Feb. 24, 1953

W. HAKKARINEN

2,629,531

EMERGENCY FIRE ESCAPE SYSTEM

Filed March 22, 1947

4 Sheets-Sheet 1

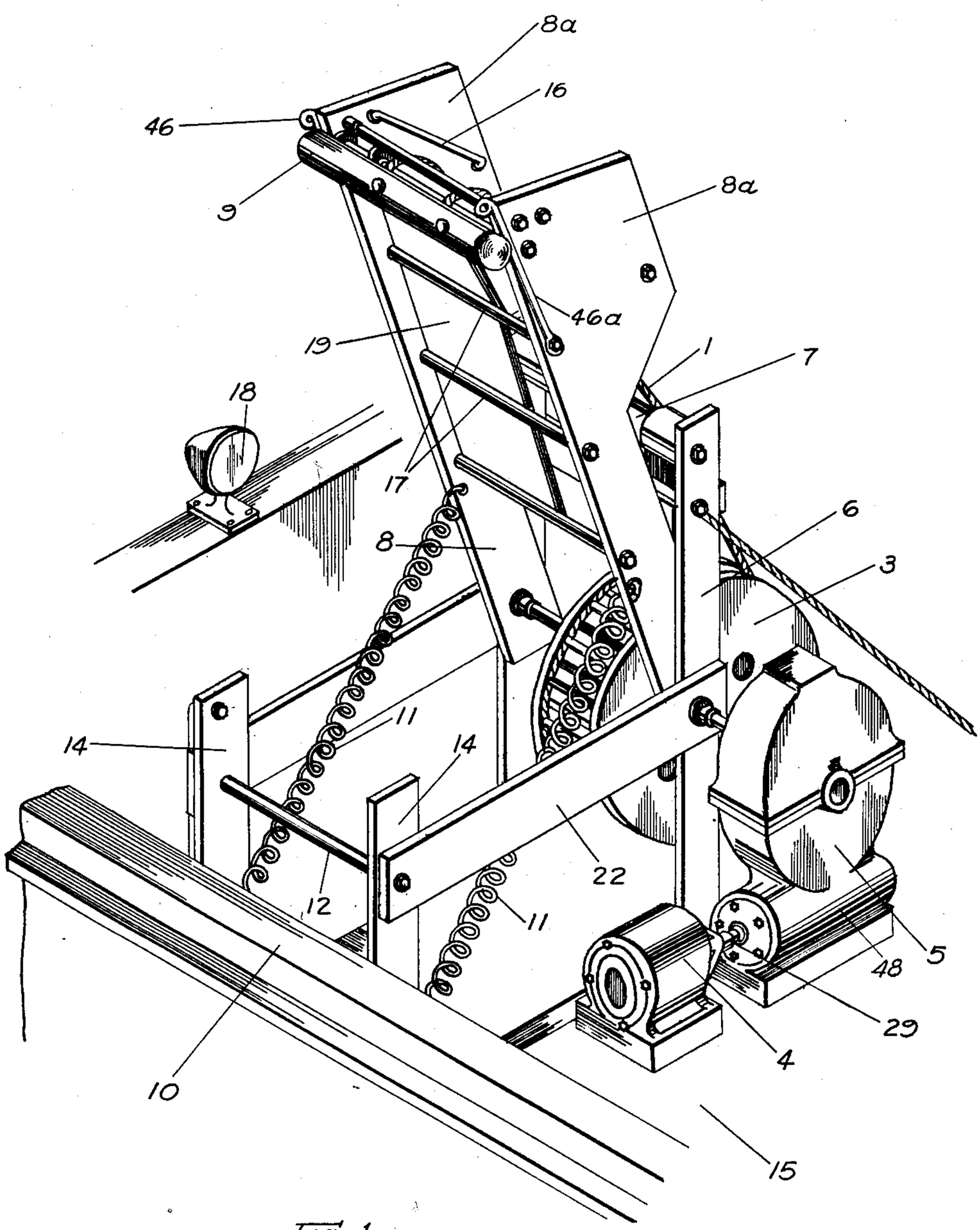

Fig. 1.

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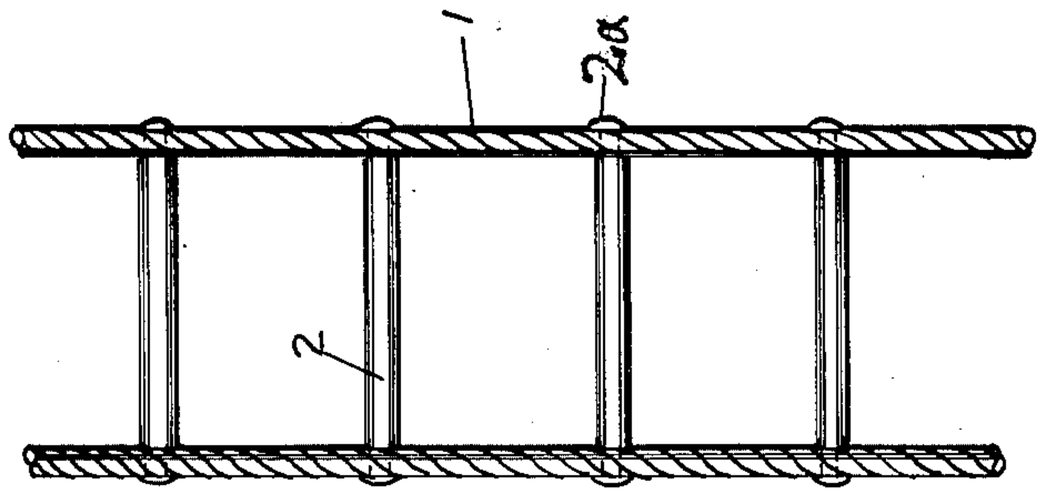

Fig. 4.

