United States Patent

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[54] **MOBILE SWIVEL LADDER**
19 Claims, 5 Drawing Figs.

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[51] **Int. Cl.** **E06c 5/04,** B66f 11/04
[50] **Field of Search** 182/2, 65

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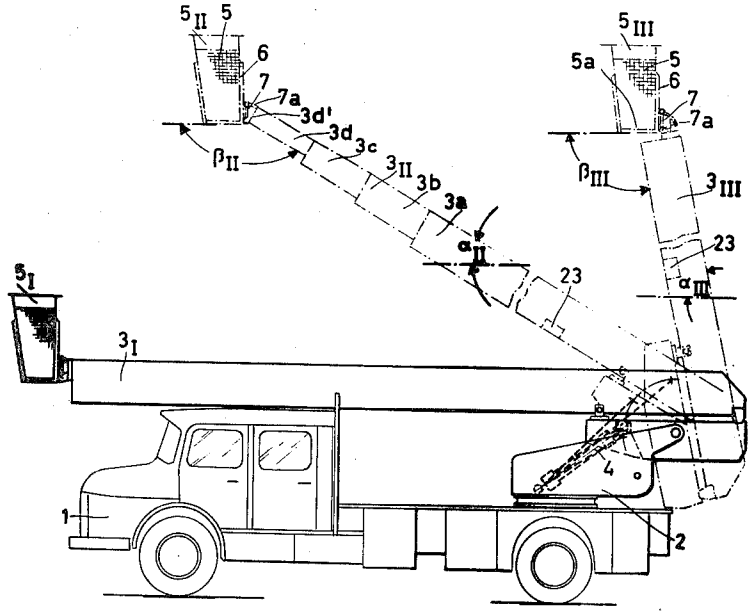
ABSTRACT: A rescue mobile ladder comprising a ladder pivotally connected at one end to a vehicle and a cage pivotally suspended on the second end of said ladder so that under the action of gravity, said cage adapts itself automatically to any change in the incline of the ladder relative to the horizontal position.



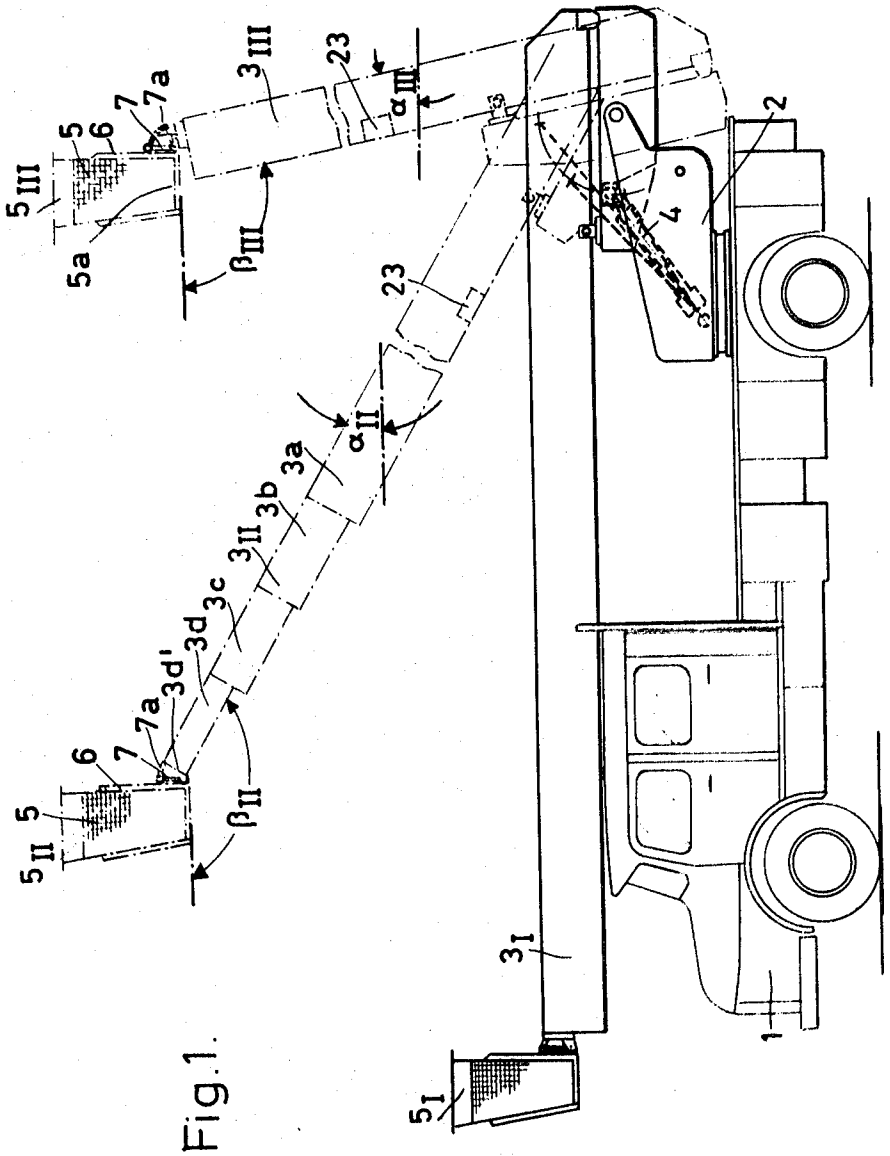

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Fig. 1.

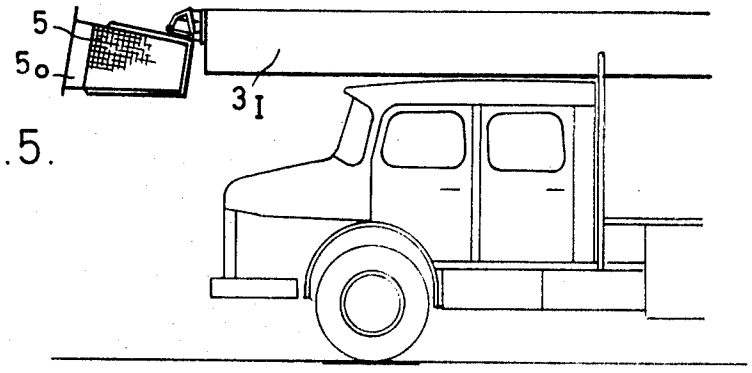

Fig.5.

