; para 80006- [0012]</td>
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<td>A</td>
<td>EP 2 730 717 A1 (SCHUCHARDT) 14 May 2014 (14.05.2014) entire document</td>
<td>1-16</td>
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<td>EP 2 631 390 A2 (MAUDERER) 28 August 2013 (28.08.2013) entire document</td>
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* Further documents are listed in the continuation of Box C.

**A** Special categories of cited documents:

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**"&"** document member of the same patent family

Date of the actual completion of the international search: 23 November 2015

Date of mailing of the international search report: **28 DEC 2015**

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