May 28, 1968 E. V. GARNETT 3,385,398

EXTENSION LADDERS

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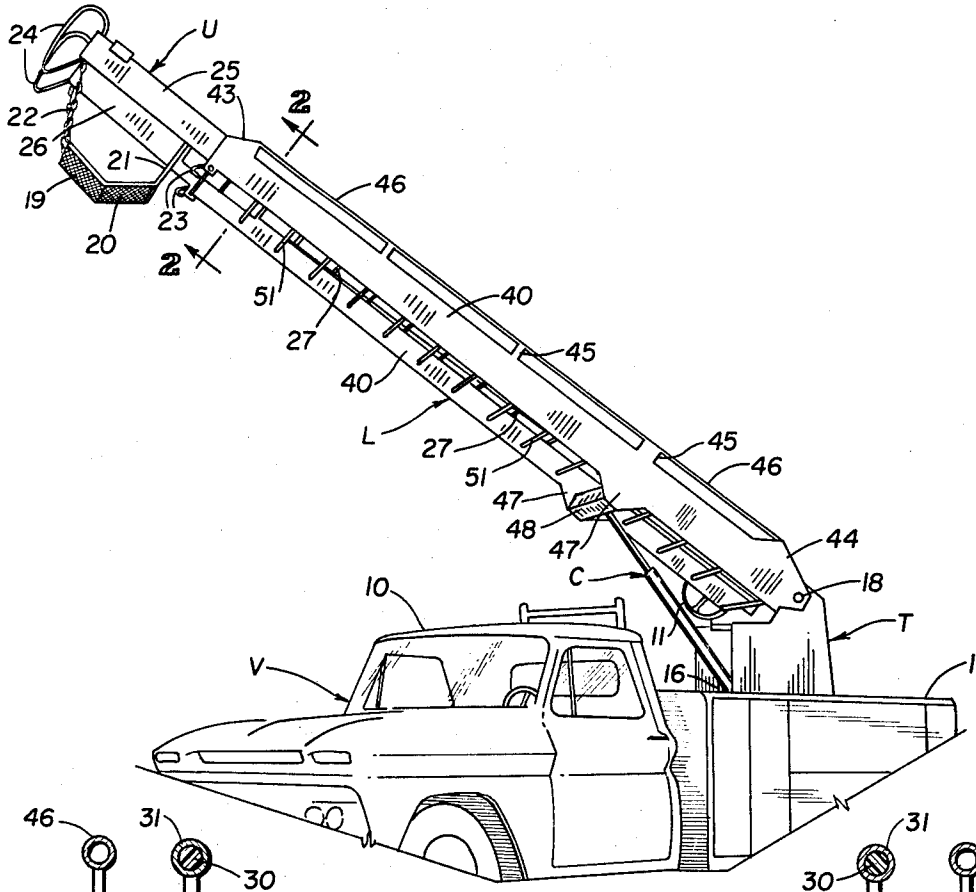