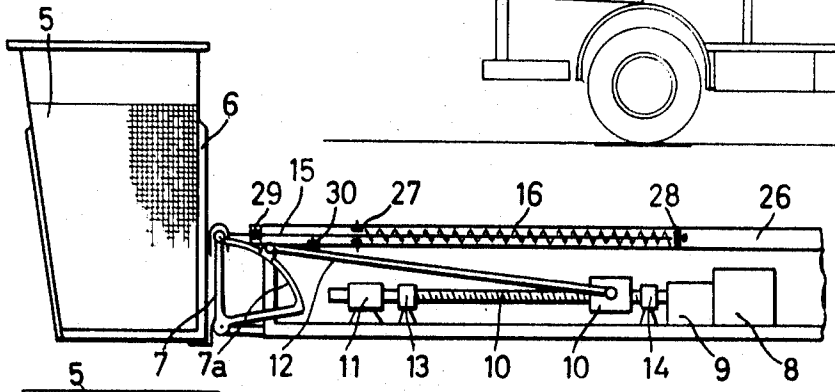

Fig.2.

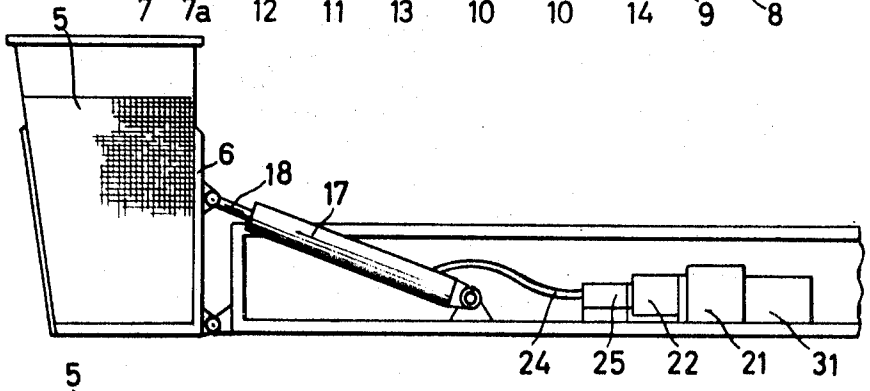

Fig.3.

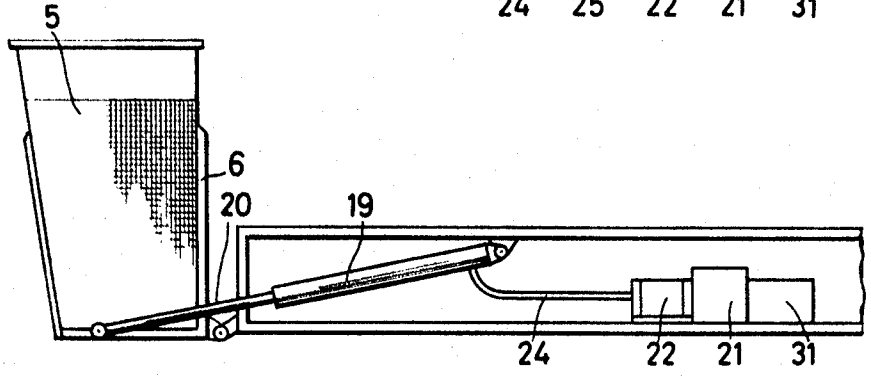

Fig.4.

MOBILE SWIVEL LADDER

The invention concerns a mobile swivel ladder comprising a mounting cage arranged at the top of the ladder for receiving people, more particularly concerns such ladders which are self-propelling and/or motor driven.

As is well known, swivel ladders serve as fire escapes for saving people in a disaster. It is already known to provide the top of the ladder with a mounting cage which is pivotally connected by way of a holding device to the free end of the top section of a set of telescopic ladder sections, hereafter called a ladder assembly, so that it disposes itself horizontally due to its own weight, according to the angle of the ladder relative to the horizontal, i.e., so that its base or platform is horizontal. Owing to the prevailing regulations for the prevention of accidents, the cages are to be entered only when the ladder is erected, extended and the motor switched off, mainly on account of the swinging movement of these cages. Accordingly, in conventional swivel ladder constructions, after the ladder has been extended, it has to be climbed to the top, then the cages must be locked in position and can only be entered after this. From experience this has, resulted in the loss of valuable time, particularly when the swivel ladder of conventional construction is used for saving lives in a disaster as, e.g., when multistorey buildings are on fire, in bringing the ladder into a position such that the cage can be entered from the dangerous building. There is also a loss of time before rescuers can enter the cage to carry old and infirm or injured persons into the cage.

The same regulations concerning the prevention of accidents make it impossible in conventional swivel ladder constructions for people to be in the cage during the movement of the ladder. Once again the reason for this is its swinging movement during, and as a result of, the motion of the ladder. This gives rise to another serious disadvantage; when it is a matter of bringing handicapped or injured persons, who have entered the cage from the place of danger, down via the ladder, it is necessary for rescuers, while the ladder is held immobile, to carry these persons down the ladder or to hand them on from man to man by means of a chain of rescuers. Once again, valuable time is thereby lost in the saving of lives which, as has been proved, may frequently be decisive in regard to the number of lives rescued. On the other hand, a considerable number of rescuers are required in order to convey a maximum number of rescued people to the ground via the ladder, in these know constructions. There is also the fact that, with a chain of helpers, the ladder is heavily laden, which means that, according to the position of the ladder, special supports must be provided, and this again requires a certain amount of time to bring them into use.

