July 16, 1963 G. L. THYM 3,097,721

AERIAL LADDER

Filed March 26, 1962 3 Sheets-Sheet 1

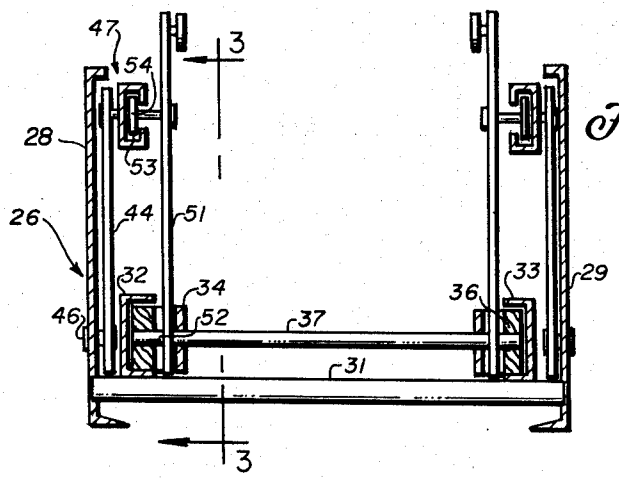


Fig. 2.

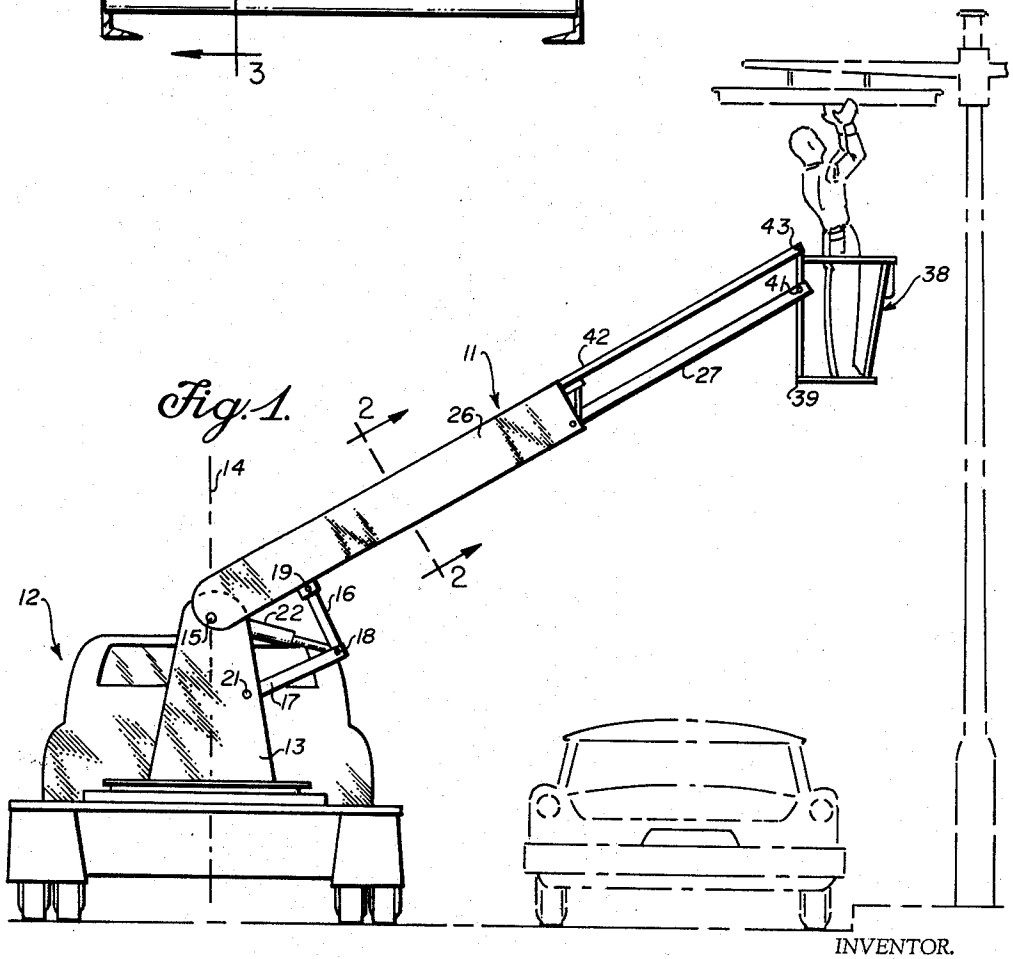


Fig. 1.

