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Grove

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[54] **AERIAL PLATFORM WITH ARTICULATING JIB**

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[52] **U.S. Cl.** **182/2**

[51] **Int. Cl.** **B66f 11/04**

[58] **Field of Search** 182/2, 141, 148; 212/17, 212/144

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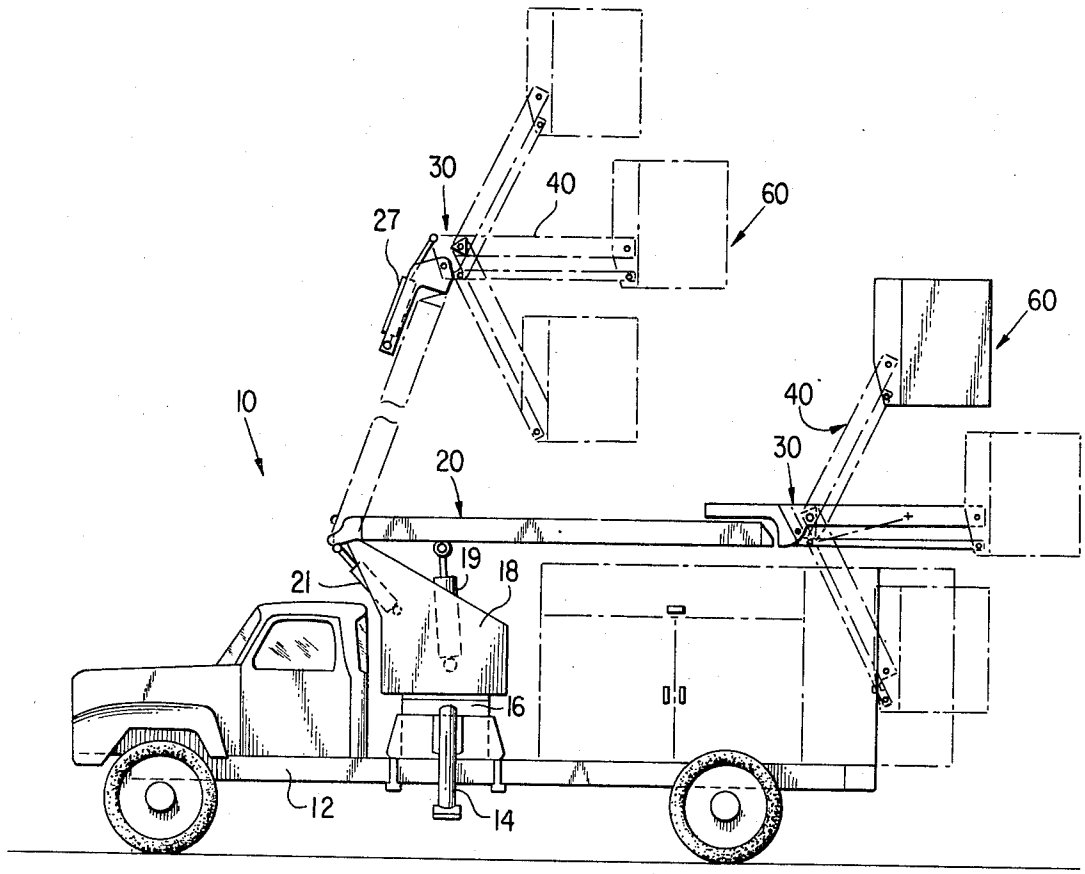
[57] **ABSTRACT**

An aerial platform is carried by an extensible boom which is mounted on a motor vehicle for swinging movement in horizontal and vertical planes: a connector is pivoted to the end of the boom, a jib is pivoted at one end to the connector for vertical swinging movement and the aerial platform is pivotally connected to the other end of the jib. The jib has upper and lower arms, which remain parallel. The platform is a basket and the arms are connected to the lower portion of the basket. Power devices cause pivoting of the connector relative to the boom, and the boom relative to the vehicle, and comprise hydraulic cylinders connected in master-slave relationship.