In order to shorten the necessary time of erection of conventional constructions by at least a short period of time, the cage has already been fitted with a brake clutch or a hydraulically operating brake cylinder for braking the swinging motion which is due to the fact that the cage starts swinging automatically when the ladder is being erected. These means acting as mechanical or hydraulic brakes can, however, only shorten the time which without these means was previously waiting time, until the pendulum motion of the cage, which was the more violent the faster and steeper the ladder assembly was extended or erected, had stopped sufficiently for the cage to be locked in its appropriate final operation position for the circumstances prevailing.

The entering of the cage during the extension of the ladder assembly is however still not made permissible, according to the regulations governing the prevention of accidents. The greater part of the erecting time required for extending and swinging the ladder is thus still lost. Again, the other disadvantage that, before the ladder is retracted and before it is pivoted, it must be cleared of people is still present. Thus, such a conventional construction cannot be used for cases where injured persons or those who are no longer capable of walking or climbing have to be rescued from a great height or over a long length of ladder bridges.

For cases of individual rescue, mobile-collapsing mast platforms are already known which are also termed boists or snorkels. With these appliances the platform is brought into the horizontal and held there by means of a telescopic shafts and angle drives during the various inclines of the jib. Other constructions of collapsing mast stages have platforms positively controlled by means of rods or parallel guides mounted on the lever arms. These mobile-collapsing masts stages have the further serious disadvantage that they are not suitable as an emergency escape for the fire service, in addition to the fact that they have, in respect of a number of people to be conveyed only the function of a ferry and not, as in swivel ladders, the function of a bridge with a continuous flow of people. Again, such an escape is very heavy and is therefore not capable of being brought to the place of use very rapidly, and the time occupied in effecting movements must be relatively long on account of the high-centrifugal force. In addition to this, on account of the multiplicity and size of the individual parts to be mounted and accurately manufactured, the cost is much higher than that of corresponding swivel ladders comprising a rescue cage.

The present invention provides a fire escape which is for both types of use, i.e., for individual rescue by receiving one or more persons in the cage and bringing the cage into use as a ferry, and also for rescuing a number of people continuously climbing down the ladder when operating as a bridge. It may be brought rapidly to the place of use as an emergency fire escape and applied thereto in its operating position. A fire escape according to the present invention is intended to avoid the disadvantages of conventional swiveling ladder constructions having swinging and engageable receiving cages, and the disadvantages of conventional collapsing mast platforms, and provides simply and economically a construction complying with existing regulations for the prevention of accidents to save persons in immediate danger, in the majority of which cases speed is decisive for the success of a rescue.

The invention is characterized by the feature that in a mobil, more particularly a self-propelling and/or motor driven resolving ladder, having a cage arranged at the top of the ladder for receiving persons, the cage at the top of the ladder is secured by means of a supporting device in such manner that, depending on the angle of the ladder relatively to the horizontal, it may be swiveled without swinging by the application of a positive force so that its base or mounting platform always assumes a horizontal position.

The present invention has a number of advantages. By use of a revolving ladder having a receiving cage, a short erection time is obtained due to the small centrifugal mass and the low weight of this escape, it can be easily and rapidly transported to the place of use and it has equally easy, simply and very rapid maneuverability at the place of use, together with the possibility of being able to bridge great heights or distances. At the same time the limitations due to the existing regulations for the prevention of accidents are compiled with or become unnecessary. In addition, the person in the cage does not need to use any hydraulic or mechanical brake for stopping the cage, since it is guided and supported by an additional positive force without swinging, in dependence on the angle of the ladder relative to the horizontal. Both types of operation, that is to say as a ferry or as a bridge are equally possible, and persons may in the cage both when the ladder is extended and swung out.

In order to achieve these advantages, the present invention provides a method of differing both from conventional revolving ladders having a swinging receiving cage and also from conventional collapsing mast stages without using the feature of these known constructions. The transmission means for keeping the platform straight, well known on broken mast platforms, by means of telescopic shafts and angles drives on revolving ladders provided with a receiving cage, would, in the case of revolving ladders having an extended height of 30 meters, requires telescopic shafts with extensions lengths of more than 20 meters which would be difficult to build with the as-

sociated angle drives (bevel and worm drives), apart from the price and apart from the fact that the advantage of low weight and low-centrifugal mass would be lost thereby. Again, the problem of keeping the base level by means of rods and parallel guides cannot be used on swivel ladders since they have to be extended telescopically and would be in the way of the rod and parallel guide members. Furthermore, a telescopic shaft of such dimensions would necessitate reinforcement of the set of ladders and, consequently, reinforcement of the revolving turret supporting the ladder, whereby once again a heavier vehicle with all its disadvantages would be necessary.

In a further development if the invention a swivel device in operative engagement with the supporting device may be provided, the actuation of which depends on the swivel motion of the ladder in a vertical direction. In a further form of the invention the swivel device has an independent drive which may be operated in two directions through a control mechanism by means of pulses derived from the change in the angle of the ladder relative to the horizontal, so that it drives the receiving cage to maintain its horizontal position by way of a transmission mechanism.

The drive of the swiveling device is formed so that it may be locked by the operating personnel after reaching the desired position of the ladder and an appropriate positively controlled horizontal position of the base of the cage, so that the cage can be loaded with a considerable weight without swiveling relative to the axis of the ladder, while, in another embodiment the drive of the swivel device may be designed so that it secures itself in a position corresponding to the horizontal position of the base platform of the cage in such manner that, without regard to the load on the platform, the platform always maintains a horizontal position corresponding to the existing position or angle of the ladder, and is held there even when the incline of the set of ladders changes as a consequence of its vertical displacement.