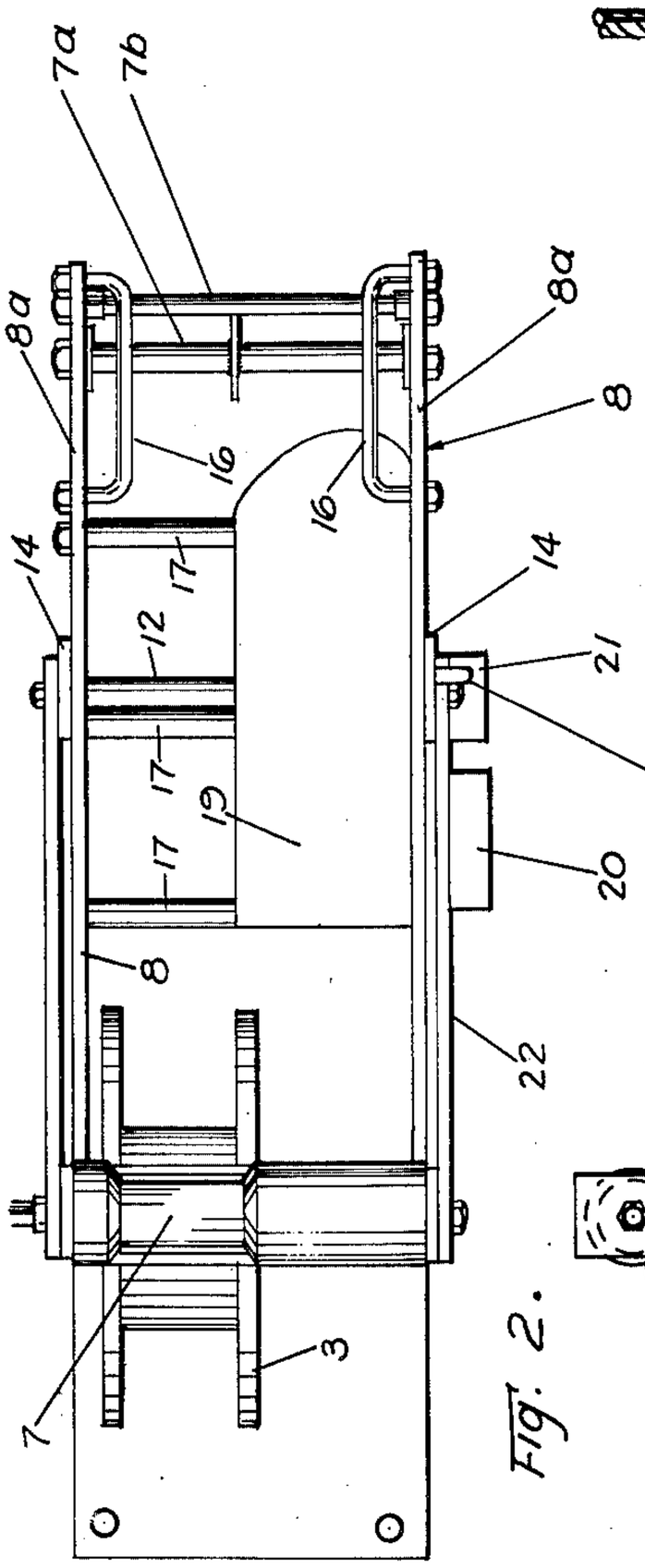

Fig. 2.