Fig. 1

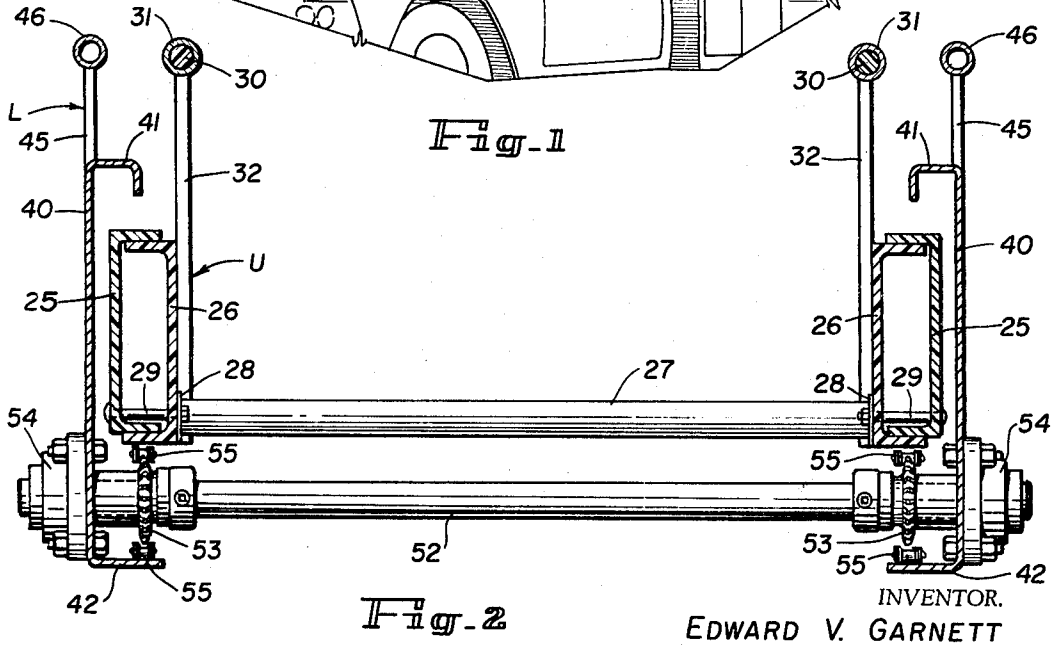


Fig. 2

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EXTENSION LADDERS

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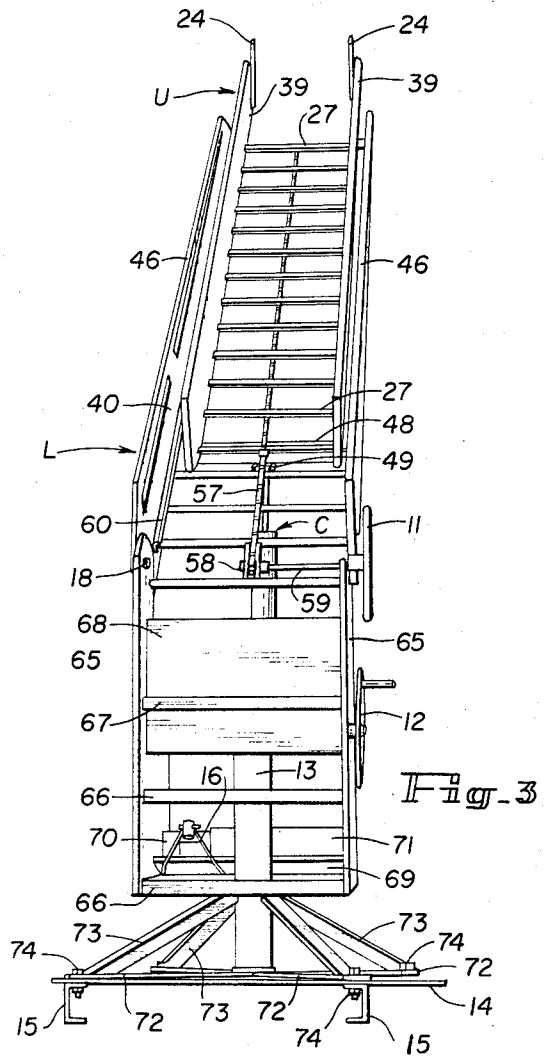


Fig_3

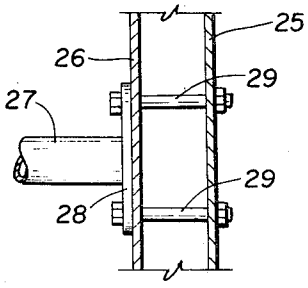


Fig_5

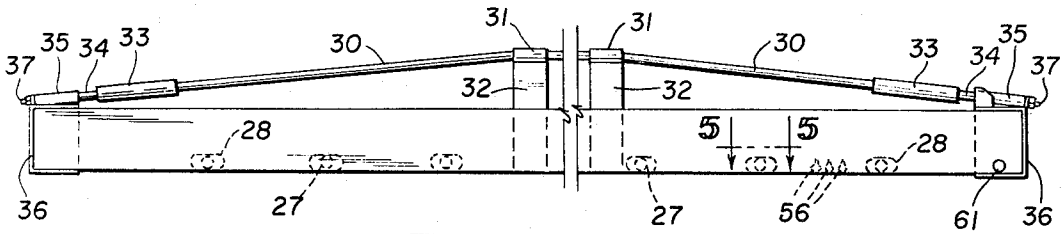


Fig_4

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EXTENSION LADDERS

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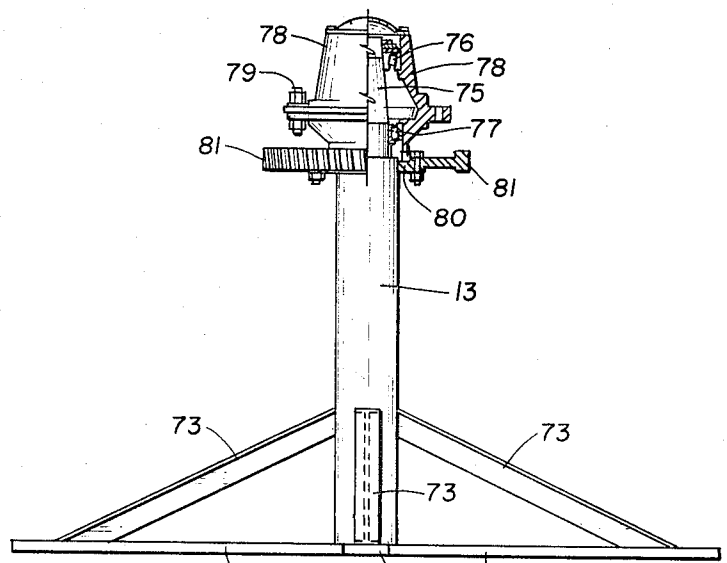