14 Claims, 3 Drawing Figures



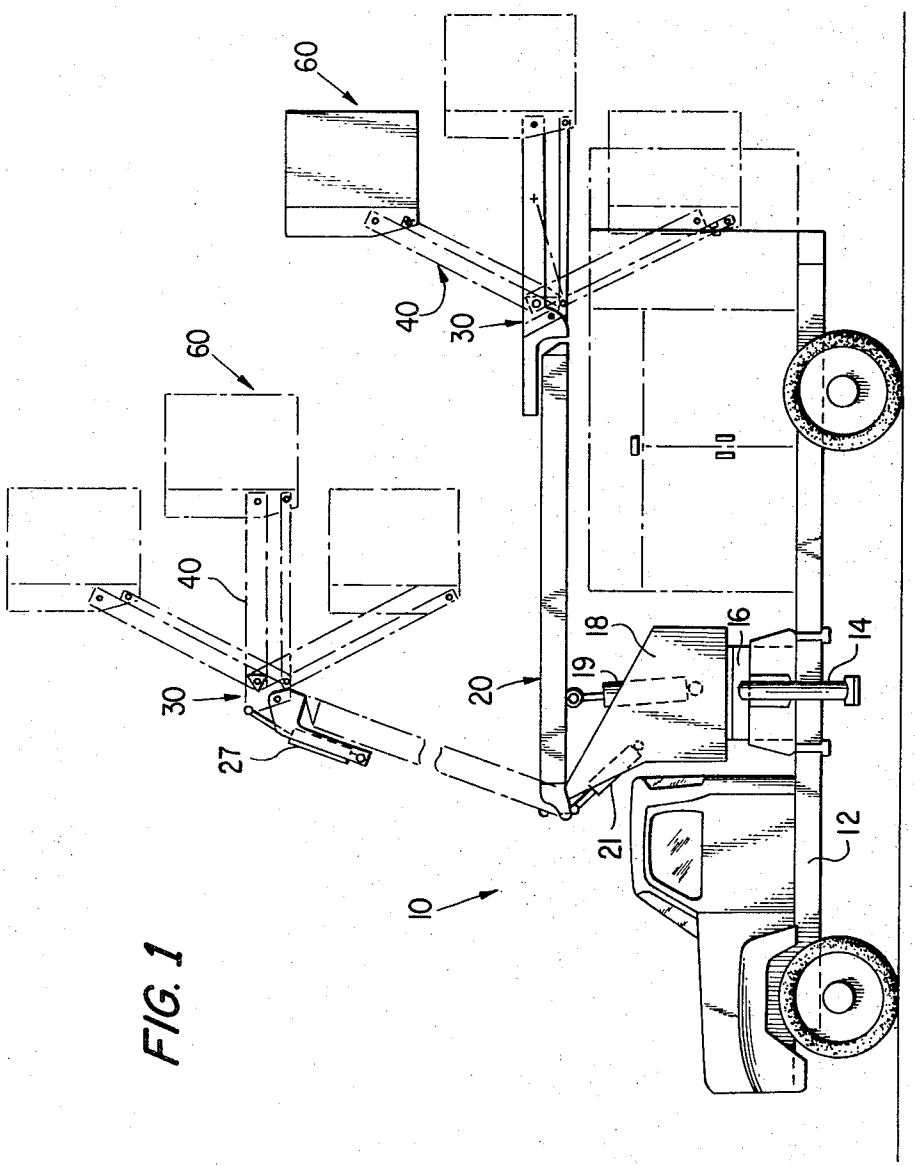


FIG. 1

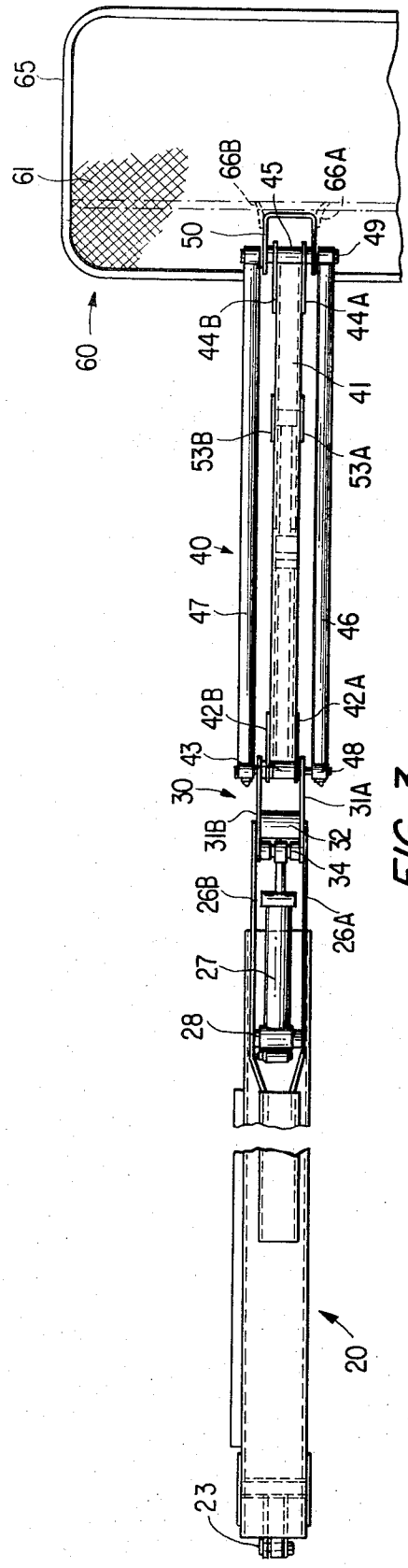

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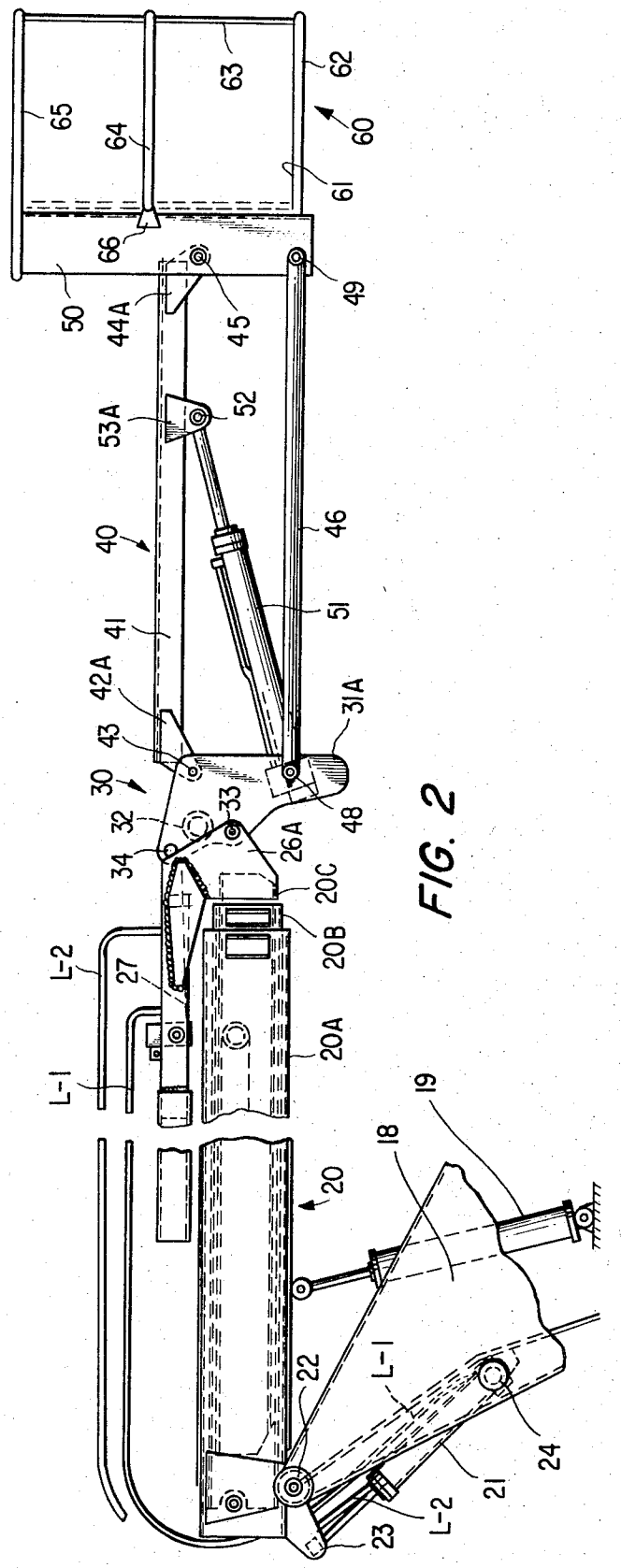
FIG. 3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26A
20C
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L-2
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20A
L-1
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18
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L-1
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L-2
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FIG. 2