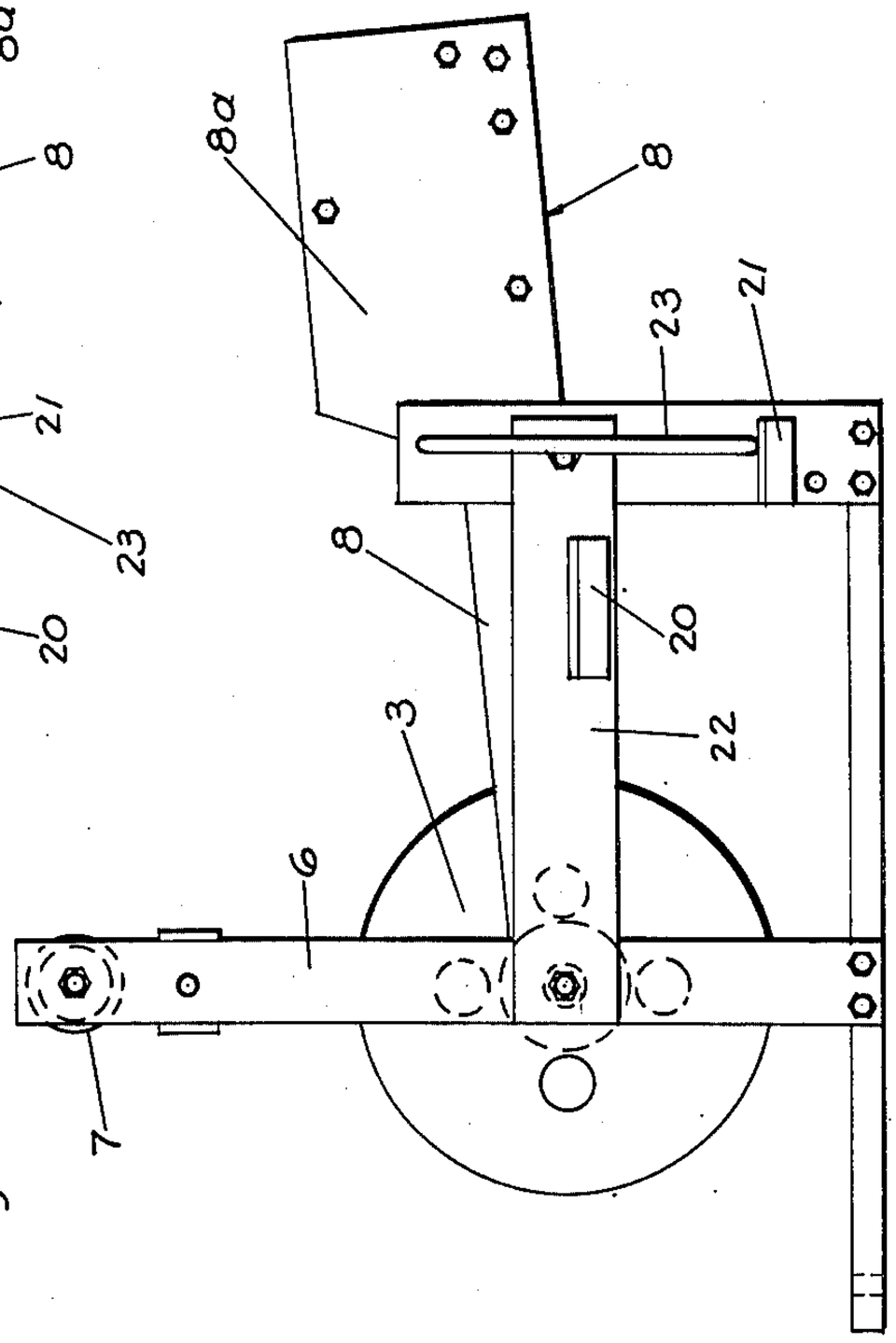

Fig. 3.

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EMERGENCY FIRE ESCAPE SYSTEM

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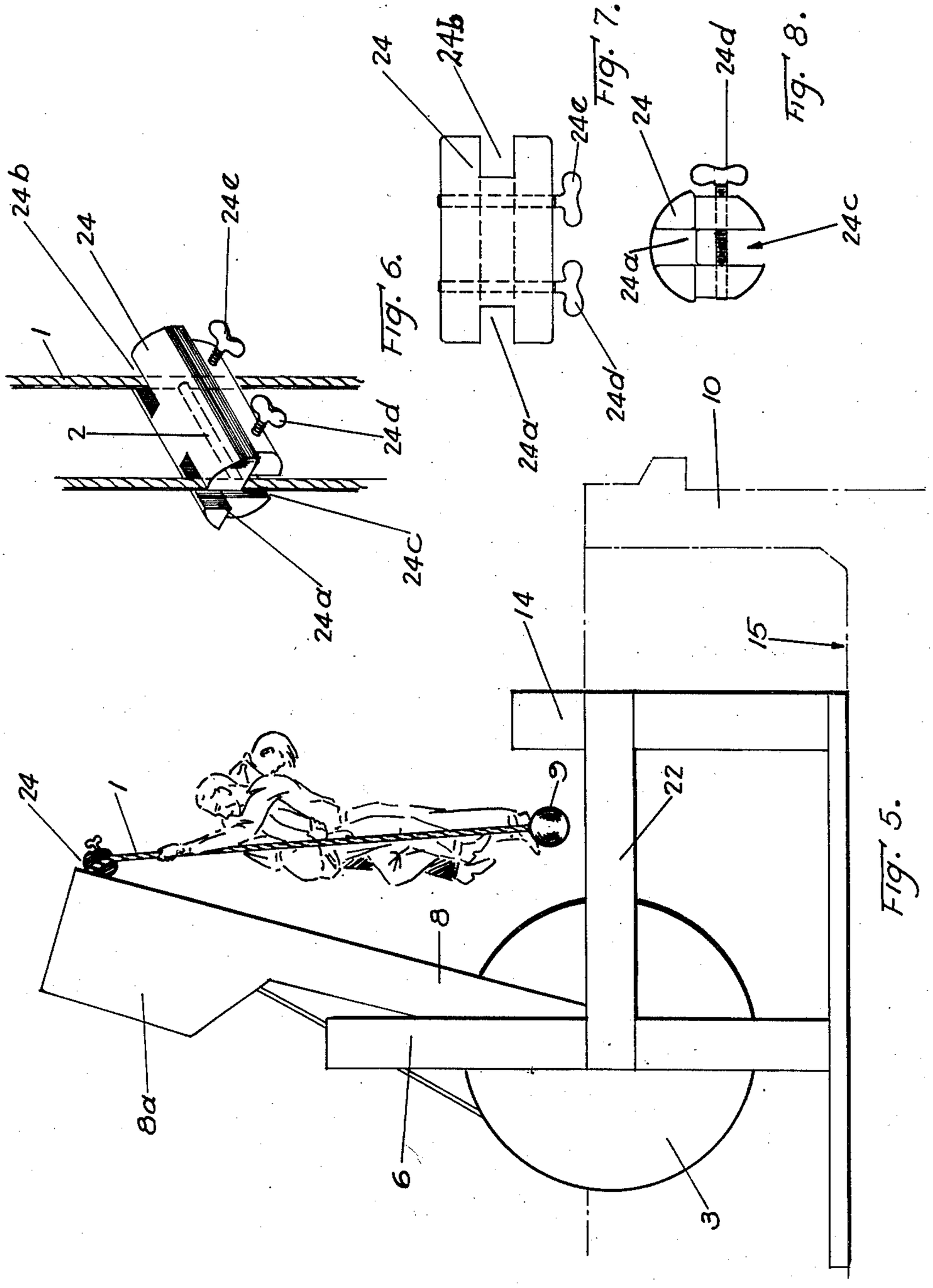