Fig. 6

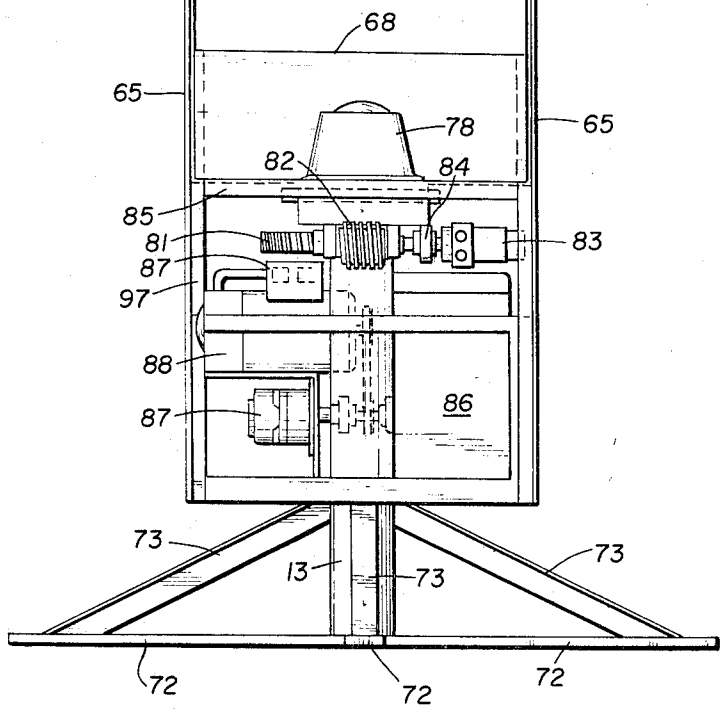


Fig. 7

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EXTENSION LADDERS

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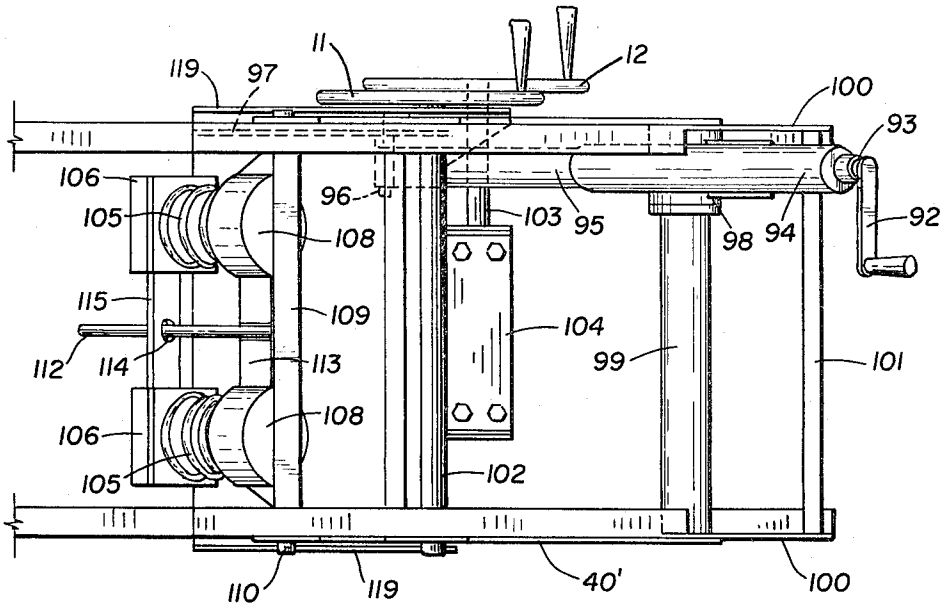


