United States Patent

Zwight et al.

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[54] ARTICULATED AERIAL DEVICE

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

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

[58] **Field of Search** 182/2, 141; 212/8, 9

[56] **References Cited**

UNITED STATES PATENTS

2,724,620	11/1955	Johnson	182/2
3,498,474	3/1970	Pierce	182/2
2,815,250	12/1957	Thornton-Trump	182/2
3,378,103	4/1968	Zwight et al.	182/2

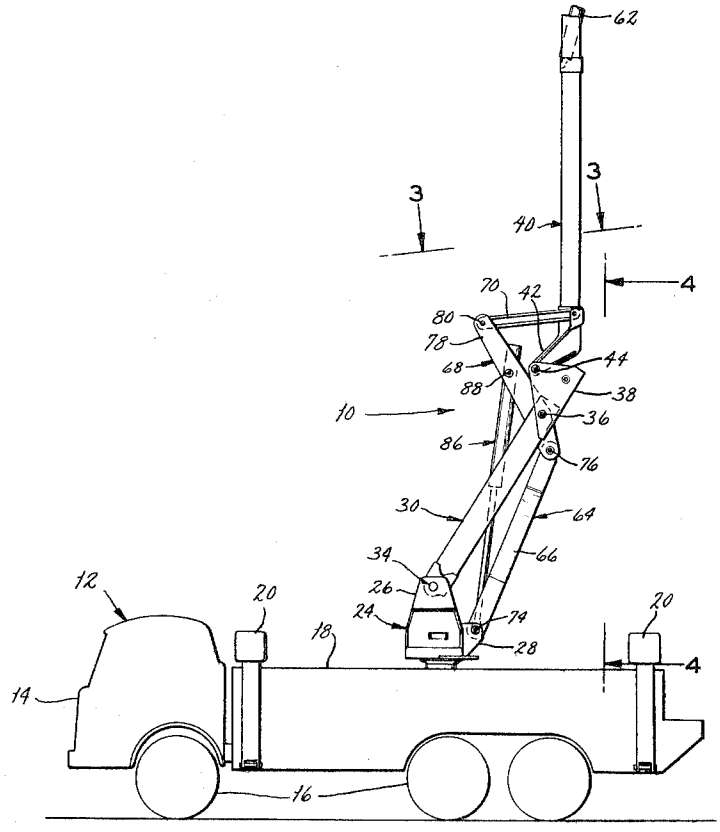
Primary Examiner—Reinaldo P. Machado

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[57] **ABSTRACT**

An articulated aerial device comprises a base and lower, middle and upper beams pivotally connected to one another, the lower beam being pivotally connected to the base. An upper linkage mechanism pivotally interconnects the upper and middle beams and a hydraulic cylinder is connected to the upper linkage for swinging the upper and middle beams with respect to one another. A Z-shaped linkage pivotally interconnects the base, the lower beam and the middle beam. A lower hydraulic cylinder is connected at one of its ends to the base and at the other of its ends to the Z-shaped linkage. Extension of the lower hydraulic cylinder causes the lower beam to swing with respect to the base and simultaneously causes the middle beam to swing with respect to the lower beam.