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 5.

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EMERGENCY FIRE ESCAPE SYSTEM

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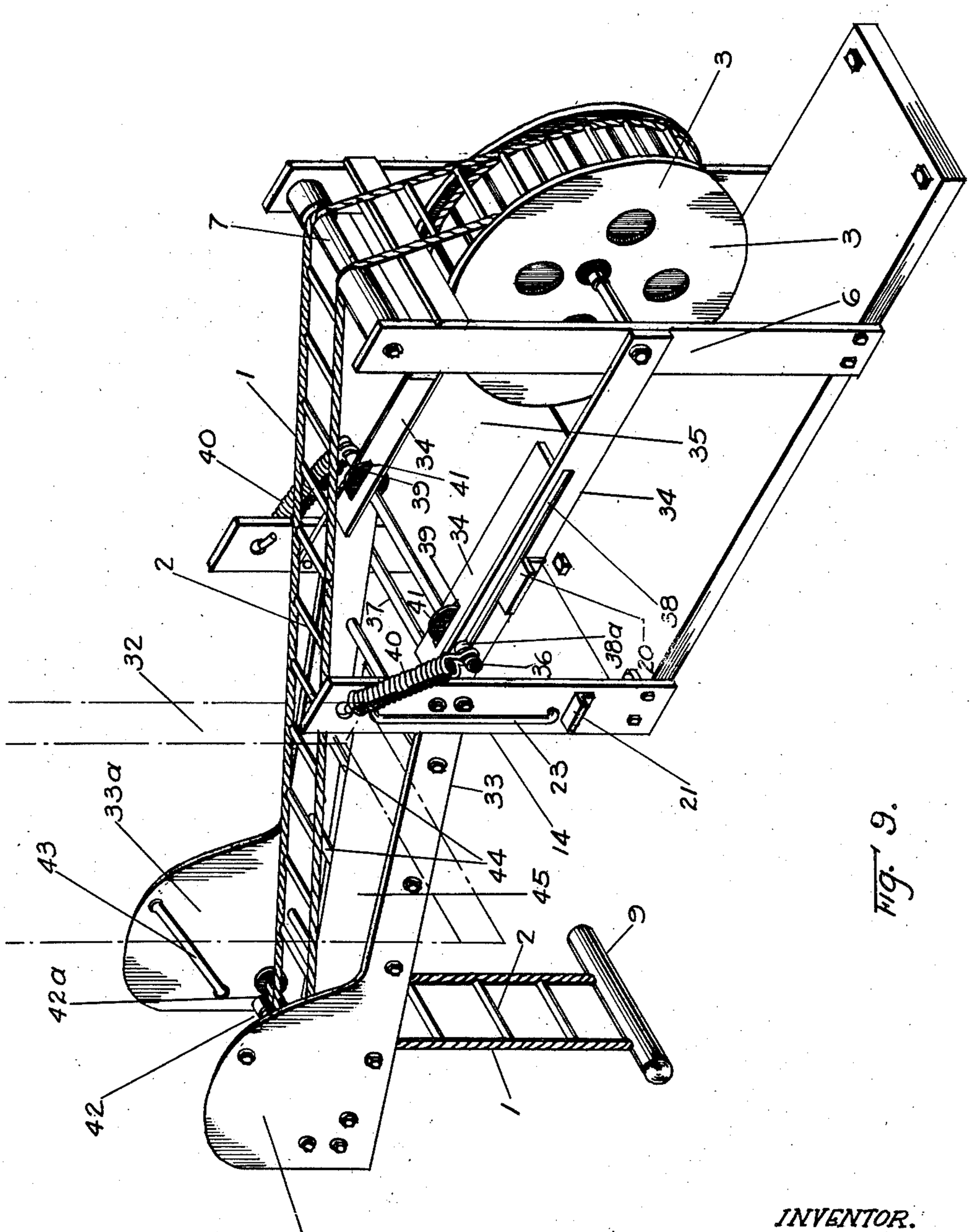

Fig. 9.