AERIAL PLATFORM WITH ARTICULATING JIB

BACKGROUND OF THE INVENTION

The present invention relates to aerial platforms for supporting workmen at positions remote from a supporting vehicle.

Aerial platforms are in wide-spread use for supporting a workman in a position which is remote from a supporting surface such as a road-way, so that the workman can perform his tasks while supported at substantial heights above the ground, or in positions laterally spaced from a supporting location, such as a roadway. Typically, aerial platforms comprise a motor vehicle having an extensible boom mounted on the vehicle for swinging movement in horizontal and vertical planes, the boom carrying a workman's platform, in the form of a basket, at its outer end. A basket comprised a floor and upstanding walls to prevent the accidental falling of the workman from the basket. The platform or basket was pivotally connected to the boom, usually at the free end thereof, and provision was made for maintaining the floor of the basket horizontal during vertical swinging movement of the boom. Typically, hydraulic cylinders were used for the swinging movements of the boom and for extending the boom, although the prior art recognized that other mechanical devices could be provided for causing such movements.

Control of the movements of the platform were provided both in the platform, and at ground level.

The constructions of aerial platforms provided heretofore have permitted the workmen to achieve a position remote from the supporting vehicle, typically a position substantially above the level of the vehicle and laterally, or to the side, of the vehicle. Thus, work could be performed in trees, on wires, on elevated structures such as the sides of buildings or of large airplanes and the like, even where the supporting vehicle could not be placed under or directly adjacent the work location.

In order to provide greater flexibility, a number of proposals have been made for alternate constructions of the above described basic aerial platform construction. In one construction, a pivoted extensible boom had an arm pivoted at one end to the free end of the boom and the arm carried at its other end a pivotally supported platform; the pivoted arm was actuated by a piston and cylinder arrangement for vertical swinging movement, the construction limiting the movement of the arm from a position forming an acute angle with the boom axis to a position substantially in line with the boom axis.

Another disclosure heretofore known provides an extensible mast which had no vertical pivoting motion, which carried at its free end a pivotal arm or jib which could move to either side of the substantially vertical boom or mast, the pivoting arm or jib supporting a platform at its outer end. This construction was limited in that the supporting vehicle could not be further from the work position than the length of the pivoted arm plus a small distance gained by the slight tilt of the boom or mast from the vertical.

Another known construction included a telescopic and articulated boom assembly having a swingable arm member pivotally connected on one boom section, and at its outer end, the pivoted arm pivotally supported a workman's basket which hung suspended beneath the pivotal connection between the basket and the arm. This construction was limited in that the pivoted arm could not move below the axis of the boom, but was required to be above or in line with the boom in all positions thereof.