The drive of the swivel device preferably includes a motor acting by way of a mechanical power transmission mechanism on the receiving cage. The mechanical power transmission mechanisms may be a screw spindle in operative engagement with the motor on which spindle a spindle nut pivotably connected by means of at least one push rod to a receiving device for the cage, is displaceably guided. For exceptionally long and heavy revolving ladder constructions, such as are used for example on fire boats, the motor may be an internal-combustion engine. A very suitable drive means in an electric motor capable of operating forward or reverse depending on the change of the incline of the ladder. The electric power may be obtained from the battery of the vessel. The weights at the top of the ladder for the auxiliary drive acting as a servo drive, keeping the cage in a state of unstable equilibrium by an external servo force are the weights of the motor and the transmission system.

If this auxiliary drive is formed as an electric drive there is only a very lightweight at the top of the ladder. In the case of a normal set of ladders mounted on a vehicle chassis by means of a revolving turret and mounting an installed electric output of approximately 200 watts has proved to be sufficient and this gives the advantage of comparatively lightweight for the servo drive (auxiliary drive). This weight may again be considerably reduced if the field winding of the electric motor is replaced by permanent magnets.

The drive of the swivel device may be a motor operating in one direction of rotation and coupled with the screw spindle by a drive operated in dependence on the angle of incline of the ladder.

In all these embodiments of the invention which have been described using a mechanical power transmission only one comparatively short and therefore light and rapidly driven screw spindle (conveyor screw) and a short light rod system comprising at least one push rod are required, independently of the type of construction of the motor.

In another preferred embodiment of the invention the drive of the swivel device is a motor acting on the receiving cage by way of a hydraulic power transmission. At the same time a hydraulic pump may be provided, the directly coupled motor of which is operable in one of two directions dependent on a change in the incline of the ladder. The hydraulic power transmission may, have a multiway slide valve, preferably a magnetically actuated control slide valve, which is actuated in dependence on the change of incline of the ladder. Finally, the servo force applied to the receiving cage may be obtained by establishing, via the ladder, a hydraulic connection to the hydraulic system of this revolving ladder. Whether a mechanical or hydraulic power transmission system is used, depends on the requirements of the individual case. In the majority of cases the drive with the hydraulic power transmission system is lighter, but more expensive, and the drive with a mechanical power transmission system is somewhat heavier, but, on the other hand, is cheaper.

The control device may be provided with a measurement value indicator responding to the change of angle of the ladder and a pulse generator converting the measurement value into pulses which are conveyed to the drive of the swivel device as control pulses. A pendulum switch, gyro switch or a liquid balance may be provided to act as a vertical switch, for a measurement value and impulse generator.

A device which is not dependent for its operation on the angle of the ladder relatively to the horizontal may be provided as a safety device in the event of complete or partial breakdown of the swivel device, by which, in the event of such a breakdown of the swivel device, pivoting of the receiving cage relative to the ladder is prevented. The safety device is intended to prevent pivoting of the cage from the effect of the load contained therein, e.g., of the persons in said cage, relative to the ladder if, due to any damage of the swiveling device, such as breakage of the screw spindle and/or of the push rod and/or of any defect of the motor or gearing, or of a breakdown of the hydraulic mechanism, the servo force locking the cage should fail. This ensures that even when a defect or blockage of the swiveling device occurs for any reason, the swivel ladder operating as a bridge continues to be serviceable, and a swivel ladder operating as a ferry can be used or lowered without danger to any persons in the cage.

The safety device may be constructed as an auxiliary drive assisting the drive of the swivel device tending to move it in the direction of a pivoting movement of the platform of the cage corresponding to a reduction of the incline of the ladder. The result of this is that, due to the safety device, the drive of the swivel device is assisted and at least partially released precisely when, if the swivel ladder according to the present invention is being used, it has to apply its greatest torque or its traction to the holding device of the cage, i.e., when the set of ladders is being lowered under load when operating as a ferry. The safety device may be formed as a push or draw member loaded by way of a power stores and pivotably connected to the cage. The safety device may, as a traction member, have a cable subjected to tension by way of a power storer, preferably a spring storer, which is guided over a circular path of a swinging segment of the holding device for keeping the power acting on the cable constant.

An effect both on the swivel device and on the safety device may be applied individually or jointly if and when the swivel device breaks down. However, in many cases it may be advisable to impart to the cage a swivel movement within certain limits relative to the inclined axis of the ladder, only when said axis results in the blocking of the swivel device and/or safety device. Consequently in another embodiment of the invention an additional device is provided which locks the swivel device and/or the safety device when a predetermined, preferably adjustable, change in the angle between the base platform of the cage and the axis of the ladder not occurring in dependence on a change in the incline of the ladder is reached. Preferably, actuation of the drive of the swivel device and/or actuation of the safety device dependent on clamping members or switches may be provided, blocking pulses, being generated by means of limit switches. In the case of such switches, a certain range

of angle for pivoting the cage, resulting from a breakdown of the swivel device, relatively to the axis of the ladder, may be considered as admissible by adjusting said limit switches whereby, when these limits of the prescribed range of swing of the cage is reached relative to the axis of the ladder, the safety device is locked by way of clamping members which prevent the cage swinging any further and fix it in its final position. The action may, however, also be applied to the swivel device by means of clamping members or other locking elements which act on push rods, screw spindles, spindle nuts or, in the case of a hydraulic piston, act on its piston rod or alternatively, act on the motor, or on hydraulic stop cocks on the hydraulic cylinder, hydraulic pump or multiway slide valve, by means of switches.