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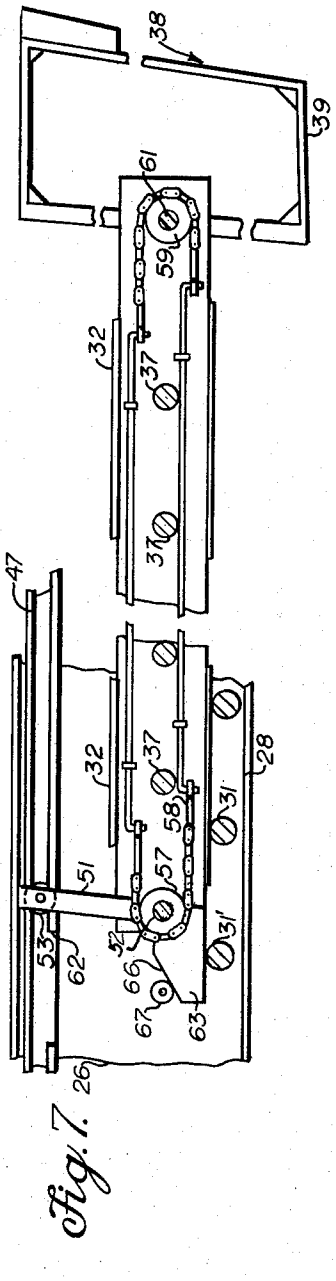


Fig. 7.

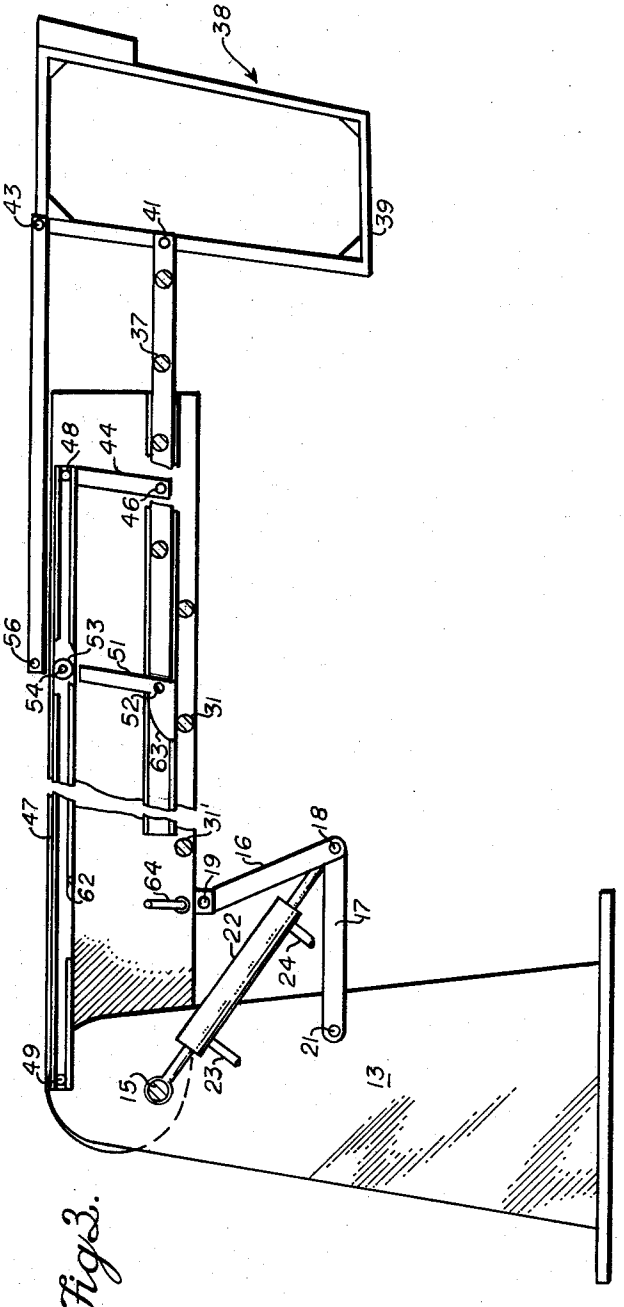


Fig. 3.

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Fig. 4.