Fig. 8

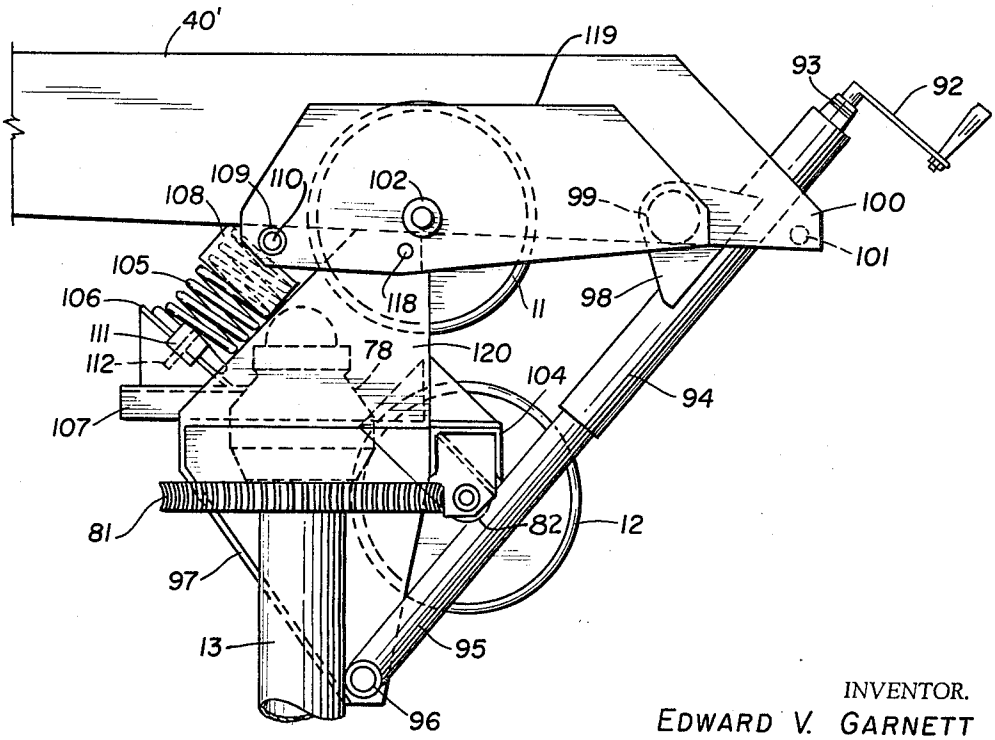


Fig. 9

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3,385,398

EXTENSION LADDERS

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7 Claims. (Cl. 182—46)

ABSTRACT OF THE DISCLOSURE

This disclosure relates to a ladder adapted to be mounted on a vehicle and including a turret supported on the vehicle for pivotal movement about a generally vertical axis, with a lower ladder section pivoted on the turret and an upper ladder section extendable and retractable along the lower section. One of the features is that the sides of one of the ladder sections is formed of electrically insulating material, the rungs are formed of non-insulating material and a series of upright members formed of non-insulating material are attached to the sides, while a rod of electrically insulating material extends along the upright members, to provide both a chord and an electrically insulated hand rail. Another feature is that a pair of coil springs mounted in spaced positions adjacent the upper end of the turret are loaded in compression to oppose the bending moment caused by the overhanging weight of the ladder, with an inclined pad for each coil spring mounted on the turret, a hollow cap attached to the lower section of the ladder and guides for the springs. An additional feature comprises a depending portion of each side of the lower ladder section, with a hollow, generally box-shaped section extending between the depending portions to resist torsional and twisting stresses on the section, so that a conventional hydraulic cylinder for moving the ladder sections up and down can be utilized, with the cylinder pivoted to the turret and the piston rod pivoted to the reinforcing section.

This invention relates to ladders, and more particularly to extensible ladders, such as those adapted to maintain a workman at any one of a large number of elevated positions.

Normally, such ladders are mounted on a vehicle, such as a truck, and are extensible and retractable, as well as movable angularly to different positions and turnable about an arc, preferably a full circle. Since such vehicle mounted ladders are often used by public utilities, the possibility of the workman or the basket or other part at which the workman is located, coming in contact with high tension wires, introduces the problem of providing adequate insulation. Since such ladders are often extended to a considerable distance, the problem of twisting due to torsional stress, thus interfering with the longitudinal movement of an upper section of the ladder relative to a lower section, is also present in each section. Since the upper section, when fully extended, is unsupported except for its connection to the upper end of the lower section, the resistance of the upper section to bending stresses should be sufficient, but the weight should be a minimum to reduce the force or effort necessary to shift the upper section and also to keep at a minimum the total weight to be carried about.

Among the objects of this invention are to provide an improved extensible and retractable ladder; to provide such a ladder in which the workman's position or support is protected against grounding; to provide such a ladder which adequately resists torsion or twisting, without adding undue weight; to provide such a ladder which is provided with a novel turntable or rotatable support; to provide such a ladder which is provided with an insulated extensible section; to provide such a ladder which is a multiple section ladder and in which each section is stabilized against torsion or twisting; to provide such a ladder which may be raised and lowered to different angular positions by an extensible and retractable hydraulic cylinder which is connected, to the lower section of the ladder, in a manner such that jumping or irregular motion in moving from one relatively high angle to another is avoided; to provide such a ladder which may exist in several different forms, including those in which one or more of the motions may be activated manually and those in which all of the motions may be power actuated; and to provide such a ladder which is reasonable in cost but is effective and reliable in use.

Additional objects and the novel features of this invention will become apparent from the description which follows, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a side perspective view of a ladder constructed in accordance with this invention, shown in an elevated and partially extended position and mounted on a vehicle shown fragmentarily;

FIG. 2 is a transverse section, on an enlarged scale, taken through the ladder along line 2—2 of FIG. 1;

FIG. 3 is a rear perspective view of a modification of the ladder of FIG. 1, showing in section a portion of the bed and frame of the vehicle on which the ladder is mounted;

FIG. 4 is a condensed side elevation of an enlarged scale, of the upper section of the ladder of FIG. 1;

FIG. 5 is a fragmentary section, on a further enlarged scale, taken along line 5—5 of FIG. 4;

FIG. 6 is a side elevation, partly in section and on an enlarged scale, of a mounting base of the ladders of FIGS. 1 and 3;

FIG. 7 is a rear elevation of a turret of rotatable support suitable for the ladder of FIG. 1, including the mounting base of FIG. 6 and cooperating parts of an hydraulic motor drive for rotating the ladder about a circle;

FIG. 8 is a top plan view of an alternative rotatable support or turret, in which the ladder is pivoted upwardly or downwardly by a jack screw; and

FIG. 9 is a fragmentary side elevation of the upper portion of the rotatable support of FIG. 8.