A further known construction of interest provided an extensible boom which was swingable in vertical and horizontal planes, and included a rotatable elbow connected to a boom section intermediate the ends of the boom for rotation through 360°, this rotatable elbow carrying a platform at its outer end, being pivotally connected to the platform at the top thereof. While in this construction the elbow could move to positions both above and below the boom axis, this construction was limited in that it would not permit the workman to be positioned in a downwardly facing opening, such as a bottom bay of a large aircraft, while the vehicle was at a relatively great distance from the aircraft.

SUMMARY OF THE INVENTION

The aerial platform of the present invention includes a vehicle having an extensible boom mounted on it for swinging movement in vertical and horizontal planes. At its free end, the boom has a connector which is pivoted to it for swinging movement in a vertical plane, being operated by a hydraulic cylinder which is a slave cylinder to a master hydraulic cylinder which causes vertical swinging movement of the boom. Consequently, the connector moves in a vertical arc equally and oppositely to the vertical swinging of the boom. An articulated jib is provided, being pivotally connected at one end of the connector, outwardly of the boom, and being pivotally connected at its other end to the lower portion of a workman's basket. The articulated jib is in the form of upper and lower parallel arms, which are swung by an independently controlled hydraulic cylinder approximately 60° above and below the boom axis.

Among the objects of the present invention are to provide an aerial platform of sturdy construction and improved flexibility. A further object of the present invention is the provision of an aerial platform which has an articulated jib capable of movement both above and below the boom axis. Yet another object of the present invention is to provide an aerial platform which is capable of positioning a workman both within a downwardly facing bay opening provided in a large airplane, while the vehicle is laterally remote from the opening, and another object is to provide such a vehicle which will enable a workman to be positioned above a point on an aircraft wing located substantially above ground level, and which point is substantially spaced from the leading and trailing edges of the aircraft wing.

Other objects and many of the advantages of the present invention will be readily understood from the following specification and drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is an elevational view of an aerial platform in accordance with the present invention, and showing the parts in alternate positions thereof.

FIG. **2** is an elevational view, with parts removed, of the boom and associated elements of the aerial platform of FIG. **1**, to an enlarged scale, and partially schematic.

FIG. **3** is a plan view of the structure of FIG. **2**, with parts removed.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, wherein like or corresponding reference numerals are used for like or corresponding parts throughout the several views, there is shown in FIG. **1** an aerial platform apparatus generally designated **10** and including a wheeled vehicle **12** of conventional engine-powered and steerable construction. The vehicle **12** includes outriggers **14**, one of which is shown in FIG. **1**, and a base **16** for supporting the boom support **18**. The boom support **18** is journalled to the base **16** so that it may rotate through a full circle about a vertical axis, in conventional manner. At its upper end, the boom support **18** pivotally supports an extensible boom **20**, so that boom **20** may be swung in a vertical plane by boom luffing cylinder **19**. At its outer end, boom **20** has pivotally secured to it a connector **30**, and an articulated jib **40** is pivotally connected to the connector **30** at its inner end, and carries a workman's basket **60** at its outer end. As may be seen from the dotted line showings in FIG. **1**, the articulated jib **40** may move to positions above and below the axis of boom **20**, and specifically in the embodiment shown, the jib **40** may move to positions substantially 63° above and below the axis of boom **20**. The attitude of the platform **60** is unchanged during movement of both the boom **20** and the articulated jib **40**, so that the floor of the platform or basket **60** always remains substantially horizontal.

It will be noted that when the extensible boom **20** is luffed or swung in a vertical plane from the horizontal position to the inclined position, the connector **30** will rotate in a vertical plane, simultaneously, equally and oppositely, so that as the boom **20** is luffed upwardly, the orientation of the articulated jib and the attitude of the basket or platform **60** will remain unchanged.

Referring now to FIG. **2**, the boom support **18** is shown, having a bearing **22** at its upper end in which is journalled a shaft which supports the boom **20** in known manner. Boom **20** is provided with an ear **23** to which is anchored the piston rod of the cylinder **21**, the cylinder **21** being connected to the boom support by a pivotal connection provided at **24**.