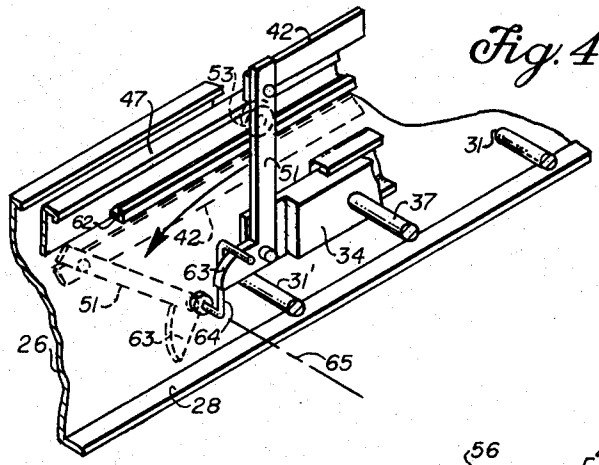


Fig. 6.

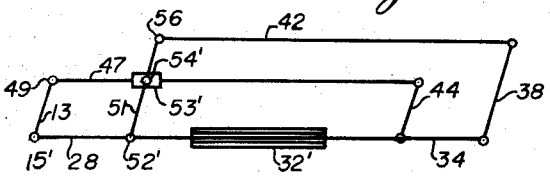
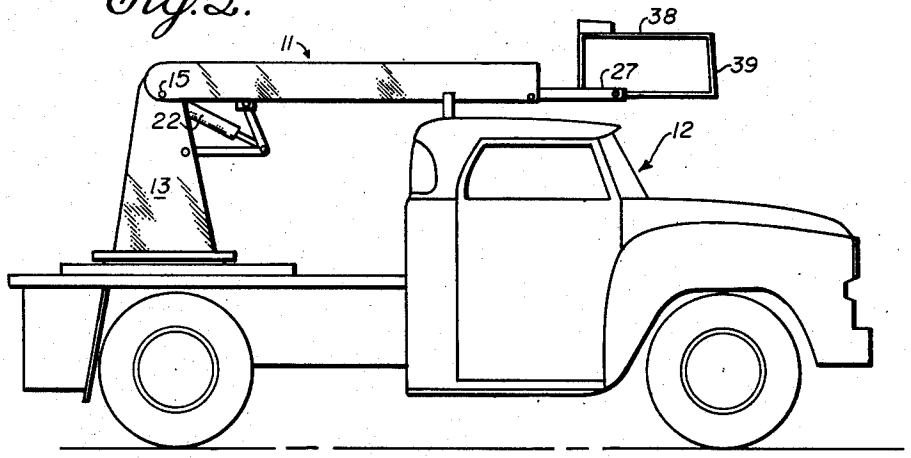


Fig. 5.



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AERIAL LADDER

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12 Claims. (Cl. 182—2)

This invention relates in general to an expansible aerial ladder useful to utility crews for street light maintenance, general line work, and tree trimming and, more particularly, to the art of maintaining a working platform on an upper section horizontal for all ladder positions.

Aerial ladders are generally mounted on a vehicle for mobility and, if the aerial ladder is of a fixed length, the problem of maintaining a platform level at the upper end as the ladder is raised or lowered is simply solved by using the parallelogram principle. Since this ladder is mounted on a vehicle its length is limited and, therefore, expansible ladders are now used so that a greater distance of reach is obtained. The parallelogram principle, as it has been known up to now, is not practical because, as the length of the ladder varies, so should vary the length of the parallelogram link disposed parallel to the ladder "link."

Attempts have been made to maintain the platform level, such as, using the force of gravity, but this is undesirable since the workmen would be standing on a "pendulum" and be rocking back and forth as he tried to work. Other attempts involved the use of loose cables, that have a tendency to become tangled and unsafe.

One object of this invention is to provide a horizontal working platform on an expansible ladder that is steady and stable.

Another object of this invention is to provide a working platform on an expansible ladder that maintains its horizontal position as either the length of the ladder is increased or the angle (horizontal) the ladder makes with the ground increases or both conditions occur together.

Another object of this invention is the provision of an improved horizontal platform on an aerial ladder having greater safety and stability.

Generally, working platforms are placed near the top of the aerial ladder so that a workman, after climbing the ladder, steps down onto the platform. This feature of the prior art is used to decrease rocking or twisting in the ladder. A platform of this type when placed on a vehicle would be in the way of the vehicle operator's vision when the ladder is stowed for transport.