The receiving cage is mainly used to rescue infirm or injured persons or children. In the case of already known swivel ladder constructions having a suspended receiving cage, persons who are capable of walking have to climb into the cage first, climb a small ladder in the cage and turn themselves round through 180° at the top of the small ladder in order to reach the main ladder. When injured persons have to be saved via the ladder when it is serving as a bridge, difficulties are further increased, due to the fact that the rescuer carrying the injured person out of the cage by way of its small ladder must turn himself round with his load through 180° at the top of the ladder. In the case of conventional constructions provided with a suspended receiving cage swinging about a center of rotation higher than the base platform, with each incline of the ladder, the space between the platform and the top rung of the ladder changes as a result of the pendulum movement, and crossing from the ladder to the platform is made partly impossible, in any case such crossing always involves danger and the positive control of the cage provided by the present invention is a substantial improvement. It is still not possible for another disadvantage to be fully eliminated. Although, due to the present invention, the swinging and the change in the distance involved therein between the top rung of the set of ladders and the top rung of the small mounting ladder in the cage is eliminated by providing a predetermined operating position of the set of ladders, with a suspended cage, the aforesaid distance changes all the time with the change in the incline of the ladder. This proves to be very unfavorable and dangerous particularly if the persons in the cage wish to or have to climb down during the retraction of the ladder, i.e., with a changing incline of the ladder, because the space between the top rung of the set of ladders and the small mounting ladder in the cage necessarily changes. Changes in the approach height or distance, however, increase the probability of accidents, as also the fact that the person has to turn through 180° while standing only on a narrow rung of the ladder in order to reach the top section of the set of ladders as safely as possible.

The other problem which has been recognized for the first time and can only be solved in conjunction with the present invention is that the swivel ladder of the invention is constructed so that the way across the set of ladders into the climbing cage and back is made possible without a change of pace.

This additional problem is solved in that the cage is linked to the top of the ladder so that the base platform of the cage occupies a position approximately at the top of the last rung. In such a cage which may also be turned "standing," the person climbing into the cage or leaving it can move without danger from the ladder to the cage or conversely without the swinging of said cage and independently of the existing angle of the ladder, without it being necessary to climb up into the cage. By this means an unimpeded and continuous flow of people is ensured if the swivel ladder is used as a bridge.

The cage is associated with the holding device in such manner that it can be suspended from the top of the ladder before the ladder assembly is extended and, after its work is completed, can be removed from the tip of the ladder and hung for transport at a suitable point of the vehicle—usually below the folded ladder assembly behind the cab of the vehicle. The cage must therefore be removed from the tip of the ladder when its use is over since, if it is formed as a suspended construction, it would impede the field of vision of the driver and hinder him as well as failing to meet the requirements of road safety; on the other hand, if it is formed as a so-called standing construction, it would increase the height of the vehicle with the result that its freedom of movement would be restricted because it would not be able to pass under bridges having a low overhead clearance or under overhead electric conductors of trams or the like. On the other hand, however, a construction provided with a cage which is driven separately from the ladder to the place of use, and upon the conclusion of operation, has to be removed, whether this cage is arranged to be suspended or standing, has serious disadvantages, especially if speed is decisive for the success of the rescue of people from acute danger. A valuable part of the erecting time may be lost in time taken to suspend the cage.

A further development of the invention makes it possible to solve the problem which is posed by the requirements which have been described. According to a further aspect of the invention, the cage is immediately available without assembly time for suspending it, and may be easily removable in order to enable the swivel ladder to be used when travelling overland or as a water tower and, finally, in a disaster, the ladder with its attached cage and direct possibility of climbing therein from the ladder without danger would be available and a possibility of safe crossing from the building to the cage ensured.

To this end the holding device is constructed so that by means of said holding device and with the ladder horizontal, the cage may be kept in a position not corresponding to this position of the ladder, preferably in a position turned through 90° approximately towards a position corresponding to the position of the ladder provided for maximum incline relative to the horizontal. This development of the invention is suitable for use both on conventional swivel ladder constructions with a suspended swinging cage and on swivel ladders of the invention with a suspended or standing positively controlled cage. Preferably the swivel device is designed so that, after the position of the cage corresponding to the horizontal position of the ladder, the swivel device may be reversed and actuated so that it brings the holding device into a position in which the cage assumes a position which does not correspond to this position of the ladder, but preferably a position turned through 90° relative to its position corresponding to this position of the ladder in the direction of its position corresponding to the position of the ladder provided for the maximum incline of the ladder relatively to the horizontal.

In the horizontal position of the ladder the cage may remain at the tip of the ladder in a position which is pivoted relative to the axis of the ladder. The field of vision of the driver is not impeded by the cage, and although the turning circle of the vehicle with the cage remaining at the tip of the ladder is somewhat enlarged it has proved by experience to be preferable to many swivel ladders still in use today without a suspended cage. The setting up of such a swivel ladder constructed according to the present invention, at the place of use in a time saving manner is as follows: According to the construction, the cage is located in its flat-folded position at the tip of the ladder during the journey to the place of use, and can be raised immediately either by a single hand lever or by the actuation of a push button or any other suitable switch member, the swiveling device being reversed so that the cage assumes a position corresponding to the actual incline of the ladder. When the set of ladders is extended, the cage is motor driven and sets itself automatically vertically. As it is no longer necessary first to secure the cage to the top of the ladder at the place of use, valuable seconds are saved which are available for saving persons rapidly from danger.

The present invention will be described in greater detail hereinafter with reference to several embodiments illustrated in the drawings in which:

FIG. 1 is a side view of an embodiment of the invention constructed as a self-propelled and motor-driven swivel ladder

comprising a cage arranged at the top of the ladder for receiving persons, three positions of the ladder being shown schematically, mainly the folded down or horizontal position, an intermediate position with an incline of approximately 30° relatively to the horizontal, and a position corresponding approximately to the end position with maximum incline, the cage standing vertically irrespective of the incline of the ladder;

FIG. 2 is a schematic side view of the end region of the section of the ladder assembly forming the top of the ladder, with a cage arranged thereon and a holding device for said gage, the swivel device acting on the holding device being constructed to operate mechanically; there is also a safety device;

FIG. 3 shows schematically another embodiment of the invention corresponding to FIG. 2, in which the swivel device for the cage is operated hydraulically;

FIG. 4 is a view of another hydraulic swivel device corresponding to FIG. 3, for the cage; and

FIG. 5 is a view of the driver's cab part of the self-propelled and motor driven swivel ladder according to FIG. 1, in the position for travel, with the cage swung through approximately 90°.