The boom **20** is an extensible boom of known configuration, having three telescopic sections, **20A**, **20B** and **20C**, telescoping movement of which may be effected by a suitable power means. The power means (not shown) for extending and retracting the boom **20**, as well as all of the other power means for swinging the boom **20** and the articulated jib **40** are controlled by control switches, control valves or the like, with control elements placed both in the platform or basket **60** and on the vehicle **12**.

The outer or free end of the boom **20**, and more particularly of the boom fly section **20C**, is provided by a pair of spaced plates **26A** and **26B** (see also FIG. **3**) fixed to either side of the end portion of the fly section **20C** and thence extending rearwardly and above the boom, as shown in FIGS. **1** and **2**. A hydraulic cylinder **27** lies between the rearward extension of the plates **26A** and **26B**, cylinder **27** being pivotally connected at its rear end to the plates **26A** and **26B** by a pivot pin **28**.

A connector **30** is pivotally connected to the free or outer end of the boom **20**, connector **30** comprising a pair of plates **31A** and **31B** which are in spaced parallel relationship, and which have a strut **32** between them. A horizontal extending pivot pin **33** pivotally connects the connector **30** to boom **20**, specifically passing through the plates **26A** and **26B** and the connector plates **31A** and **31B**. The piston rod of cylinder **27** (see also FIG. **3**) is pivotally connected by a pin **34** to the connector **30**.

The boom **20** is raised by supplying pressure from a pump (not shown) to the lower end of boom luffing cylinder **19**. As boom **20** is raised in a vertical plane, pivoting counter-clockwise about pivot **22**, the ear **23** is also pivoted, and forces the piston rod of the master cylinder **21** downwardly, expelling liquid from the lower end of the cylinder **21**. This liquid passes by hydraulic line L–1 to the rear or left end of the hydraulic cylinder **27**, thereby causing the piston of hydraulic cylinder **27** to move to the right, so as to rotate the connector **30** about the pivot pin **33** in a clockwise direction. Cylinders **21** and **27** are of equal bore diameter, rod diameter and stroke. The construction is such that the connector **30** is caused to swing in a vertical plane substantially simultaneously with the vertical swinging or luffing of the boom **20**, connector **30** moving equally and oppositely to the swinging movement of the boom **20**. This master-slave connection of the cylinders **21** and **27** serves to maintain the articulated jib **40** in its original attitude during luffing movement of the boom **20**. When boom **20** is lowered through movement in a vertical plane, the piston of hydraulic cylinder **21** will travel upwardly and hydraulic liquid will flow through the hydraulic line L–2 from the upper end of cylinder **21** to the right hand or outer end of cylinder **27** through said hydraulic line L–2, thereby causing counter-clockwise rotation or swinging movement in a vertical plane of the connector **30**. This movement, also, will be simultaneously, equally and opposite to the movement of the boom **20**.

The articulated jib **40** comprises an upper arm **31** which is located between the plates **31A** and **31B**, upper arm **41** being of hollow rectangular cross section and having at its left or rear end a pair of ears **42A** and **42B** which also extend within the plates **31A** and **31B** and which are pivotally connected by a pivot pin **43**, as is clearly shown in FIG. **3**. At its outer or forward end, the upper arm **41** has a pair of ears **44A** and **44B** through which passes a pivot pin **45**.

A pair of lower arms **46** and **47** cooperate with the upper arm **41** to form the jib **40**, the lower arms **46** and **47** being preferably of tubular construction, and being connected at their left or rear ends by a horizontally extending pivot pin **48** to the connector **30**. The arms **46** and **47** lie outwardly of the plates **31A** and **31B** forming the connector **30**, and at their forward ends, the lower arms **46** and **47** are journalled to a lower pivot pin **49**.