Therefore, another object of this invention is to provide a means in combination with the above objects whereby the platform is made to rotate upward when the ladder is retracted and in its horizontal position.

In this invention an expansible ladder that contains two or more telescoping sections has a parallelogram linkage that has one link fixed to the lower telescoping section and an adjacent link fixed to the vehicle whereby the angle between the links changes as the horizontal angle of the ladder changes. A third link is pin-connected to the adjacent telescoping section whereby it engages one link of the parallelogram linkage at a given spaced distance from the pinned end and sides along this link as the ladder is expanded or retracted. This link is disposed on the upper section whereby it is always parallel to the fixed

link on the parallelogram linkage to become the "fixed" reference link for this upper section. When the ladder is placed in its stowed position, a feature is provided whereby the link on the upper section disengages the parallelogram linkage to allow the platform to rotate. Since the working platform is now maintained substantially horizontal and rigid, another feature is provided on the ladder wherein the ladder could be safely rotated to an angle below the horizontal line whereby a workman could be supported down into a ravine or a cliff.

This invention possesses other features of advantage, some of which, with the foregoing, will be set forth in the following description of this invention. One understands that this invention is not limited to the disclosure of species herein, as variant embodiments thereof may be adopted within the scope of the claims.

Referring to the drawings:

FIG. 1 is a view of an aerial ladder in use,

FIG. 2 is a section of the ladder taken on line 2—2 of FIG. 1,

FIG. 3 is a section of the ladder taken on line 3—3 of FIG. 2,

FIG. 4 is a pictorial, broken-away view of a portion of the ladder,

FIG. 5 is a view of the ladder in a stowed position,

FIG. 6 is a simplified schematic representation of the mechanism used herein, and

FIG. 7 is an alternate embodiment.

Referring to FIG. 1, an extended aerial ladder **11** is shown with a workman and the ladder **11** is mounted preferably on a vehicle **12** through the intermediary of a pedestal **13**. As with most aerial ladders mounted on vehicles, the pedestal **13** is free to rotate on a vertical axis **14** and the lader **11** is free to rotate on a horizontal axis represented by a pin **15**. The mechanism to increase or decrease the horizontal angle of the ladder preferably comprises two links **16** and **17** that are pin-connected together by a suitable pin **18** and also pin-connected to ladder **11** and pedestal **13** by suitable pins **19** and **21** respectively (FIG. 3). Of course, the axes of pins **16**, **19** and **21** should be susbtantially parallel to each other and to axis **15** to provide free motion for the ladder. Means are provided in conjunction with the quadrilateral linkage formed by ladder **11**, pedestal **13** and links **16** and **17** for raising or lowering the ladder. The means is preferably a hydraulic cylinder, and piston assembly **22** that is pivotally connected between pins **16** and **18**. Hydraulic fluid under pressure is used to increase or decrease the distance between pins **15** and **18** and the fluid is suitably supplied through fluid lines **23** and **24**.

This quadrilateral linkage, including links **16**, **17**, ladder **11** and pedestal **13**, allows the ladder to be lowered as well as raised from its horizontal position to allow a workman to work suspended down into or over a ravine. A workman could do this in safety, provided that there is a stable, level safety platform on the other end of the ladder. This feature will now be described.

Referring again to FIG. 1 the ladder **11** is a telescoping ladder which has the advantage in that a fellow workman could safely climb the ladder should additional tools or help be needed on the job. The ladder shown has preferably two telescoping sections **26** and **27**, although, after one skilled in the art studies teachings of

this invention, the feature described herein could be combined with a telescoping ladder having more than two sections.

Referring to FIG. 2, the lower section 26 has two depth channel stringers 28 and 29 with a plurality of ladder rungs 31 suitably spaced and fastened between the stringers 28 and 29. Fixed on the ladder rungs are two spaced guide channels 32 and 33 that slidably engage the upper section 27. The upper section includes two stringers 34 and 36 that engage channels 32 and 33 respectively, and also includes a plurality of spaced ladder rungs 37. Suitable power means or manual means (not shown) could be used to extend or retract the ladder sections 26 and 27. On the end of section 27 is defined a basket 38 that has a platform 39 (FIG. 1) in which a workman can safety stand.