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UNITED STATES PATENT OFFICE

2,629,531

EMERGENCY FIRE ESCAPE SYSTEM

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Application March 22, 1947, Serial No. 736,503

7 Claims. (Cl. 228—43)

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My invention relates broadly to emergency fire escape systems and more particularly to improved fire escape equipment for installation on buildings.

One of the objects of my invention is to provide improved permanently installed equipment for the protection of occupants of buildings by an emergency escape system.

Another object of my invention is to provide a construction of emergency fire escape system in which the equipment is normally concealed adjacent the top of the building structure and which may be brought into operation under emergency fire conditions for the saving of life and property.

Another object of my invention is to provide an improved construction of flexible, corrosion-resistant steel wire rope ladder system which may be lowered from the roofs of buildings adjacent the windows under conditions of fire emergency and operated by a motor system for elevating entrapped people to the roof of the building and/or enabling entrapped people to descend in safety.

A further object of my invention is to provide a construction of emergency fire escape system for buildings including a positive drive elevating mechanism for a flexible-ladder system for raising a flexible-ladder system adjacent the windows of a building for enabling entrapped people to escape from the fire engulfed building by climbing upon the ladder which is raised under positive power for elevating the people to safety.

Still another object of my invention is to provide an arrangement of emergency fire escape system which may be readily installed and projected through a window adjacent the top of a building and capable of being ejected under emergency conditions to direct and guide a flexible-ladder elevator adjacent the exterior of the building for providing an emergency escape for persons through the windows of a fire engulfed building.

Other and further objects of my invention reside in the arrangement of control means for emergency fire escape systems and auxiliary equipment and mechanism associated therewith as set forth more fully in the specification hereinafter following by reference to the accompanying drawings in which:

Figure 1 is a perspective view of one arrangement of the emergency fire escape system of my invention installed on the roof of a building in which the occupants are to be protected, the

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view illustrating the equipment in retracted position preparatory to operation; Fig. 2 is a top plan view of the equipment illustrated in Fig. 1 moved to fire rescue position; Fig. 3 is a side elevational view of the equipment illustrated in Fig. 2; Fig. 4 is a fragmentary view of the flexible, corrosion-resistant steel wire rope ladder which is normally housed on the reel system of the emergency escape equipment and which is lowered to rescue position under conditions of emergency; Fig. 5 is a side elevational view of the emergency escape system raised to rescue position at the end of an elevating operation during rescue procedure; Fig. 6 is a perspective view of one of the attachable chocks which I provide for the flexible-ladder in limiting the retractile length of the flexible-ladder to a point where occupants retained on said ladder are raised bodily to the roof; Fig. 7 is a top plan view of the chock illustrated in Fig. 6; Fig. 8 is an end view of the chock shown in Figs. 6 and 7; and Fig. 9 is a perspective view of a modified form of emergency fire escape system embodying my invention in which provision is made for installation of the equipment in projectable relation to one of the upper windows adjacent the roof of a building in which the occupants are to be protected.

My invention pertains to an emergency escape system from tall buildings when such conditions as fire are tending to destroy the building. Rather than have the limitations which exist when ladders are raised from the ground, my system provides flexible, corrosion-resistant steel wire-rope ladders which are let down from the roofs of buildings.

These ladders of corrosion-resistant metal do not deteriorate with time and are therefore always ready. Normally the ladders are wound on a motor-driven reel firmly anchored on the roof of the building. The reel is fitted with a rigid, flexible-ladder guide frame which shifts angularly with respect to the reel by means of gravity and a spring force until it just meets the top of the wall of the building. In this position it extends approximately two feet out over the side of the building and the weighted end of the flexible-ladder pulls the flexible-ladder to the ground as the reel continues to unwind. In the normal position the rigid flexible-ladder guide frame is not visible from the ground.

The novel features of my invention will become apparent in the following description of the operation of the system. In my system flexible, corrosion-resistant wire rope ladders 1 are let down

from the roof or the uppermost story of the building. For most buildings the cable diameter need only be approximately ¼ inch and the steel rungs 2 approximately ¼ inch. The ladder 1 is approximately ten inches wide and the rungs 2 have shoulders 2*a* on each end. The undercut ends 2*a* are forced through the cable 1, contact welded and riveted to the cable 1. The rungs 2 are spaced approximately fourteen inches apart. Normally the ladder 1 is wound on a drum 3 approximately 3½ feet in diameter and the winding and unwinding action of this drum 3 is controlled by means of an electric motor 4 and speed reducer gear system 5. A motor of approximately 5 H. P. capacity and approximately a 100/1 speed reducer gear system will suffice for most installations. There is a centrifugal speed governor 48 on the motor side of the reducer which will operate to let the ladders down at a safe speed in case of motor failure. The centrifugal governor 48 employed herein is of the general class, described in the following publications, which provides braking under conditions of excess speed:

"Hiscox Mechanical Movements," published by Norman D. Henley & Co., 132 Nassau Street, New York city, copyright 1899, page 89, paragraph 319; and "Practical Marine Engineering" by C. W. Dyson, published by Marine Engineering, New York city, copyright 1917, pages 386–388.