As illustrated in FIG. 1, a ladder having a lower section L and an upper section U may be mounted on a vehicle V, such as a truck, with the lower section L being pivotally mounted on a rotatable turret T and the upper section U being extensible and retractable, i.e., movable outwardly or inwardly on the lower section L. The lower section L is pivoted upwardly or downwardly by a hydraulic cylinder C and turret T is rotated, so that the ladder may be placed in a storage position over a cab 10 of the truck, with the upper section U fully retracted, or moved to any angular position around a full circle, with the ladder in either a horizontal or an elevated angular position, or any desired position between. Also, the upper section U may be extended or retracted, to reach positions at different elevations.

The ladder shown in FIG. 3 has a lower section L which is similar to the lower section of the ladder of FIG. 1, while the upper section U' of FIG. 3 differs from the upper section of FIG. 1. In each instance, the upper section of the ladder is extended and retracted by a hand wheel 11, but the turret T of the ladder of FIG. 3 is turned by a hand wheel 12, while the turret T of FIG. 1 is rotated by an electric motor, in a manner described below. In each form, the turret T is supported for rotation by a post 13 which is mounted on a bed 14 of the truck and attached through the bed to beams 15 of the truck chassis, in a manner also described below. Hydraulic fluid for cylinder C may be supplied through a hydraulic line 16, as in FIG. 1, while the truck may also be provided with storage panels 17 at opposite sides of the bed.

The lower section L of the ladder is pivotally mounted on the turret T by pivot pins **18**, while a support or platform for the operator may be attached to the upper end of the upper ladder section, as in the form of a conventional basket (not shown) or a so-called tri-level basket, which includes angularly disposed, mesh sections **19**, **20** and **21** of FIG. 1, with the section **19** being used when the ladder is in a more nearly horizontal position, the section **20** being used when the ladder is in an intermediate angular position, such as shown in FIG. 1, and section **21** being used when the ladder is in a more elevated angular position. The workman's basket is pivotally mounted at its inner end on the upper ladder section, so as to be supported by chains **22**, when the upper section is extended, as to the position of FIG. 1. The basket is also adapted to be moved automatically to a collapsed position within the upper section, when the upper section is fully retracted for storage purposes, through engagement with guides **23** mounted at the lower edge of the upper end of the lower ladder section and adapted to engage the workman's platform, to cause it to pivot within the upper section when the upper section is fully retracted within the lower section. A pair of guards **24** may be mounted at the upper end of the upper section, to act as resilient bumpers and prevent a pole, cross arm or the like from damaging the upper end of the ladder, either when the upper section is extended into the pole or cross arm, or when the ladder is rotated, with the upper section in an extended position.

In accordance with this invention, each side of the upper section is formed, as in FIG. 2, by a pair of interfitting channels **25** and **26**, formed of a fiberglass reinforced plastic, such as a polyester resin, to provide a hollow beam section, which not only provides insulation but also reduces weight and resists torsion or twisting. At each side, the channels **25** and **26** are interfitted with the flanges thereof overlapping each other, as shown, and attached together by a suitable adhesive, such as an epoxy resin. The hollow plastic cross section also increases the resistance to damage by weather, as through water, while the interior of the box section may be filled with a light, expanded polyurethane foam, to prevent water collecting inside the hollow beam section.