As will be seen from FIG. **2**, the pivot pins **43** and **48** lie in substantially vertical alignment in the position of the parts as shown, as do the pivot pins **45** and **49**. The latter two pivot pins connect the jib **40** to a U-shaped basket support **50** which is rearwardly facing, and of substantial vertical extent. Thus, the articulated jib **40**, together with the connector **30** and support **50** form a parallelogram. The jib **40** may be articulated, or swung in a vertical plane relative to the connector **30** by means of the hydraulic cylinder **51** having its one pivotally connected to the connector **30** by the pivot pin **48**, and having the piston rod thereof pivotally connected

by a pivot pin **52** which extends between ears **53A** and **53B** which are secured to and depend from the upper arm **41.** Extension and retraction of the jib actuating cylinder **51** will cause the jib **40** to move from the position shown in FIG. **2** to a position in which the arms **41, 46** and **47** are substantially 63° above or below, as required, the axis of the boom **20.**

The basket **60** is of generally known construction, comprising a floor **61** which is preferably of expanded metal or the like, and which is bounded by a lower rail **62.** Vertical rails **63** extend upwardly from lower rail **62,** and are connected with a mid-rail **64** and an upper rail **65,** the basket **60** being of generally rectangular plan form. Ears **66A** and **66B** are secured to portions of the basket or platform **60** and to the support **50,** so as to secure the basket **60** to support **50.** Conventional welding techniques are utilized to assemble the basket **60,** and to secure it to the support **50.**

In operation, the aerial platform apparatus **10** may be moved to the location of the work, which in the present instance, for illustrative purposes, is taken to be maintenance of a large aircraft having a downwardly facing bay opening in the belly thereof, located many feet above the ground. The vehicle **12** cannot be placed directly under the aircraft bay, and so is placed laterally of the vertical projection thereof. The workman mounts the platform or basket **60,** and through controls therein (not shown) actuates the cylinder **21** to raise the boom **20** in a vertical plane. Due to the master-slave connection of the cylinder **27,** the connector **30** will be rotated about the pivot pin **33** in a clock-wise direction (as viewed in FIGS. **1** and **2**), the rotation of connector **30** being substantially simultaneously with and equally and opposite to the swinging movement of boom **20,** so as to maintain the attitude of the platform or basket **60** constant: that is, the floor **61** remains substantially horizontal while the boom **20** is being raised. The boom **20** may also be swung in a horizontal plane, in conventional manner. Further, the boom **20** is extended, so that the basket **60** is in position beneath the bay opening. The cylinder **51** may then be actuated to raise the jib **40** above the axis of boom **20,** and as necessary the boom **20** may also be extended. This action will move the inner end of the jib **40** outwardly, and closer to the aircraft bay, permitting the workman in the basket **60** to move upwardly into the aircraft bay, this movement being facilitated by the connection of the jib **40** to the lower portion of the support **50** and basket **60.** Adjustment in normal manner of the several hydraulic cylinders will continue until the exact position desired by the workman within the elevated downwardly opening aircraft bay is achieved.

Thereafter, by appropriate manipulation of the controls to thereby effect movement of the several hydraulic cylinders, the workman may remove the platform or basket **60** from the aircraft bay, and the aerial platform apparatus **10** may then be moved to a different position relative to the aircraft, to permit the workman to have access to the upper surface of the aircraft wing which is between the leading and trailing edges of the aircraft wing. As is known, it is often necessary for workmen to be positioned on the wing, so that they may have access to fuel openings or other maintenance points provided adjacent a spar which will support the weight of the workmen. The weight-supporting spar is spaced rearwardly of the wing leading edge and forwardly of the wing trailing edge, and the present apparatus **10** will permit the basket **60** to be placed in position above the spar, and then the jib **40** may be moved downwardly of the axis of the boom **20,** so that the connector **30** is substantially above the aircraft wing while the floor **61** of the basket **60** lies closely above the wing upper surface. In reaching the wing upper surface, the vehicle **12** may be placed either beneath the aircraft wing, or forwardly or rearwardly of it, so that there is a minimum of restriction of the positioning of the vehicle **12** relative to the point on the aircraft wing which is desired to reach.