25 Claims, 5 Drawing Figures



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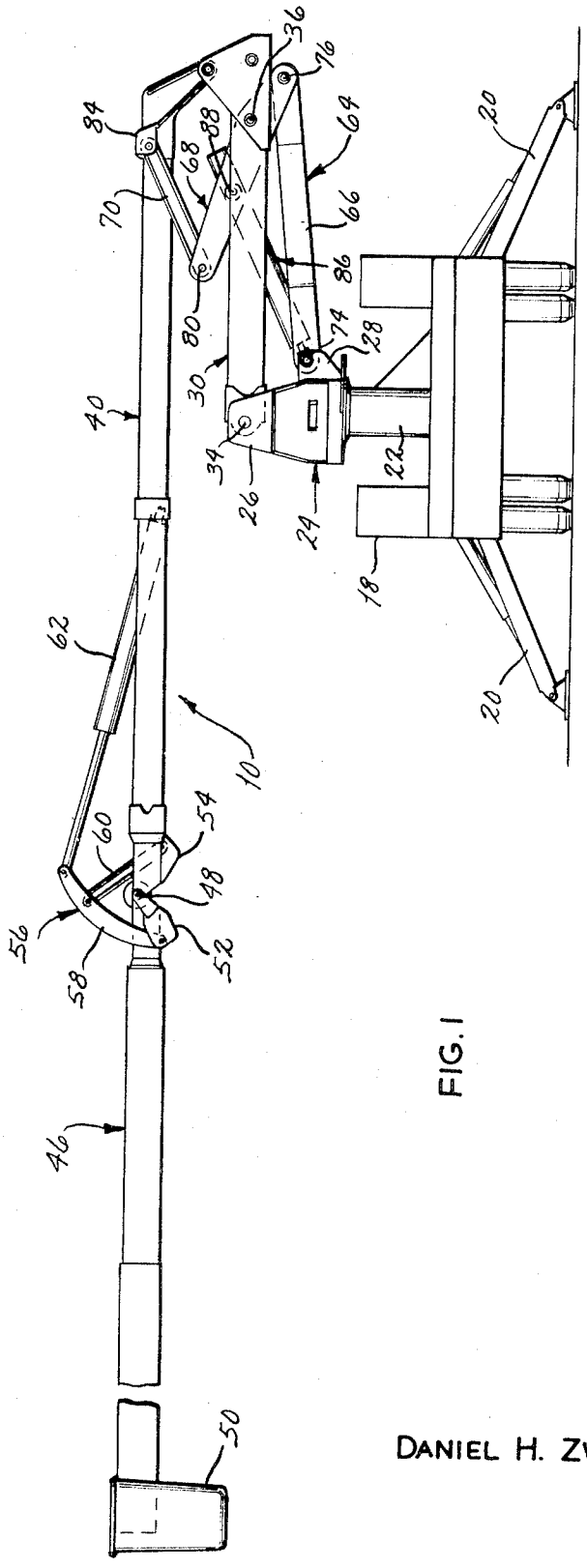


FIG. 1

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FIG. 3

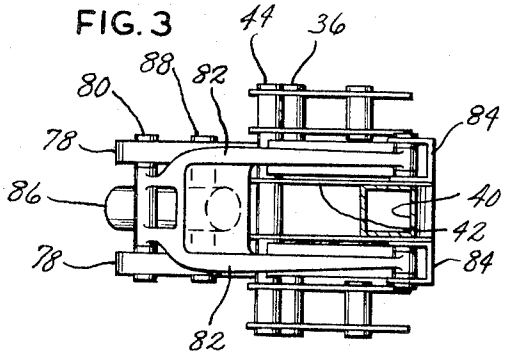


FIG. 2

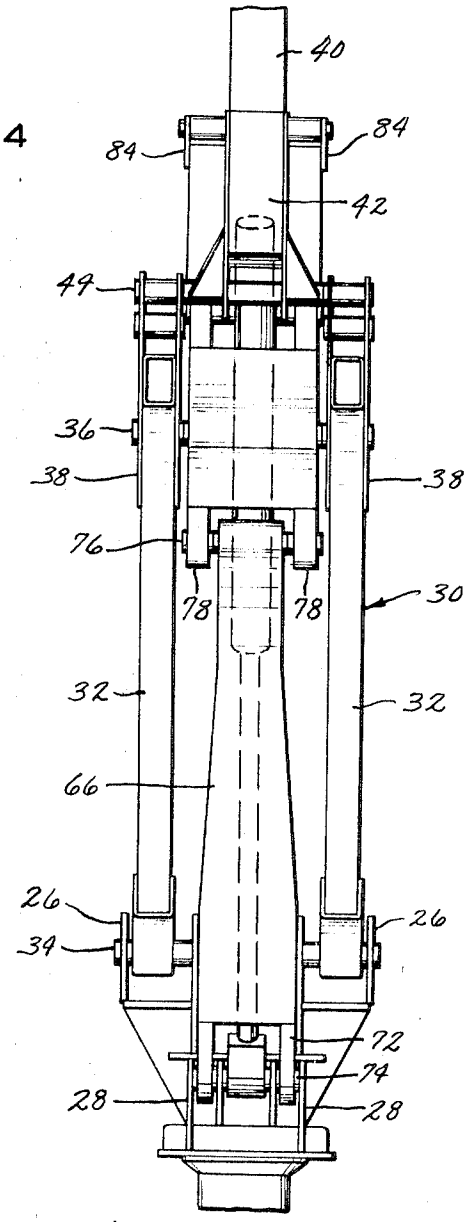
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FIG. 4