The basket 38 is preferably pinned to the upper section by a pin 41 that should be substantially parallel to pin 15 so that the basket 38 could be free to rotate therewith to place platform 39 in the horizontal position. The basket 38 could be stabilized by a rigid bar 42 pinned by a pin 43 to the basket 38. Pin 43 and pin 41 are also substantially parallel. Now, if the length of the ladder is constant, the length of bar 42 need be only of constant length and the basket would be maintained vertical (platform 39 horizontal) as the ladder 11 is raised or lowered. But, since the length of the ladder is variable, I have provided a means by which the basket 38 could be held in a stable vertical position and the platform 39 horizontal.

Referring to FIG. 3, at the upper end of one of the stringers 28 of the lower section 26, a link 44 is pinned thereto by a pin 46. The axis of pin 46 is also substantially parallel to the axis of pin 15. Pins 46 and 15 preferably lie within the plane defined by the upper section. Another link 47 is pinned to link 44 and to pedestal 13 by means of pins 48 and 49 respectively. The distance between pins 15, 46, 48 and 49 is such that opposite links are always maintained parallel, thereby simulating a pinned-parallelogram linkage with the pedestal 13 (between pins 15 and 49) being the fixed link. Now, if the fixed link is vertical, of course, the link 44 would be vertical. Now this vertical reference should be transferred to the adjacent section.

I have solved this problem by installing a lever 51 pin-connected to the upper section by a pin 52. The axis of pin 52 is disposed so that it lies substantially in the plane defined by the axis of pins 15 and 46 as the upper section 27 is extended or retracted. On lever 51 is mounted a roller 53 on an axle 54. The distance between the axis of axle 54 and the axis of pin 52 is substantially equal to distance between the axis of pins 46 and 48. Link 47 has a C-cross section and is shaped (FIG. 2) so as to engage roller 53 and allow it to roll or slide along the link 47 whereby the axis of axle 54 substantially lies in the plane defined by the axis of pins 48 and 49. Now, as the ladder is raised from its horizontal position the parallelogram closes because link 47 moves toward the ladder link. Since the distance between the axis 52 and 54 is fixed, link 51 should rotate the same number of degrees with respect to the ladder. Now, link 51 and link 44 are always substantially parallel. The link 42 could now be a fixed length and be pin-connected to link 51 by pin 56 and the fixed vertical reference is transferred to the basket 38 because the distance between pins 52 and 56 is equal to distance between pins 41 and 43 and because the distance between pins 41 and 52 is equal to the distance between pins 43 and 56.

To explain the principle involved in this invention and and used in combination with an aerial ladder to provide greater safety to a workman and more mobility, refer to FIG. 6. This figure is a schematic drawing of the linkage involved. The fixed link 13 is the pedestal to which is pinned links 47 and 28 (the lower section). At the other end of links 47 and 28 is pinned link 44. Through well known principles of mechanics, links 13, 47, 28 and 44 form a parallelogram. Superimposed over it, is placed another parallelogram which includes links 51, 42, 38 (the basket) and 34 (the upper section). The channel structure 32 that allows links 28 and 34 to slide only lengthwise with respect to each other is shown by member 32'. The roller 53 is represented by a slide 53' that slideably engages link 47 and that is fixed but free to rotate about pin 54' with respect to lever 51. Again, as link 34 slides to the left, slide 53' should follow an equal amount because links 47 and 28 are parallel and the distance between 54' and 52' is fixed. Now, as the angle between link 13 and link 28 is closed, link 34 remains aligned with link 28 and the distance between link 47 and 28 shortens whereby lever 51 should rotate to remain parallel to link 13 because the distance between 52' and 53' was made equal to the distance from 15' to 49'.

One skilled in the art could now substitute mechanical equivalents for the embodiments shown, for example, referring to FIG. 7, lever 51 is fixed to pin 52 so that pin 52 rotates with the link. A pinion gear 57 is keyed to the pin 52 and engages a chain 58 that engages another pinion gear 59 which is keyed to a shaft 61 on the upper end of the section 27. The basket 38 could be fixed to rotate with shaft 61. Since shaft 61 rotates the same number of degrees with respect to the section 27 as lever 51, the platform 39 could be maintained horizontal.

As mentioned above, the basket 38 is generally made so that the workman is required to step down onto the working platform 39. Therefore, when the ladder is horizontal, as in the stowed position (FIG. 5), the basket 38 would then be in way of the driver's vision. Therefore, it should be rotated upward only when in its extreme retracted position. This feature is desirable since it locks the platform when the ladder is expanded, and the workman could not be dumped accidently as the ladder is rotated above and below the horizontal line.