In normal position then, the system components on the roof of the building consist of an electric motor 4, a speed reducer or torque converter 5 with a suitable governor 48 on the high speed shaft, a winding drum 3, a vertical upright frame 6 between which the drum 3 rotates, a ladder guide 7 at the top of the vertical frame 6, and a ladder guide frame 8 pivoted to the vertical frame 6. The ladder guide frame 8 is maintained in a substantially vertical position by the tension of the flexible-ladder 1 passing over the guide 7 on the top of the vertical frame 6 to the winding drum 3.

There are two guides 7*a* and 7*b* at the end of the ladder guide frame 8, and the flexible-ladder 1 passes between these guides 7*a* and 7*b* to a weight 9 which limits the retractible length of the flexible-ladder 1 because the weight 9 is physically too large to pass between the guides 7*a* and 7*b*. These two guides 7*a* and 7*b* serve two fundamental purposes, namely, they permit the flexible-ladder 1 to be used as a link to the drum 3 to pull the ladder guide frame 8 away from its position over the side of the building indicated at 10 and prevent any possibility of the flexible-ladder 1 being forced away from the flexible-ladder guide frame. The importance of this second purpose will become more evident in the discussion of the use of the system under emergency operating conditions. This ladder guide 8 is urged by springs 11 and gravity to fall into a horizontal position as the drum 3 begins to unwind. It is pulled downward until it comes to rest on a rigid metal bar 12 between two vertical uprights 14 spaced about four feet forward of the drum 3.

This metal bar 12 for the ladder guide frame 8 keeps the downward strain of the system from being exerted on the extension of the side wall of the building 10 above the roof while distributing a horizontal stress to the flexible-ladder 1 hanging over the side of the building 10. This ladder guide frame 8 is about ten inches wider than the flexible-ladder 1 and so has walking space for people to readily make passage between

the roof at 15 and the descending portion of the flexible-ladder 1 and vice versa. There are rigid hand rails 16 on the wind-break side walls 8*a* of the ladder guide frame 8 which aid people in climbing down to the roof to make the transition from vertical to horizontal motion where the flexible-ladder 1 changes its direction of motion at the end of the ladder guide frame 8. A small ladder 17 is in position to aid the passage of people between the ladder guide frame 8 and the roof 15 by providing properly spaced foot supports.

The ladder 17 is supplemented with a supporting or ladding platform 19 which further aids persons in climbing from the flexible-ladder 1 to the roof 15. As a further aid in conducting persons to safety steps 20 and 21 are mounted on the transverse frame 22 and the vertical frame 14 respectively in association with hand holds 23 enabling people to climb safely to the roof 15.

Upon operation of the system, motor 4 revolves and the flexible-ladder 1 begins to unwind from drum 3. The springs 11 urge the ladder guide frame 8 to descend and the guide 7 above the drum 3 keeps the weight 9 on the end of the flexible-ladder 1 against the guides 7*a*, 7*b*, until the ladder guide frame 8 comes to rest against the stop 12. The guide frame 8 now extends about two feet over the side of the building 10 and the weight 9 at the end of the flexible-ladder 1 continues to pull it down after being given an initial urging by residual thrust springs 46, 46*a*.

People may escape through open windows and ride in safety on with the ladder 1 as it descends at about two feet per second. More people get on to the ladder 1 but it continues to descend at approximately the same rate because of the control exerted by the braking action of the motor 4 and the governor 48 operating through the speed reducer or torque converter 5. Finally the ladder 1 reaches to the ground and will continue to unwind until about fifty feet rests on the ground at which point there is none left on the drum 3 to unwind. People may climb down the rungs 2 of the ladder 1 if they had escaped earlier.

The flexible-ladder 1 provides connections for a safety belt and ladder chocks 24 such as shown in Figs. 6, 7 and 8 across the rung 2 which may be applied by a rescue man in proper location on the flexible ladder. The control center may control the elevation of the rescue man on the flexible-ladder 1 to reach an incapacitated person in the building. The rescue man may seize the incapacitated person from a window and both are raised to the top of the side of the buiding. The flexible-ladder chocks shown in Figs. 6, 7 and 8 form a stop against the two end guide rollers 7*a* and 7*b* of the flexible-ladder guide frame 8 and the two are pulled upward with it back to the safety of the roof, as shown in Fig. 5.

With the selection of fifty feet as the spacing between the ladders 1 to be let down, a set of interconnected rooms occupying this distance around the perimeter of the building would be protected. Thus one ladder 1 could serve this distance in which passage through the corridor would not be necessary to reach it. However, it must be remembered that the ladder guide frame 8 extending over the side of the building is designed to permit horizontal stress to be applied to the flexible-ladder 1 and rescue workers may lash two ladders together near the top of the building to cover the intervening space between the ladders in their normal position. Thus economy in

installation is effected without much sacrifice in efficiency.