There has been provided an aerial platform apparatus of strudy construction and great flexibility, the apparatus including an extensible boom having a connector pivoted to it, with an articulated jib connected to the connector and to the workman's basket by horizontal pivots. The platform is moved by a cylinder connected to the main boom working cylinder in master-slave relationship for simultaneous, equal and opposite swinging movement to the boom, so that the platform remains level or of constant attitude during boom luffing. Further, there has been provided a platform apparatus providing access to difficult-to-reach places, such as the downwardly facing bay of a large aircraft, where positioning of the vehicle of the apparatus relative to the bay is restricted to a position substantially laterally of the bay. Further, the articulated jib of the herein disclosed aerial platform apparatus may move substantially 60°, actually 63° in the preferred embodiment, above and below the boom axis, and the articulated jib itself is of sturdy construction and is connected to the lower portion of the workman's basket, thereby providing greater access to remote working locations.

It will be obvious to those skilled in the art that various changes may be made without departing from the spirit of the invention and therefore the invention is not limited to what is shown in the drawings and described in the specification but only as indicated in the appended claims.

I claim:

1. Aerial platform apparatus comprising:

a. a vehicle,

b. a linearly extensible boom,

c. means mounting said boom on said vehicle for swinging movement in vertical and horizontal planes,

d. a connector pivoted to the boom free end for swinging movement thereabout in a vertical plane,

e. means for vertically swinging said boom,

f. means for vertically swinging said connector substantially equally and oppositely to the vertical swinging of said boom,

g. load support means, and

h. vertically swinging jib means extending between and pivotally connected to said load support means and said connector and comprising actuating means for raising and lowering said load support means relative to the axis of said boom while maintaining constant the attitude of said load support means.

2. The aerial platform apparatus of claim **1,** said low support means comprising a personnel support platform having a floor, said last mentioned means maintaining said floor substantially horizontal during vertical swinging movement of said platform.

3. The aerial platform apparatus of claim 1, wherein said boom and connector swinging means comprises a pair of hydraulic cylinders.

4. The aerial platform apparatus of claim 3, wherein one said cylinder swings said boom and a second said cylinder swings said connector, and conduit means connecting said cylinders in master-slave relationship.

5. The aerial platform apparatus of claim 1, said last mentioned means comprising upper arm means and lower arm means, said arm means being substantially parallel.

6. The aerial platform apparatus of claim 5, said lower arm means comprising a pair of laterally spaced arms.

7. The aerial platform apparatus of claim 6, said upper arm means comprising an arm in a vertical plane between said pair of lower arms.

8. The aerial platform apparatus of claim 7, and hydraulic cylinder means for swinging said arm means.

9. Aerial platform apparatus comprising:

a. a vehicle,

b. a linearly extensible boom,

c. means mounting said boom on said vehicle for horizontal swinging movement,

d. means mounting said boom on said vehicle for vertical swinging movement,

e. a connector pivotally connected to said boom for vertical swinging movement about an axis through said boom,

f. means for rotating said connector,

g. platform means spaced from said connector, and

h. means connected to said platfrom means and to said connector for swinging said platform means to and from positions above and below the axis of said boom and for maintaining constant the attitude of said platform means.

10. The aerial platform apparatus of claim 9, wherein said last mentioned means comprises upper and lower parallel arms pivotally connected to said connector and to said platform means.

11. The aerial platform apparatus of claim 10, wherein said platform means comprises a floor and wall means extending upwardly therefrom, and wherein said arm means are pivotally connected to said basket at the lower part thereof.

12. The aerial platform apparatus of claim 10, wherein said last mentioned means comprises hydraulic cylinder means for swinging said arm means.

13. The aerial platform apparatus of claim 9, wherein said last mentioned means comprises arm means having a range of movement of approximately 60° above and below said boom axis.

14. The aerial platform apparatus of claim 9, wherein said connector is pivotally connected to the free end of said extensible boom.

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