In the case of the swivel ladder shown in FIG. 1 and 5 the chassis of the swivel ladder is indicated by 1, the revolving turret by 2, the ladder assembly by 3, comprising the sections 3*a*, 3*b*, 3*c*, 3*d*, and the drive is a hydraulic cylinder 4, for swiveling the ladder assembly in a vertical direction. The horizontal folded positions 3_I of the ladder assembly is shown in full lines, and in chain dotted lines an intermediate position of the ladder assembly of approximately 30° relatively to the horizontal with an angle of incline αII, the individual ladder sections 3*a*, 3*b*, 3*c* and 3*d* being shown. The position of maximum incline of the ladder or approximately 80° (angle α_{III}), relative to the horizontal—is also illustrated, with the ladder in its retracted position. These positions of the ladder are indicated by 3_1, 3_2 and 3_3 respectively, these indications corresponding to the respective incline of the ladder relatively to the horizontal α_I, α_{II}, α_{III}.

As may be seen, the cage is shown in each position of the ladder 3_I, 3_{II}, 3_{III}, held at the top 3d' of the ladder by means of a holding device 6, 7 pivotably connected thereto, in such a position that its base or platform 5*a* always assumes a horizontal position. The position of the base platform 5*a* relative to the axis of the ladder changes for each position of said ladder 3_I, 3_{II} and 3_{III}. The positions of the cage 5 associated with the appropriate position of the ladder 3_I, 3_{II} or 3_{III} are indicated by 5_I, 5_{II} and 5_{III} respectively, and, the angle of incline between base platform 5*a* and ladder axis 3 by β_I, β_{II} and β_{III}. It must be remembered that, since the folded-down position is the horizontal position, $\alpha_1=0°$ and $\beta_1=180°$.

A mechanical holding and swiveling device 6, 7 only indicated in FIG. 1, is shown on a magnified scale relative to the ladder 3 in FIG. 2. The cage 5 consists of a supporting frame of welded section rod material forms, combined with a base platform 5*a* and suitable wire netting or sieve material parts. This cage is suspended from a pair of swivel segments in any suitable manner. Each swivel segment is made from welded section bar material, and an angle of approximately 90° is formed between the two outer rod members of each swivel segment 7, the outer ends of these rod members being connected together by an arcuate connecting member 7*a*. The swivel segments 7 are in operative engagement at one of their ends with a receiver 6 for the cage 5, and the swivel segments 7 are pivoted to the upper end 3d' of the ladder section 3*d* (FIG. 1). This produces a pivotable connection between the cage 5 and the ladder 3.

The section 3*d* of the ladder is shown schematically in FIG. 2 by its main beams. A screw spindle 10 is rotatably mounted by means of a bearing 11 and a turning gear 9 is also provided on the section 3*d* driven by an electric motor 8. A spindle nut 10*a* is axially displaceable on the screw spindle 10 and is in operative engagement with the swivel segments 7 by way of a push rod pivotably connected to the screw spindle 10 and the arcuate portion 7*a* of one swivel segment 7. Two push rods 12 one on each side may be provided, pivotably connected at one end to the spindle nut 10*a* and at the other end to one of the two swivel segments 7.

The electric motor 8 is nonreversible and coupled in a suitable manner (not described) to the reversing gear 9. Instead of the electric motor 8 an internal-combustion engine may be used. The swivel movement of the cage 5, during a change in the incline α_I, α_{II}, or α_{III} of the ladder, proceeds as follows: at a suitable place in the ladder assembly a pendulum switch, gyro switch or a liquid balance 23 is arranged serving as a measurement means and pulse generator. It acts as a "vertical" deflecting switch and is connected to the motor 8. This measurement value indicator responds to changes in the ladder incline α relatively to the horizontal and converts the appropriate measurement value simultaneously into a pulse which is fed to the reversing gear 9 as a starting pulse for the motor 8, and as a switching pulse. According to the change of direction in the incline α of the ladder the reversing gear 9 is moved to one direction or the other, and at the same time the motor 8 is started. By this means the screw spindle 10 is set rotating in one direction or the other and the spindle nut 10*a* is axially displaced thereon in one direction or the other. This displacement is transmitted by way of the push rod 12 to the swivel segment 7 and swivels the cage 5 by way of the receiver 6 so that is baseplate 5*a* always assumes a horizontal position. For defining the end of the movement of the spindle nut 10*a* limit switches 13, 14 are provided and upon contact of the nut 10*a* therewith render any further drive in the same direction impossible.

Approximately in the region of the junction of the rod member of one or both swivel segments 7 with the receiver 6, a cable 15 is connected which is introduced into the upper length of the ladder section 3*d* formed as a tube 26 and associated with the segment 7 and has at its end a terminal plate 28. Within the tube 26, near the tip of the ladder is a stop which is formed as an annular flange 27 against which one end of a compression spring 16 rests, the other end being supported against the plate 28. The compression spring 16 acting between the parts 27 and 28 supplies an additional holding force applied by way of the cable 15 to the holding device 6, 7 independently of the existing incline α_I, α_{II} or α_{III} of the ladder relatively to the horizontal. Even if the drive 8–14 of the swivel device should fail at any time when people are in the cage 5, the additional force applied by the spring 16 by way of the cable 15 would prevent the cage 5 swiveling, so that there is no danger that people would fall out of the cage 5. This device for applying to the cage 5 an additional force independent of the tilt of the ladder, acts as a safety device.