The ladder chocks 24 shown in Figs. 6, 7 and 8 are of very special design and comprise a transverse bar of substantially cylindrical contour, one semi-cylindrical section of which has a length which may pass between the spaced sides of the flexible-ladder 1, and the other semi-cylindrical section of which has a length projecting beyond the sides of the flexible-ladder 1. The ends of the bar are bifurcated as indicated at 24*a* and 24*b* to embrace the sides of the flexible-ladder 1 and the shorter semi-cylindrical section is slotted as shown at 24*c* to fit over the rung 2. Quick operating securing screws 24*d* and 24*e* are screw-threaded through the slotted portion of the chock and serve to secure the chock over the rung 2 of the flexible-ladder 1.

When the design of a building does not permit the roof type of installation, the modification of the system of my invention as shown in Fig. 9 is provided. In this arrangement the installation is made on the topmost floor of the building facing a window opening 32. The window 32 is hinged from the top to swing outward under the action of spring hinges when the window latch is opened. This latch is opened by the extension of the ladder guide frame 33 and the window is automatically pulled back out of the way for the operation of the system. The window must be manually closed once it has been released from the latched position. With this arrangement the horizontally extendable flexible-ladder guide system installed within a room of the building can equal the performance of the roof installed type.

This modification features a horizontally extendable ladder guide frame 33 to move the weight 9 on the end of the flexible ladder 1 within a building to a position over the side of the building through window 32 before it begins to pull the flexible-ladder downward as the drum 3 unwinds. The design of the components is identical with the roof type shown in Figs. 1–5, except for the following changes. The two horizontal members 22 which formerly served only to brace the two vertical frames 6 and 14 together are now made from right angle pieces to form the sides 34 of a fixed base unit of a two-section extendable rigid frame. The bottom of the fixed section is a solid metal plate 35 and the sides and partially enclosed top are formed by right angle pieces 34 fastened to the sides of the bottom plate 35 and then to the two vertical frames 6, 14. Across the forward end of the sides 34 a roller shaft 37 is supported by these sides. Both sides of the frame 34 have a slot 38 of approximately two inches in width extending along the sides 34 to within approximately six inches from each end. The forward end of the slot is widened at 38*a* to form a rectangular cut-out approximately two inches by four inches. About ½ foot from the forward end of the frame in the partial top formed by the sides of the angles, two slots 39 approximately one inch by six inches are cut two inches in from each side. A connection for the attachment of springs 40 is provided on each of the forward vertical supporting members for this base section.

The horizontally extendable section of this unit acting as a flexible-ladder guide frame is similar to the type used on a roof installation except for a few minor changes. In lieu of the drum shaft formerly provided, there is a shaft 36 which extends through the side slots 38 of the rigid

section 34 and which has wheels 41 extending through slots 39 to allow this section to roll on the bottom plate 35 and the forward roller 37 at the front of the fixed section. Spring 40 connected between the shaft 36, which extends through the slots 38 of the fixed section, and the forward vertical supporting members 14 for this section urge the ladder guide frame 33 into its extended or projected position as the tension of the flexible-ladder 1 is released when the drum 3 unwinds. At the desired extension the wheels 41 which press against the underside of the partial top fall into the slots 39 due to the upward component of the spring force and the unbalance of the ladder guide frame on the roller 37 at the front end of the fixed section as a fulcrum. Thus the extension in a locked position tilts downward at an angle of approximately twenty degrees from the horizontal and can only be moved therefrom by a combined upward and backward pull as is normally caused when the retraction of the flexible-ladder 1 is limited by chocks 24 or the weight 9 on the end of the flexible-ladder 1 coming to meet the two rolling guides 42, 42*a* at the end of the ladder guide frame 33.

The extendable frame 33 is provided with similar facilities described in connection with the form of my invention shown in Figs. 1–5, that is, the side shields 33*a* and the hand holds 43 together with short ladder 44 and platform 45. The shields 33*a* protect the people from flames, cross-currents of wind and the elements as they are climbing to safety. Residual thrust springs 46, 46*a* are not used.

Although I have set forth specific dimensions in the foregoing description, I desire that it be understood that these dimensions are presented for illustrative purposes only to provide a reasonable approximation of the proportions employed in the equipment of my invention. Under no circumstances are these dimensions intended as restricting or limiting my invention and are to be regarded in the illustrative sense only.