When the ladder is horizontal, the distance between parallel links 28 and 47 (FIG. 6) is the greatest. The slide 53' or the roller 53 should be able to disengage the link 47 so that the parallelogram formed by links 51, 42, 34 and 38 could be closed or folded and the basket 38 could be rotated upward out of the truck driver's vision. Referring to FIG. 4, a typical means by which link 51 could disengage link 47 is shown. Herein link 47 has a C-cross section whereby roller 53 is "gripped" so that it moves only along the link 47. On link 47 as close to the pedestal 13 as practical, a portion of the lower flange is removed forming a cutout 62. Now, when the upper section is retracted, the roller 53 would be free to move downward through the cutout 62. To ensure "quick-like," rapid rotation for link 51, a leg 63 is placed thereon forming a bell-crank. As the upper section is retracted, the leg 63 would engage a crank 64 that is connected to stringer 28 and is free to rotate on a horizontal axis 65. As the ladder is further retracted, the link 51 would be forced downward by the action of the crank 64 (as shown by dash lines) to rotate the basket 38 upward placing the ladder in the stowed position as shown in FIG. 5.

When the ladder is to be used, the ladder would first be extended, and in so doing the leg 63 would engage a cam which in this embodiment would be a ladder rung 31' rotating link 51 upward to where roller 53 would pass through cutout 62 to engage link 47. The ladder is now ready for use.

Referring to FIG. 7, another embodiment by which link 51 could be made to "quickly" disengage link 47 is to provide leg 63 with a tapered edge 66. When the upper section is retracted, edge 66 engages a cam 67 on stringer 28 to force the leg 63 downward. Roller 53 again is forced out through cutout 62. When the upper section is again extended, ladder rung 31' again rotates link 51 upward to engage link 47.

Since the operation of folding the basket 38 upward should preferably be done with the ladder in the hori-

zontal position, safety switches (not shown) could be adapted to prevent rotation of the ladder upward until link **51** engages link **47**.

Referring again to FIG. 2, the novel mechanism is shown duplicated on both sides of the ladder on stringer **29** for greater rigidity and safety, but it could be only placed on one side of the ladder.

I have provided a ladder that is safer and has more mobility than ladders of the prior art. A workman standing in the basket is standing on a firm platform although the ladder could be extended or rotated upward. Another workman has access to the basket by simply climbing the ladder. The ladder could be extended over or lowered into a ravine, still providing a suitable safe working platform. The invention is not limited to the described structure as other structures could be used to perform the disclosed features.

I claim:

1. An expansible aerial ladder comprising a lower section, an upper section disposed to telescope into said lower section, a pedestal, said lower section mounted at one end on said pedestal to rotate about a first axis, a first link also mounted on said pedestal to rotate about a second axis, a second link pin-connected by one end to said first link to rotate about a third axis therewith and pin-connected by its other end to said lower section to rotate about a fourth axis therewith whereby said lower section, said pedestal, said first link and said second link form a parallelogram linkage; a lever pin-connected to said upper section and disposed to rotate therewith on a fifth axis; said first and fourth axes being substantially parallel, and said fifth axis being free to move in the plane formed by said first and fourth axes and substantially parallel thereto; and means for securing said lever to said first link at a fixed spaced distance from said fifth axis and in sliding relation to said first link whereby said lever remains substantially parallel to said second link when said ladder is expanded and rotated to higher elevations and to lower elevations.

2. The aerial ladder of claim 1 wherein means are provided on said upper section and connected to said lever to maintain a working platform on said ladder substantially horizontal.

3. The aerial ladder of claim 2 wherein said means includes a third link pin-connected to said upper section and spaced from said lever, a fourth link pin-connected to said lever and said third link forming another parallelogram linkage, and said platform is fixed to said third link.

4. The aerial ladder of claim 2 wherein said means includes a shaft mounted on said upper section spaced from said lever, and means coupled between said lever and said shaft for rotating said shaft with respect to upper section approximately the same number of degrees said lever rotates with said upper section.

5. The aerial ladder of claim 2 wherein a fifth link is pin-connected to said pedestal and disposed to rotate on a sixth axis located below said first axis, a sixth link is pin-connected to said lower section and pin-connected to said fifth link; said fifth link, said sixth link, said lower section, and said pedestal forming a quadrilateral linkage, and means connected to said quadrilateral linkage for changing the distance between the pin-connection of said fifth and sixth linkage and said first axis whereby said ladder rotates above and below a horizontal.