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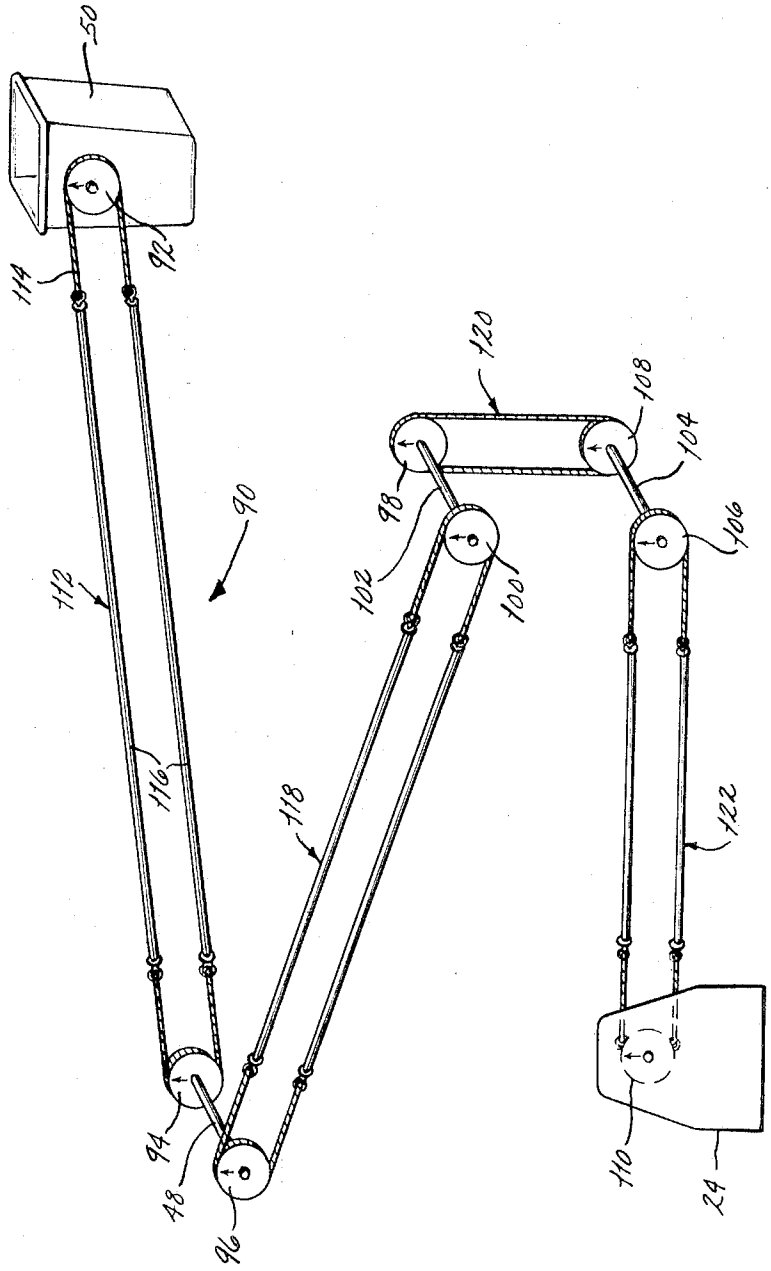


FIG. 5

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ARTICULATED AERIAL DEVICE

This invention relates to articulated aerial devices which include a plurality of beams swingably mounted with respect to one another.