While I have described my invention in certain of its preferred embodiments I realize that the principles of my invention may be embodied in various modifications and I desire that it be understood that no limitations upon my invention are intended other than may be imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. An emergency fire escape system comprising a frame structure adapted to be supported on the roof of a building structure adjacent the side wall thereof, a ladder-guide frame pivotally mounted in said frame structure and angularly movable from a substantially vertical position to a substantially horizontal position projecting beyond the side wall of the building structure, said ladder-guide frame having a platform thereon with a pair of vertically extending protective side walls forming a pedestrian passage through said ladder-guide frame, a winding drum journaled in said frame structure, said winding drum carrying a flexible-ladder thereon, coacting ladder-guides on said frame structure and on said ladder-guide frame, a flexible-ladder wrapped on said drum and directed over said ladder-guides and through the pedestrian passage in said ladder-guide frame, said flexible-ladder being weighted at the free end thereof for enabling said ladder to be gravitationally lowered along the side wall of the building structure when said ladder-guide frame is moved to a position projecting beyond

the side wall thereof, drive means and a torque converter interposed between said drive means and said drum on said ladder-guide frame, whereby said ladder-guide frame may be moved from a substantially vertically disposed position to a substantially horizontal position and said ladder lowered and raised through said ladder-guide frame adjacent the pedestrian passage in said ladder-guide frame.

2. An emergency fire escape system comprising a frame structure adapted to be supported on the roof of a building structure adjacent the side wall thereof, a ladder-guide frame pivotally mounted in said frame structure and angularly movable from a substantially vertical position to a substantially horizontal position projecting beyond the side wall of the building structure, said ladder-guide frame having a platform thereon with a pair of vertically extending protective side walls forming a pedestrian passage through said ladder-guide frame, a winding drum journaled in said frame structure, said winding drum carrying a flexible-ladder thereon, coacting ladder-guides on said frame structure and on said ladder-guide frame, a flexible-ladder wrapped on said drum and directed over said ladder-guides and through the pedestrian passage in said ladder-guide frame, said flexible-ladder being weighted at the free end thereof for enabling said ladder to be gravitationally lowered along the side wall of the building structure when said ladder-guide frame is moved to a position projecting beyond the side wall thereof, drive means and a torque converter interposed between said drive means and said drum on said ladder-guide frame, whereby said ladder-guide frame may be moved from a substantially vertically disposed position to a substantially horizontal position and said ladder lowered and raised through said ladder-guide frame adjacent the pedestrian passage in said ladder-guide frame, hand grips disposed interiorly of the walls of said ladder-guide frame and a plurality of steps disposed at different elevations adjacent the exterior of said frame for facilitating the movement of pedestrians from the pedestrian passage through said ladder-guide frame to the roof on which said frame structure is mounted.

3. A fire escape system, comprising a motor operated drive, a reel driven by said motor, a flexible corrosion-resistant wire rope ladder adapted to be wrapped on said reel, a frame extending from said reel, a ladder-guide pivotally mounted with respect to said frame and swingable from said frame for supporting said ladder in a pendant position, a weight attached to the pendant end of said ladder and spring means for facilitating the movement of said ladder-guide with respect to said frame.

4. A fire escape system, comprising a motor operated drive, a reel driven by said motor, a flexible corrosion-resistant wire rope ladder adapted to be wrapped on said reel, a frame extending from said reel, a ladder-guide pivotally mounted with respect to said frame and swingable from said frame for supporting said ladder in a pendant position, a weight attached to the pendant end of said ladder, spring means for facilitating the movement of said ladder-guide with respect to said frame, and a platform carried by said ladder-guide extending immediately adjacent the upper end of said ladder when in pendant position.

5. An emergency fire escape system, comprising a frame structure, a reel journalled in said frame structure, a flexible corrosion-resistant wire rope ladder adapted to be rolled on and rolled off of said reel, a ladder-guide pivotally mounted on said frame, guide means for said ladder carried by said frame, said ladder extending over said guide means and over said ladder-guide and terminating in a pendant end weight device, a platform carried by said ladder-guide extending immediately adjacent the upper end of said ladder when in pendant position, and protective shields carried by said pivotally mounted ladder-guide and extending on opposite sides of the platform and the ladder which passes through the ladder-guide.

6. An emergency fire escape system, comprising a frame structure, a reel journalled in said frame structure, a flexible corrosion-resistant wire rope ladder adapted to be rolled on and rolled off of said reel, a ladder-guide pivotally mounted on said frame, guide means for said ladder fixed to said frame, said ladder extending over said guide means and over said ladder-guie and terminating in a pendant end weight device, a platform carried by said ladder-guide extending immediately adjacent the upper end of said ladder when in pendant position, protective shields carried by said pivotally mounted ladder-guide and extending on opposite sides of the ladder which passes therethrough for forming a protective path for pedestrians over said platform and a chock secured adjacent the pendant end of said ladder and operative to limit the extent of retraction of the ladder on to said reel.

7. An emergency fire escape system, comprising a frame structure, a reel journalled in said frame structure, a flexible corrosion-resistant wire rope ladder adapted to be rolled on and off of said reel, a ladder-guide pivotally mounted on said frame, guide means for said ladder fixed to said frame, said ladder extending over said guide means and over said ladder-guide and terminating in a pendant end weight device, a platform carried by said ladder-guide extending immediately adjacent the upper end of said ladder when in pendant position, protective shields mounted on said pivotally mounted ladder-guide and extending on opposite sides of the ladder which passes therethrough and above said platform and a detachable chock fastened at a selected position along the pendant end of said ladder and operative to abut against said pivotally mounted ladder-guide for restricting the length of said ladder rewound upon said reel.

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