A series of rungs **27** extend between the two sides of the upper section of the ladder, being attached to the inner channels **26** by fittings **28** and bolts **29**, as in FIG. 5. Since the channels **25** and **26** are formed of insulating material, the rungs **27** may be formed of a lightweight metal, such as iluminum, while the bolts **29** preferably extend through both channels and thus not only attach the rungs to the sides of the ladder section, but also clamp the channels **25** and **26** together. In further accordance with this invention and as in FIG. 4, a rod **30**, formed of a suitable insulating material, such as fiberglass reinforced plastic, performs a dual purpose, serving both as a hand rail and also as a chord, to strengthen considerably the beam section of the channels **25** and **26** and resist bending moments on the upper section of the ladder. The rod **30** extends through a series of sleeves **31** attached to the upper ends of plates **32** disposed in a corresponding position and attached to the sides of the ladder, as by bolts similar to bolts **29**, at a plurality of intermediate positions. At each end, the rod **30** is attached to a hollow socket **33**, as by inserting therein and attached by a suitable adhesive, such as an epoxy resin, the opposite end of the socket being interiorly threaded to receive a stud **34**, which extends through a sleeve **35** attached to or formed integrally with a bracket **36** attached to the corresponding end of each side of the ladder section. A nut **37** engaging the outer end of each stud **34** is tightened to product a desired tension on rod **30**. The nuts **37** may be tightened until the rods **30** are merely taut, or the nuts may be tightened to produce a condition of autofrettage in the beam sections of the sides of the ladder, i.e., the nuts may be tightened until the upper flanges of the channels **25** and **26** are in compression and the lower flanges are in tension, so that, when a load producing a bending moment is placed on the outer end of the ladder section, the tension in the lower flanges must first be overcome and compression stresses produced, before the usual tension in the upper flanges and compression in the flanges are produced, due to the bending moment. Through the use of an electrically non-conductive hand rail as a tension rod, the cross sectional areas and consequent weight of the channels **25** and **26** may be reduced considerably, but sufficient width and depth of the box section of each side of the upper section of the ladder retained to provide resistance to twisting or torsion. Thus, not only is the weight decreased but also the performance characteristics are increased, as compared with a prior type of upper ladder section, such as the upper ladder section U' of FIG. 3, each side rail **39** of which is merely a plywood panel covered with plastic.

The lower ladder section L, as in FIG. 2, includes a plate **40** at each side having an inwardly extending, upper flange **41**, downturned along its inner edge, and an inwardly extending, lower flange **42**. Since the upper ladder section is normally extended, when the possibility of encountering a power line or wire is present, the side plates **40** of the lower ladder section L may be formed of metal, such as steel. Also, each side plate **40** may be formed to provide upwardly extending portions **43** at the top and **44** at the bottom, with a series of upwardly extending flanges **45** attached, as by welding, at several intermediate positions. A tubular hand rail **46** extends between the upper and lower portions **43** and **44** and is attached thereto, as by welding, as well as to the tops of the intermediate flanges **45**. If desired, the hand rail tube **46** at each side of the lower section L may be provided at each end with tightening means used for a similar purpose to nuts **37** of the upper section.

In further accordance with this invention, at the position of attachment of cylinder C to the lower ladder section L, each side plate **40** is provided with a depending portion **47**, either formed integrally with plate **40** or attached thereto, as by welding, and a closed box section **48** extending therebetween, which resists torsional or twisting stresses. The upper end of the piston rod of cylinder C is pivotally connected to the rear of box section **48**, as at a central pivot bracket **49** of FIG. 3. Due to the resistance of the box section to torsion or twisting, resisted in previous ladders by a heavy yoke connected to the upper end of the pivoting cylinder, the point of connection of cylinder C to the lower section L may be spaced sufficiently from the pivot pins **18** that, even at angles of, say, 75° or more, the rod of cylinder C moves an appreciable distance for each degree of increase or decrease in angularity, so that the tendency of ladders whose cylinders are connected close to the pivot points to jump or move irregularly at such angularities is avoided.

The lower section of the ladder is provided with rungs **51**, as of steel or other metal, extending between the side plates **40** and attached thereto in any suitable manner, as by welding. At the upper end of the lower ladder section, a shaft **52**, on which are mounted sprockets **53**, as in FIG. 2, extends between the side plates and is journaled in bearings **54** conveniently mounted on the outside of the side plates, to permit the sprockets to be positioned directly beneath the sides of the upper ladder section. The upper ladder section U of FIG. 1 is extended and retracted through a similar pair of sprockets mounted on a shaft similar to shaft **52**, but at the lower end of the lower ladder section and turned by hand wheel **11**. The sprockets engage a pair of chains **55** which extend around the sprockets at the upper and lower ends of the lower ladder section, but are each attached to the underside of the upper ladder section, as at the position of nuts **56** of FIG. 4, embedded in the plastic. Although the chains are continuous, in extending around both the upper sprockets and lower sprockets, the connection of the

chains adjacent the lower end of the upper ladder section moves the latter upwardly, as the chains are moved in one direction, to extend the upper ladder section and also moves it downwardly, as the chains are turned in the opposite direction, to retract the upper ladder section. The lower reach of each chain, as in FIG. 2, is prevented from dropping by the corresponding lower flange **42** of the side plate **40**, while the upper reach of each chain merely rides between the underside of the upper ladder section and the rungs **51**.

In the alternative construction of FIG. 3, a single chain **57**, which extends around a sprocket mounted on a bracket **58** adjacent the lower end of the lower ladder section, is connected to the lowermost rung of the upper ladder section, with the upper reach of this chain being disposed between the rungs of the ladder sections and extending around a corresponding sprocket at the upper end of the lower ladder section, and the lower reach of the chain merely extending along the underside of the rungs of the lower ladder section. The sprocket engaged by chain **57** is, of course, connected to a shaft **59**, which is turned by hand wheel **11**. Also a conventional dog stop arrangement (not shown) may be utilized in connection with the lower sprocket mounted in bracket **58**, to hold the upper section of the ladder in any desired extended position, without the possibility of slipping back. The lower ladder section is also provided with a longitudinal guide channel **60** at each side and just above the rungs, for reception of a pin, corresponding to pin **61** of FIG. 4, to maintain the lower end of the upper ladder section in the same plane relative to the lower ladder section during movement relative thereto and also prevent it from tipping when in an extended position. The upper end of guide channel **60** may be transversely closed, to act as a stop and, of course, is located below sprockets **53** of FIG. 4. The upper ladder section may be guided for movement and restrained against tipping in the lower ladder section in other ways, as by rollers or slide blocks mounted on the inside of the side plates of the lower section.