Mobile aerial devices are presently used for tasks which require lifting men in the air. For example, these devices are commonly used for doing work on utility lines. One form of construction for aerial devices includes a plurality of beams swingably mounted with respect to each other for articulated movement. These articulated aerial devices have heretofore usually been limited to two swinging beams. They include a linkage which interconnects the two beams and a hydraulic cylinder connected at one of its ends to the linkage and at its opposite end to one of the beams. Extension of the hydraulic cylinder causes articulated movement of the beams with respect to one another. An example of this type of articulated aerial device is disclosed in U.S. Pat. No. 3,378,103. Two-beam articulated aerial devices presently require two hydraulic cylinders and two systems of hydraulic lines. One hydraulic cylinder is used for swinging the two beams with respect to each other and the other is used for swinging the lower beam with respect to its pivotal mounting on the base.

Since aerial devices are often mounted on a vehicle for mobility, the length of the beams must be limited to permit the vehicle to travel on streets and on highways. Therefore, in order to increase the height to which the aerial devices will reach by articulation, one must provide additional beams which can be folded over upon one another for compactness during transport by the vehicle. However, increasing the number of beams to three or more presents several problems. A three-beam aerial device requires three hydraulic cylinders if constructed according to presently known methods, and these cylinders, together with the hydraulic lines necessary to operate them, add an undesirable amount of weight to the aerial device. Increased weight is undesirable because lateral swinging of the beams results in large moments being created with respect to the vehicle. Weight becomes an increasingly important factor when the length of the beam assembly is increased as is the case with a three-beam device. Furthermore, a three-cylinder hydraulic system would be more expensive than a two-cylinder system.

The articulated aerial device of this invention utilizes three beams and two hydraulic cylinders. One hydraulic cylinder is connected to a conventional linkage such as shown in U.S. Pat. No. 3,378,103 for swinging the upper beam with respect to the middle beam. The second hydraulic cylinder is pivotally connected at one of its ends to the base and at the other of its ends to a Z-shaped linkage which pivotally interconnects the base, the lower beam and the middle beam. The extension of this latter cylinder causes the lower beam to swing with respect to the base and simultaneously causes the middle beam to swing with respect to the lower beam. Thus applicant's invention provides an articulated aerial device having three beams which can be fully extended by means of two hydraulic cylinders.

The articulated aerial device of this invention is so constructed that its center of gravity is relatively near the vehicle at all times during movement of the various beams. The Z-shaped linkage and the lower hydraulic cylinder provide a counterbalance when the upper beam is extended laterally with respect to the vehicle. An additional advantage is gained by a three-beam device in that flexibility of movement is increased considerably over two-beam devices and maneuvers are possible which were heretofore unattainable.

Among the several objects of the present invention may be noted the provision of an aerial device which includes three articulated beams; the provision of a three-beam articulated aerial device which can be mounted on and transported by a vehicle; the provision of a three-beam aerial device which can be fully extended by means of no more than two hydraulic cylinders; the provision of a three-beam aerial device which is nearly as compact as a two-beam aerial device but which will extend further and higher than a two-beam aerial device; the

provision of an aerial device which provides greater flexibility of movement and greater maneuverability than devices heretofore known; the provision of an aerial device which provides a counterbalance when its outer end is positioned laterally with respect to its base; the provision of an aerial device which has three beams and which minimizes swaying when fully extended to its maximum height; the provision of an aerial device which has its center of gravity located near its base throughout all its movements; and the provision of an aerial device which is economical to manufacture and durable in use. Other objects and features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which one of various possible embodiments of the invention is illustrated,

FIG. 1 is an elevational view of the aerial device of this invention as viewed from the rear of a vehicle;