The spring 16 of this safety device is affected by whether the entire torque about the linking point of the holding device at the tip of the ladder 3*d* is supported by way of the push rod 12, the spindle nut 10*a*, the spindle 10 of the reversing gear 9 or motor 8, or whether some or all is transmitted through the cable 15 to the spring. If the load is on the spring 16 it is compressed by a certain amount whereby the cable 15 is somewhat displaced. In order to keep the swiveling of the cage 5 within certain limits relative to the ladder 3 and to lock the cage 5 in its position, a contact element may be provided at the end of the cable 15 located between the end of the spring 16 nearest the cage 5, and the connecting point of the cable 15 to the holding device 6, 7, which element comes into operative engagement, when the spring 16 is deflected, with the complementary limit contact 30 arranged on the ladder section 3*d*. A clamping device 29 formed as a clamping jaw, is brought into action by closure of this limit contact, and by clamping the cable 15 prevents any further deflection and thereby keeps the cage 5 in the position it has reached. This takes place independently of the size of the load in the cage. Dependent on the deflection of the spring 16, impulse generators constructed and arranged in a suitable manner provide pulses for further actuation of the drives 8–14. By suitable circuits an action can be exerted on the lifting drive 4 of the ladder and/or on the ex-

tension drive (not shown) in such manner that when the safety mechanisms 7a, 15, 16, 26–30 comes into action, further actuation of the lifting drive 4 is locked until, while the incline α of the ladder remains the same relative to the horizontal, the ladder assembly is completely retracted, Thereafter the ladder 3 can only be lowered by further actuation of the lifting drive 4 and finally, when it reaches its folded down position 3_I all the ladder drives remain blocked until the failure of the drive 8–14 of the swivel device for the cage 5 is corrected and actuation of the ladder drives released again by a suitable release pulse.

The contact 30 is adjustable on the ladder member 3d in the direction of the cable 15. By this means, as required, and taking into consideration the characteristics of the spring 16, a certain movement of the cable 15 is permitted until the clamping device 29 is operated by the operation of the switch 30. Accordingly, by a suitable adjustment, a maximum angle for swiveling of the cage 5 relative to the ladder 3 is determinable and the clamping device 29 comes into action only when this angle is exceeded.

In the case of a correctly operating drive 8–14 of the swiveling device for the cage 5, the load therein or the moment (torque) about the pivot of the cage 5 resulting therefrom, supports the swivel drive 8–14 when the ladder assembly is raised from its horizontal position 3_I into its position 3_{III} of maximum incline. This torque tends to reduce the angle β_I, β_{II} or β_{III} between the baseplate 5a of the cage 5 and the axis of the ladder 3 by the action of gravity. When the ladder 3 is lowered this angle β_{III}, β_{II} must be increased to reach the angle β_I (horizontal position), the swivel drive 8–14 having to operate the against the torque around the swivel segment 7 and ladder section 3d, which is unchanged as a result of the centrifugal force. Due to the design of the safety device 7a, 15, 16, 26–30 according to FIG. 2, said device now acts as an auxiliary drive assisting the swivel drive 8–14 of the cage 5 when the ladder is lowered since the spring 16 applies a torque by way of the cable 15 counteracting the torque caused by the action of gravity on the load in the cage 5. Due to the fact that the cable 15 is connected to the holding device 6, 7 in such manner that, when said device is swiveled, it rolls over the arcuate part 7a of the swivel segment 7, the torque assisting the swivel drive 8–14 is kept comparatively constant by the fact that its leverage is always constant and only the force acting in the cable 15 can vary within limits determined by the characteristic of the spring 16.

In the hydraulic swivel drive which is shown in FIG. 3, the safety device according to FIG. 2 for the cage is not shown for reasons of clarity. The embodiment shown in FIG. 3, may however, be provided with such a safety device, also acting as an auxiliary drive. At the same time the embodiments shown in FIGS. 3 and 4 may also have a swivel segment 7 according to FIG. 2 arranged between the receiver 6 of the holding device and ladder section 3d, said segment 7 not being shown in FIGS. 3 and 4 simplicity.

FIG. 3 shows an oil tank 31, an electric motor 21, a hydraulic pump 22, a multiway slide valve 25, a flexible tube connection 24, a hydraulic cylinder 17 and its piston rod 18. Oil tank 31, electric motor 21, hydraulic pump 22 multiway slide valve 25 and hydraulic cylinder 17 are mounted on ladder section 3d. The receiver 6 for the cage 5 is directly pivoted on ladder section 3d. The hydraulic cylinder 17 is pivotably connected at one end to the bottom portion of ladder section 3d, and its piston rod is connected to the receiver 6 above its connecting point with ladder section 3d. The control pulses from the impulse generator 23 (FIG. 1) are transmitted to a pulse-conducting control circuit (not shown) and, dependent on the change of ladder angle α_I, α_{II}, α_{III} are fed in a suitable manner to the nonreversible electric motor in FIG. 3, and simultaneously to the multiway slide 25 formed as a magnetically actuated control slide valve; this starts the electric motor 21 and actuates the multiway slide valve 25, so that, depending on the change in the angle α_I, α_{II}, α_{III} of the ladder, the base platform 5a of the cage 5 is kept in a horizontal position.

The embodiment according to FIG. 4 differs from that shown in FIG. 3 only by the feature that the hydraulic cylinder 19 is pivotably connected to the upper beam of ladder section 3d and its piston rod 20 to the base of receiver 6 for the cage 5. In addition, the electric motor 21 of the embodiment shown in FIG. 4 is reversible and coupled directly to the hydraulic pump 22. The multiway slide valve 25 according to FIG. 3 is omitted, since, due to the pulses fed by the combined measurement value and pulse generator 23 (FIG. 1), the electric motor is switched from one direction to the other.

In FIG. 5 the swivel ladder of the present invention is shown in the position for transport. In this position the cage 5 is shown in its position for transport 5_0 in which it is tilted forward through approximately 90° relatively to its position 5_I corresponding to the horizontal position 3_I of the ladder assembly 3. After reaching the horizontal position 3_I of the ladder 3 the drive 8 to 14 of the swivel device is operated by a switch provided in the control circuit for swinging the cage 5 to the position shown. The swivel drive 8 to 14 is switched off by a limit switch when the cage 5 reaches the transport position 5_0 and in addition a locking or fixing device is actuated by which the cage 5 is secured in its transport position 5_0.