The turrets T of FIGS. 1 and 3 are similar, with the principal exception of the former being rotated by a hydraulic motor and the latter by hand wheel **12**, thus including side plates **65** between which a pair of lower step plates **66** and an upper step **67** are mounted with a back plate **68** for the upper step being disposed vertically between the side plates **65**. A column **13** extends upwardly, just behind the steps and the back plate **68**, while in FIG. 3 on the opposite side of the turret, a transverse mounting bracket **69** supports a combined motor and pump **70** and a hydraulic fluid reservoir **71**. Column **13** is tubular and is attached at the bottom, as in FIGS. 3 and 6, to a series of cross plates **72**, which are reinforced by angular braces **73** and the outer ends of which may be attached, as by bolts **74**, to the bed **14** of the vehicle. Bolts **74** preferably extend through bed **14** and also through the upper flanges of chassis beams **15**, so as to bolt column **13** and its supporting structure firmly and securely to the truck chassis. The cross plates **72** and braces **73** may, of course, be welded to each other and to column **13**.

In accordance with this invention, as in FIG. 6, column **13** is one half of the axle of a conventional axle and hub assembly for a transport trailer or the like, with the other half of the axle carrying the opposite hub assembly being used for another ladder. Column **13** is hollow but integral with a solid spindle **75** and the assembly has the capacity to withstand the thrust load imposed by the ladder, as through a pair of roller thrust bearings **76** and **77**, on which the two-piece hub **78** having bolts **79** and a cap or cover, as shown, is mounted for rotation. The turret T is attached to hub **78** by bolts **79**, while a stationary worm gear **81** is mounted on the conventional brake flange **80**, extending laterally from the upper end of axle column **13**, as by bolts, as shown. As will be evident, the hub **78** and turret may rotate about shaft **75** and also may be turned by a worm, such as worm **82** of FIG. 7, in engagement therewith. The worm **82** may be turned by hand wheel **12** of FIG. 3, or, in the embodiment of FIG. 1, by a hydraulic motor **83** of FIG. 7, connected to the worm through a coupling **84**. A flanged, transverse plate **85** is attached, as by welding, to side plates **65** and upper step back plate **68** and is provided with a hole and bolt holes around the same, for attachment to hub **78** by bolts **79** of FIG. 6. A gas engine **86**, supply independent power to the ladder, conveniently drives a hydraulic pump **87** directly and an electric generator **88** through a sheave and pulley arrangement, hidden by column **13** in FIG. 7. The current from electric generator **88** may be used to operate power tools, used by the workman, or for an electric motor to extend and retract the upper ladder section. The rotation of the turret and elevation of the ladder may be controlled by appropriate elements of a control box **89**. Each upper side of the turret may also be provided with a cable anchor **90**, for use when desired, while on the rear side, the turret may be reinforced by a framework **91** including upright angles or channels and transverse angles, channels or tubular members, as described.

As will be evident, the embodiment of FIG. 1, having a hydraulic cylinder C and a hydraulic motor for turning the turret, may be a longer ladder than the modification of FIG. 3, wherein the turret is turned by a hand wheel. However, by use of a conventional wheel hub and axle assembly normally produced in large quantities for use in trailers or trailer vans, not only is easy turning and adequate support of the turret assured, but a marked reduction in cost of the completed product can be obtained.

For a slightly shorter and thus lighter ladder, a rotatable support as shown in FIGS. 8 and 9, in which all adjustments are manual, may be utilized. Thus, in the modification of FIGS. 8 and 9, the lower section of the ladder may be raised or lowered to different angular positions by a jack screw operated by a hand crank **92**, which is attached to a center spindle **93**, adapted to turn a screw (not shown) which is enclosed within an upper sleeve **94** and engages screw threads provided on the inside of a lower sleeve **95**, the latter being pivotally connected to a pivot pin **96** mounted on a bracket **97** at one side of the turret. The upper screw sleeve **94** is pivotally connected, as by a bracket **98**, to a tubular strut **99** which extends between the opposite side plates **40'** of the lower ladder section, with a pair of side brackets **100** and a transverse rod **101** providing an additional rung for the operator to climb on the lower section of the ladder. Hand wheel **11** is mounted on a shaft **102**, for turning sprockets engaging the chain or chains which extend and retract the upper ladder section, or merely moving a wire rope wound around the shaft, while the hand wheel **12** is connected by a shaft **103** with worm **82**, which is mounted in and protected from damage, as by an accidental blow from above, by an open bottom housing **104**.