FIG. 2 is a plan view of the aerial device of this invention shown in its fully extended position;

FIGS. 3 and 4 are sectional views taken along lines 3—3 and 4—4, respectively, of FIG. 2; and

FIG. 5 is a schematic view of the workman's basket-leveling device of this invention.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Referring to the drawings, an articulated aerial device **10** is mounted on a vehicle **12** having a cab **14**, wheels **16** and a rear box frame **18**. Mounted on the lateral sides of box frame **18** are four outriggers **20** which are adapted to move from an inoperative position shown in FIG. **2** to an extended position as shown in FIG. **1** wherein they engage the ground laterally of vehicle **12** to provide stability thereto during operation of aerial device **10**.

Rigidly mounted within box frame **18** is a mast **22**, and mounted on the upper end of mast **22** is a base or turret **24** which is adapted to rotate about a vertical axis with respect to mast **22**. Turret **24** includes two spaced-apart pairs of upstanding flanges **26** (FIG. **4**). Adjacent the lower end of turret **24** are two pairs of horizontally extending flanges **28** which are spaced apart from one another.

A lower beam **30** includes two spaced-apart beam members **32** having shafts **34**, **36**, extending through the lower and upper ends thereof, respectively. Shaft **34** also extends through upstanding flanges **26** to pivotally mount the lower end of lower beam **30** to turret **24**. Rigidly mounted to the upper end of each beam member **32** is a triangular gusset **38**. A middle beam **40** includes an angled lower end **42** which is pivotally mounted between triangular gussets **38** by means of a shaft **44**. An upper beam **46** is pivotally mounted to the upper end of middle beam **40** be means of a shaft **48**. On the extreme upper end of upper beam **46** is pivotally mounted a workman's basket **50**. If desired, a pair of workman's baskets **50** can be mounted on the upper end of upper beam **46**. The lower end of upper beam **46** includes an ear **52** rigidly mounted thereto and the upper end of middle beam **40** includes a similar ear **54** rigidly mounted thereto. An upper linkage **56** pivotally interconnects ears **52**, **54**, and includes an arcuate member **58** and a straight member **60**. An upper hydraulic cylinder **62** is pivotally secured at one of its ends to middle beam **40** and at the other of its ends to arcuate member **58** of upper linkage **56**. Extension and retraction of upper hydraulic cylinder **62** causes upper beam **46** to swing with respect to middle beam **40**. The particular structural arrangement of upper linkage **56** and ears **52**, **54**, is such that hydraulic cylinder **62** is capable of swinging upper beam **46** from a folded position wherein it is in side-by-side relationship with middle beam **40** through an angle of approximately 240°. Upper linkage **56** and its mode of operation are described in U.S. Pat. No. 3,378,103.

A lower linkage **64** includes a lower link **66**, a middle link **68** and an upper link **70**. Lower link **66** includes at its lower end a yoke **72** which is pivotally connected to horizontally ex-

tending flanges 28 by means of a shaft 74. Lower link 66 tapers inwardly at its upper end where it is pivotally connected to the lower end of middle link 68 by means of a shaft 76. Middle link 68 includes two spaced-apart middle link members 78 (FIGS. 3 and 4) which extend from below lower beam 30 upwardly between beam members 32 where they terminate at their upper ends. A shaft 80 joins the upper ends of middle link members 78 and pivotally connects them to the lower end of upper link 70. Middle link members 78 are also pivotally connected to lower beam 30 by means of shaft 36. Upper link 70 is formed from two spaced-apart upper link members 82 (FIG. 3) which are pivotally secured at their upper ends to a pair of ears 84 rigidly secured to the opposite sides of middle beam 40.