The control circuit for the swivel device can operate with electric, mechanical or hydraulic power. Accordingly, its individual measurement and pulse generator components and its switches and other control and pulse transmission members are designed according to the selected type of power. The cage 5 is constructed so that, when required, it can be removed from the ladder assembly and accommodated at a suitable point on the vehicle chassis, e.g., in the free space between the crew's cab and the revolving turret 2.

We claim:

1. Mobile swivel ladder assembly comprising a ladder having a first end and a second end, means for selectively displacing said ladder about its first end through a vertical angle from a horizontal position to a position of maximum incline of said ladder to the horizontal position in which position the second end of said ladder is spaced vertically from its first end, a cage pivotally mounted on the second end of said ladder and having a platform therein on which persons can stand so that they can step from or onto said platform in entering and leaving said cage when said ladder is in a position angularly displaced from its horizontal position, and means independent of the equipment used for angularly displacing said ladder for angularly displacing said cage relative to the second end of said ladder so that its platform is maintained in a substantially horizontal position, said means comprising a source of power located on said ladder adjacent the second end thereof and spaced from said cage, said source of power arranged to supply the power for angularly displacing said cage relative to the second end of said ladder, and power transmission means connected to said source of power and to said cage for angularly displacing said cage relative to the second end of said ladder.

2. Mobile swivel ladder assembly, as set forth in claim 1, wherein a self-locking device for locking said cage with its platform in the horizontal position when said ladder is disposed in the horizontal position.

3. Mobile swivel ladder assembly, as set forth in claim 1, wherein said source of power is a motor, and said power transmission means comprises mechanical transmission means in operative engagement with said motor.

4. Mobile swivel ladder assembly, as set forth in claim 3, wherein said mechanical transmission means comprises an elongated screw spindle in operative engagement with said motor and extending therefrom toward the second end of said ladder, a spindle nut movably displaceably mounted on said screw spindle, at least one push rod articulated at one end to said spindle nut, a receiver for supporting said cage, and said push rod secured to said receiver at its end opposite the end secured to said spindle nut.

5. Mobile swivel ladder assembly, as set forth in claim 4, wherein said motor is arranged for imparting rotation in one direction, a reversing gear for coupling said motor to said

screw spindle and said reversing gear being reversible in dependence on the degree of inclination of said ladder to the horizontal.

6. Mobile swivel ladder assembly, as set forth in claim 1, wherein said source of power comprises means for supplying the pressurized hydraulic fluid to said power transmission means.

7. Mobile swivel ladder assembly, as set forth in claim 6, wherein said means for supplying pressurized hydraulic fluid comprises a hydraulic pump, a motor directly coupled to said pump and capable of two-directional rotation for operating the pump in dependence on the degree of inclination of said ladder.

8. Mobile swivel ladder assembly, as set forth in claim 6, wherein said power transmission means comprises a multiway slide valve which is actuated in dependence on the varying degree of inclination of said ladder.

9. Mobile swivel ladder assembly, as set forth in claim 1, wherein control means associated with said means for angularly displacing said cage in which impulses are generated based on the degree of angular inclination of said ladder.

10. Mobile swivel ladder assembly, as set forth in claim 9, wherein said control means comprises a measured value transmitter which responds to the degree of angular inclination of said ladder, and an impulse transmitter for transforming the measured value into impulses which are supplied into said source of power.

11. Mobile swivel ladder assembly, as set forth in claim 1, wherein a safety device located adjacent the second end of said ladder and connected to said cage for preventing pivotal movement of said cage relative to said ladder in the event of a failure in said means for angularly displacing said cage.

12. Mobile swivel ladder assembly, as set forth in claim 11, wherein said safety device affording an auxiliary support for said cage and combining with said means for angularly displacing said cage for supplying a positive force for maintaining the platform in said cage in a horizontal position when said ladder is being angularly displaced toward its horizontal position.

13. Mobile swivel ladder assembly, as set forth in claim 11, wherein said safety device comprises a member articulated to said cage for selectively imparting one of a pushing and pulling action thereto, and an accumulator in operative engagement with said member for affording the selected pushing and pulling action to said cage.

14. Mobile swivel ladder assembly, as set forth in claim 13, wherein said member comprises a cable, means for spring loading said accumulator, said power transmission means comprising an arcuate segment pivotally attaching said cage to said ladder, and said cable guided over said arcuate swivel segment for maintaining the force constant which acts through said cable.

15. Mobile swivel ladder assembly, as set forth in claim 11, wherein a device is positioned on said ladder adjacent the second end thereof and is arranged in the path of said safety device and blocks the operation of said means for angularly displacing said cage when a predetermined angular variation is reached between said platform of said cage and said ladder.

16. Mobile swivel ladder assembly, as set forth in claim 15, wherein said device comprises a clamping member associated with said safety device, a contact movably adjustable on said ladder adjacent its second end and arranged to contact said clamping member for blocking impulses transmitted to said means for angularly displacing said cage.

17. Mobile swivel ladder assembly, as set forth in claim 1, wherein said ladder having a plurality of rungs therein with a last rung located at its second end, said cage articulated to the second end of said ladder so that its platform and the last rung at the second end of said ladder are disposed in the same plane.

18. Mobile swivel ladder assembly, as set forth in claim 1, wherein means associated with said cage for angularly displacing said cage so that its platform is displaced from the horizontal position when said ladder is in the horizontal position.

19. Mobile swivel ladder assembly, as set forth in claim 18, wherein said means for displacing said cage so that its platform is displaced from the horizontal includes a switch member for disconnecting the operation of said means for angularly displacing said cage so that its platform is maintained horizontal.

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