In further accordance with this invention, to counterbalance the weight of the ladder, particularly when the ladder is in a horizontal or low position, a pair of coil springs **105** are mounted on pads **106**, in turn mounted on a transverse bracket **107**. A hollow cap **108** around the top of each coil spring **105** is attached to a cross tube **109** which may pivot about a rod **110** extending therethrough. An inverted U-shaped clamp **111** extends across the lower coil of each corresponding spring, then downwardly on each side of the pad **106**, being attached to the pad by a central bolt, to hold the lower end of the coil spring securely in position. A guide pin **112** is attached, as by welding, to a cross plate **113** which is welded to cap **108** and tube **109**, to extend downwardly and loosely through a hole **114** in an inclined, transverse plate **115**, welded between pads **106**. As will be evident, the coil springs **105** will be compressed to the greatest extent, when the ladder is horizontal, or nearly so. However, under the greatest compression, the springs exert the greatest

resistance against the bending moment caused by the ladder. As will be evident, as the ladder is pivoted upwardly, the bending moment will decrease but the coil springs will be permitted to expand until the ladder reaches its greatest angularity, such as approximately 70° to the horizontal. The coil springs **105** are mounted opposite the pivot point of the ladder from the jack screw, such as a pin placed in each of opposed holes **118** in reinforcing plates **119** of the lower ladder section and corresponding holes in turret plates **120**. As the jack screw is extended, the coil springs will support more and more of the load of the ladder. As will be evident, the coil springs **105** do not reduce the load or stress on the column **13** or on the thrust bearings within the hub **78**, but do reduce the force necessary to be exerted through the jack screw, in order to pivot the ladder upwardly and thus permit the pivotal position of the ladder to be changed manually more quickly, as well as to permit a smaller jack screw to be used.

From the foregoing, it will be evident that the objects and novel features set forth hereinabove have been fulfilled to a marked degree. It will be understood that, although different embodiments and variations thereof have been illustrated and described, other embodiments and other variations may exist, all without departing from the spirit and scope of this invention.

What is claimed is:

1. In a ladder adapted to be mounted on a vehicle and including a turret supported on said vehicle for pivotal movement about a generally vertical axis, an elongated lower ladder section mounted on said turret for pivotal movement about a generally horizontal axis, an elongated upper ladder section extendable and retractable along said lower ladder section, and said ladder sections having spaced sides and rungs extending between said sides, the improvement wherein at least one of said ladder sections has:

sides formed of electrically insulating material;

rungs formed of non-insulating material;

a series of longitudinally spaced, upright members attached to said sides and formed of non-insulating material; and

a rod at each side and formed of electrically insulating material, each said rod extending between the opposite ends of said ladder section and along the upper ends of said upright members to provide a chord and an electrically insulated hand rail concurrently.

2. In a ladder as defined in claim **1**, including:

means for tensioning the opposite ends of each rod.

3. In a ladder as defined in claim **1**, wherein:

each said upright member is provided at its upper end with a hollow sleeve through which said rod passes.

4. In a ladder adapted to be mounted on a vehicle and including a turret supported on said vehicle for pivotal movement about a generally vertical axis, an elongated lower ladder section mounted on said turret for pivotal movement about a generally horizontal axis, an elongated upper ladder section extendable and retractable along said lower ladder section, and resilient means mounted between said turret and said lower ladder section and constructed and arranged to oppose the bending moment caused by the overhanging weight of said ladder, wherein:

said resilient means includes a pair of coil springs mounted in laterally spaced positions adjacent the upper end of said turret and constructed and arranged to be loaded in compression.

5. In a ladder as defined in claim **4**, including:

a pad for each coil spring mounted on said turret and inclined upwardly from the pivotal axis of said turret;

a hollow cap engaging the upper end of each coil spring and attached to a transverse pivotal member mounted on said lower section of said ladder; and

guide means for said springs disposed between said springs.

6. In a ladder adapted to be mounted on a vehicle and including a turret supported on said vehicle for pivotal movement about a generally vertical axis, an elongated lower ladder section mounted on said turret for pivotal movement about a generally horizontal axis, an elongated upper ladder section extendable and retractable along said lower ladder section, and said lower section of said ladder has upright sides, the improvement wherein:

each side of said lower ladder section has a depending portion correspondingly spaced from the pivot axis of said lower section;

reinforcing means extends between said depending portions of said sides and is constructed and arranged to resist torsional and twisting stresses on said section; and

hydraulic cylinder means for tipping said lower section about its pivotal axis, said cylinder means including a cylinder pivotally connected at its lower end to said turret and a piston rod pivotally connected at its upper end to said reinforcing means.

7. In a ladder as defined in claim **6**, wherein:

said reinforcing means comprises a hollow, generally box-shaped section.

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