A lower hydraulic cylinder 86 is pivotally connected at its lower end to turret 24 by means of shaft 74, and is pivotally connected at its upper end to middle link 68 by means of a shaft 88. The relative positions of lower beam 30, middle beam 40, lower link 66, middle link 68, upper link 70 and lower hydraulic cylinder 86 are such that their longitudinal centerlines lie in the same vertical plane so that they are all symmetric with respect to that plane. This symmetry insures that all stresses and forces will be applied symmetrically to these components during the extension and retraction of lower hydraulic cylinder 86. Lower linkage 64 normally forms a Z-shaped configuration. Of particular importance are the relative positions of shafts 76, 80, 36, and 88 which extend through middle link 68. The opposite ends of middle link 68 are pivotally attached to lower link 66 and upper link 70. Shaft 36 is located intermediate these two points. Shaft 88 is located between shaft 36 and shaft 80. By virtue of these respective locations of the pivot points, extension of lower hydraulic cylinder 86 causes swinging movement of lower beam 30 with respect to turret 24 and simultaneously causes swinging movement of middle beam 40 with respect to lower beam 30. In their folded position (FIG. 1) lower beam 30 and middle beam 40 are parallel and folded over one another. Lower beam 30 is substantially shorter than middle beam 40 so that turret 24 and mast 22 will be located intermediate the lengths of middle and upper beams 40, 46, when they are folded with respect to one another. During extension of lower hydraulic cylinder 86, lower beam 30 swings approximately 60° to 70° with respect to the horizontal, and at the same time middle beam 40 moves approximately 160° to 170° with respect to lower beam 30. In a fully extended position hydraulic cylinder 86 holds middle beam 40 in a slightly overcenter vertical position as shown in FIG. 2.

Because aerial device 10 is carried by vehicle 12, the location of the aerial device's center of gravity with respect to vehicle 12 is critical. If the center of gravity is located too far laterally with respect to vehicle 12, it will cause the vehicle to tip. One important feature of the structure of aerial device 10 is that its center of gravity is always located relatively close to mast 22 regardless of the position of beams 30, 40, 46. This is made possible by the fact that the respective centers of gravity of lower hydraulic cylinder 86 and lower linkage 64 are each located intermediate the opposite ends of lower beam 30 regardless of the position of beams 30, 40, 46. In most positions the center of gravity of the entire aerial device 10 is considerably closer to mast 22 than the length of lower beam 30. For example, in the position shown in FIG. 1, basket 50 creates a moment about mast 22 but this moment is counterbalanced by the moment created by lower beam 30, hydraulic cylinder 86 and lower linkage 64. In the position of aerial device 10 shown in FIG. 2, a substantial amount of the mass of aerial device 10 is located close to mast 22, thereby causing the center of gravity to be spaced from mast 22 a distance less than the length of lower beam 30.

Thus, lower linkage 64 permits the extension of a three-beam aerial device by means of only two hydraulic cylinders. Furthermore, a greater flexibility of movement and greater maneuverability can be achieved with a three-beam device than could previously be achieved with two-beam devices. For example, if the workman's basket of a two-beam device were positioned in its highest position and simultaneously were positioned flush against a pair of high-voltage wires, it would be impossible to move the basket horizontally away from the wires without moving the vehicle. However, such movement is possible with the device of this invention merely by retracting lower hydraulic cylinder 86. Such retraction causes the basket (assuming the basket to be at its highest position) to back away from the wire in a direction which would be almost horizontal. The particular arrangement of lower linkage 64 also lends great stability to the aerial device and minimizes swaying of the basket when it is in a fully extended position.