6. A mechanism comprising a first parallelogram linkage, and a second parallelogram linkage, one of said links of said first parallelogram linkage being fixed, one of said links on said second parallelogram linkage disposed to traverse lengthwise with another link on said first parallelogram linkage which said another link is adjacent said one fixed link, means for confining the motion between said one link of said second parallelogram and said another link of said first parallelogram to lengthwise motion, another link that is linked to said one link on said second parallelogram linkage slideably engaging a parallel link to said another link on said first parallelogram linkage, said another link on said second parallelogram linkage slideably engaging said parallel link at a fixed distance from said one link on said second parallelogram whereby said another link of said second parallelogram is parallel to said fixed link on said first parallelogram linkage as said second parallelogram linkage slides lengthwise with respect to said another link on said first parallelogram linkage and as said another link of said first parallelogram rotates with respect to said fixed link.

7. An expansible aerial ladder comprising a lower section, an upper section disposed to and telescope into said lower section, a pedestal, said lower section mounted at one end on said pedestal to rotate about a first axis, a first link also mounted on said pedestal to rotate about a second axis, a second link pin-connected by one end to said first link to rotate about a third axis therewith and pin-connected by its other end to said lower section to rotate about a fourth axis therewith whereby said lower section, said pedestal, said first link and said second link form a parallelogram linkage; a lever pin-connected to said upper section and disposed to rotate therewith on a fifth axis; said first and fourth axes being substantially parallel, and said fifth axis being free to move in the plane formed by said first and fourth axes and substantially parallel thereto; and means for securing said lever to said first link at a fixed spaced distance from said fifth axis and in sliding relation to said first link whereby said lever remains substantially parallel to said second link when said ladder is expanded and rotated to higher elevations; and means for disengaging said lever from said first link of said parallelogram linkage when said ladder is fully retracted whereby said lever is free to rotate without reference to said second link.

8. The aerial ladder of claim 7 wherein a fifth link is pin-connected to said pedestal and disposed to rotate on a sixth axis located below said first axis, a sixth link is pin-connected to said lower section and pin-connected to said fifth link; said fith link, said sixth link, said lower section, and said pedestal forming a quadrilateral linkage, and means connected to said quadrilateral linkage for changing the distance between the pin-connection of said fifth and sixth linkage and said first axis whereby said ladder rotates above and below a horizontal.

9. An expansible aerial ladder comprising a lower section, an upper section disposed to telescope into said lower section, a pedestal, said lower section mounted at one end on said pedestal to rotate about a first axis, a first link having a C-cross section pin-connected to said pedestal to rotate about a second axis, a second link pin-connected at one end to said lower section and disposed to rotate therewith on a fourth axis and pin-connected at the other end to said first link whereby said lower section, said pedestal, said first link, and said second link forming a parallelogram linkage; a lever pin-connected to said upper section and disposed to rotate therewith on a fifth axis; said first and fourth axes being substantially parallel and said fifth axis being free to move in the plane formed by said first and fourth axes and substantially parallel thereto; a roller and axle mounted to said lever and spaced from said fifth axis, said roller disposed in said first link to roll lengthwise therewith as said ladder is expanded and rotated to higher elevations and to lower elevations.

10. The aerial ladder of claim 9 wherein said first link has a cutout disposed substantially near said pedestal and facing substantially the same direction that said second link extends whereby said roller is freed as said ladder is retracted to free said lever to rotate.

11. The aerial ladder of claim 9 wherein said lever has a leg portion forming a bell-crank, means engaging said leg portion as said ladder is being retracted to quickly cause said lever to rotate and free said roller from said first link, and cam means for rotating said lever back to

where said roller engages said first link and said ladder is being expanded.

12. The aerial ladder of claim 9 wherein a fifth link is pin-connected to said pedestal and disposed to rotate on a sixth axis located below said first axis, a sixth link is pin-connected to said lower section and pin-connected to said fifth link; said fifth link, said sixth link, said lower section, and said pedestal forming a quadrilateral linkage, and means connected to said quadrilateral linkage for changing the distance between the pin-connection of said fifth and sixth linkage and said first axis whereby said ladder rotates above and below a horizontal.

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