Referring to FIG. 5, basket 50 is provided with a leveling mechanism 90 which automatically maintains basket 50 in an upright position regardless of the relative movement of beam 30, 40, 46. Leveling mechanism 90 includes a sprocket 92 which is fixed to basket 50 and which is adapted to rotate with respect to upper beam 46. Two sprockets 94, 96, are fixed to shaft 48 which forms the pivotal axis between upper beam 46 and middle beam 40. Sprockets 94, 96, are free to rotate independently of upper and middle beams 46, 40. Two more sprockets 98, 100, are mounted within the lower end of middle beam 40 and are fixed to a shaft 102 which is free to rotate independently of middle beam 40. A similar shaft 104 and pair of sprockets 106, 108, are pivotally mounted within the upper end of lower beam 30. An anchor sprocket 110 is fixed to turret 24. Lower beam 30 is free to swing about the axis of anchor sprocket 110. An upper loop 112 is trained around sprockets 92, 94, and includes chains 114 at its opposite ends and connector rods 116 extending therebetween. Chains 114 are meshed with sprockets 92, 94, so that loop 112 is held against slipping movement with respect to sprockets 92, 94. A middle loop 118 identical in construction to upper loop 112 is trained over sprockets 96, 100. A connector loop 120 similarly interconnects sprockets 98, 108, and a lower loop 122 similarly interconnects sprocket 106 and anchor sprocket 110. For illustrative purposes each sprocket shown in the drawings is marked with a vertically disposed arrow indicating the rotational position of the sprocket. As beams 30, 40 and 46 swing throughout their various positions every sprocket will be held in its vertical position by virtue of the stationary position of anchor sprocket 110. Thus all the arrows shown on the sprockets will maintain their vertical position regardless of the position of beams 30, 40, and 46.

The control mechanism for controlling hydraulic cylinders 62, 86, is not shown in the drawings and may be of any conventional type presently known. The controls may be located at the base of aerial device 10 and an additional set of controls may also be provided in workman's basket 50.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. An articulated aerial device comprising a base; a first beam and a second beam pivotally connected to one another for relative swinging movement; means pivotally mounting said first beam on said base for swinging movement relative thereto; a linkage mechanism pivotally interconnecting said base, said first beam, and said second beam; and power means pivotally coupled with both said base and said linkage mechanism whereby to swing said first beam with respect to said base and simultaneously swing said second beam with respect to said first beam.

2. An aerial device according to claim 1 wherein said linkage mechanism includes a lower link pivotally connected to said base, an upper link pivotally connected to said second beam, and a middle link pivotally connected to said first and second links.

3. An aerial device according to claim 2 wherein said middle link is additionally pivotally connected to said power means.

4. An aerial device according to claim 3 wherein said middle link is pivotally connected at its opposite ends to said upper and lower links; said power means and said first beam being pivotally connected to said middle link at points between said opposite ends.

5. An aerial device according to claim 1 wherein said power means is a single hydraulic cylinder pivotally connected at one of its ends to said base and pivotally connected at the other of its ends to said linkage mechanism.

6. An aerial device according to claim 5 wherein a third beam is pivotally connected to said second beam; a second linkage mechanism pivotally interconnecting said second and third beams; a second hydraulic cylinder connected to both said second beam and said second linkage mechanism whereby to swing said second and third beams with respect to one another.

7. An aerial device according to claim 6 wherein a workman's basket is pivotally mounted on said third beam; a leveling mechanism being provided to hold said workman's basket in the same rotational position with respect to the horizontal; said leveling mechanism including a plurality of loops interconnecting sprockets on said basket, on the pivotal axis between said second and third beams, on each of the adjoining ends of said first and second beams, and on the pivotal axis of said first beam with respect to said base; all said sprockets except said last-mentioned one being free to rotate independently of said beams; said last-mentioned sprocket being fixed to said base.

8. An aerial device according to claim 1 wherein said linkage mechanism has a Z-shaped configuration formed from a lower link connected to said base, an upper link connected to said second beam, and a middle link interconnecting said upper and lower links.

9. An aerial device according to claim 8 wherein said power means is pivotally coupled with said middle link at a first pivot point located intermediate the pivotal connection of said middle link to said upper link and the pivotal connection of said middle link to said lower link.

10. An aerial device according to claim 9 wherein said middle link is pivotally connected to said lower beam at a point intermediate said first pivot point and he pivotal connection of said middle link to said lower link.

11. An aerial device according to claim 8 wherein said power means is a hydraulic cylinder extendible from a retracted position to an extended position; said first and second beams moving approximately 170° with respect to one another in response to movement of said cylinder between its retracted and extended positions; said lower beam simultaneously swinging approximately 70° with respect to the horizontal in response to said movement of said cylinder.

12. An articulated aerial device comprising a vehicle; a base mounted on said vehicle; a lower beam having upper and lower ends, said lower end of said lower beam being pivotally connected to said base; a middle beam having upper and lower ends, said lower end of said middle beam being pivotally connected to said upper end of said lower beam; an upper beam pivotally connected to said upper end of said middle beam; an upper linkage pivotally interconnecting said upper and middle beams; an upper power means carried by said middle beam and pivotally connected to said upper linkage for swinging said upper and middle beams from a folded position wherein they are in side-by-side relation to an unfolded position wherein they are end to end and form an angle of at least 180° with respect to one another; and means for swinging said lower beam with respect to said base and said middle beam with respect to said lower beam; said lower and middle beams being movable to a folded position wherein they are folded over on one another; whereupon said lower beam and part of said middle beam provide a counterbalance with said base as a fulcrum when said upper and middle beams are in their unfolded position and said lower and middle beams are in their folded position.

13. An articulated aerial device according to claim 12 wherein said lower beam is substantially shorter than said upper beam.

14. An articulated aerial device according to claim 12 wherein said means for swinging said lower beam includes a Z-shaped linkage interconnecting said base, said lower beam, and said middle beam; said Z-shaped linkage having a center of gravity which is intermediate the opposite ends of said lower beam.

15. An articulated aerial device according to claim 14 wherein said means for swinging said lower beam also includes a hydraulic cylinder pivotally connected at its opposite ends to said base and said Z-shaped linkage; the center of gravity of said hydraulic cylinder being intermediate said opposite ends of said lower beam.

16. An articulated aerial device according to claim 12 wherein said base is rotatable with respect to said vehicle about a vertical axis.

17. An articulated aerial device according to claim 12 wherein said means for moving said lower beam is a Z-shaped linkage formed from a lower link, a middle link, and an upper link; said lower beam being formed from two spaced apart and parallel lower beam members; said middle link extending between said lower beam members.

18. An articulated aerial device according to claim 17 wherein said middle link is formed from two spaced apart and parallel middle link members; a hydraulic cylinder being connected at one of its ends to said base and at the other of its ends to a shaft spanning the distance between said middle link members.

19. An articulated aerial device according to claim 17 wherein the longitudinal centerlines of said lower beam, said upper beam, said upper link, said middle link, and said lower link all lie in the same plane.

20. An articulated aerial device comprising a base, a beam assembly having at least two beams swingably connected to one another, one of said two beams being pivotally mounted to said base, a power mechanism operatively connecting said beam assembly and said base for swingably moving said two beams with respect to one another and with respect to said base from a first position wherein both beams are substantially horizontally oriented to a second position wherein both beams are substantially vertically oriented.

21. An aerial device according to claim 20 wherein a third beam is pivotally connected to the other of said two beams; a second power mechanism operatively connecting said other and said third beams for swingably moving them with respect to one another.

22. An aerial device according to claim 1 wherein said linkage mechanism includes a lower link pivotally connected to said base and an upper link pivotally connected to said second beam, said upper and lower links having a common connection.

23. An aerial device according to claim 1 wherein a third beam is pivotally connected to said second beam, said second beam including secondary power means provided thereon for moving said third beam with respect to said second beam.

24. An aerial device according to claim 23 wherein at least one workman's basket is pivotally mounted on one of said beams, said device further including leveling means for holding said workman's basket in a predetermined position.

25. An aerial device as claimed in claim 24 wherein said leveling mechanism includes a nonrotatable sprocket fixed to said base and freely rotatable sprockets arranged to rotate independently of movement of said beams, said rotatable sprockets being mounted at the junction between the workman's basket and the third beam, and at the remaining ends of said beams, said leveling mechanism further including a plurality of loops interconnecting pairs of sprockets such that the rotational position of the sprocket mounted to said basket is the same as the rotational position of said fixed sprocket.