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SAFETY DEVICE FOR PANEL SHUTTER

Technical Field

The present invention relates to a safety device for a panel shutter and, more particularly, to a safety device for ensuring safety during opening and closing operation of a panel shutter of the type having a plurality of panels for constituting a shutter curtain, the panels being suspended from chains which are driven by guide sprockets so as to open and close an opening of a building.

Background Art

A conventional panel shutter has a plurality of panels each having roller shafts extending from both ends thereof. These roller shafts are connected to chains so that the panels form a shutter curtain. The remainder portions of the chains are engaged by and suspended from guide sprockets which are provided on the left and right sides of a shutter case connected to the upper end of guide rails. The arrangement is such that, as the guide sprockets are rotated forward and backward, the shutter curtain is raised or lowered so as to open and close the opening of a building. More specifically, when the shutter is in the closed state, the panels are held by guide rails substantially perpendicularly. As the guide

sprockets rotate forward, the panels are lifted keeping a constant distance between the adjacent panels. During this operation, rollers rotatably carried by the roller shafts on both ends of each panel roll upward along the guide rails. Then, the rollers of the uppermost panel and the following panels successively roll, past the upper ends of the guide rails, onto accommodation rails which are laid so as to extend back and forth along the inner surfaces of the left and right side panels of the shutter case. In consequence, the panels move laterally so as to be placed in a side-by-side fashion in vertical posture. The vertical movement of the shutter is ceased when the bottom surface of the lowermost panel moving upward has become flush with the bottom surface of the lintel, whereby the opening of the building is opened.

When the guide sprockets are reversed, the lowermost panel moves downward along the guide rails. As a result, the series of panels which have been borne by the accommodation rails and held in side-by-side fashion in vertical position are successively moved laterally along the accommodation rails and then moved downward along the guide rails while being suspended from the chains. In consequence, the panels are held by the chains along the

guide rails so as to form a vertically continuous shutter curtain thereby closing the opening of the building.

On the other hand, there is another type of known shutter referred to as "winding" type shutter in which a plurality of elongated steel sheets are pivotally connected at their upper and lower ends to adjacent panels so as to form a continuous shutter curtain which can be rolled up onto and paid-off from a take-up shaft rotatably mounted in a shutter case, thus opening and closing an opening of a building. It is to be noted that the first-mentioned panel-type shutter is advantageous as compared with the winding type shutter in that it produces less noise by virtue of the fact that no friction nor collision takes place between adjacent panels and between the panels and the rails during opening and closing operation of the shutter. For these reasons, the panel-type shutter is finding wide spread use particularly in shops in underground streets where noise tends to cause resonance and in shops in residential areas. The panel-type shutter, however, still suffers from the following disadvantages in regard to safety during opening and closing of the shutter.

More specifically, this type of shutter is equipped with an upper limit switch for preventing the lowermost panel from being raised above a predetermined opening

stop position, i.e., the position where the bottom of the lowermost panel becomes flush with the bottom of the lintel, by the forward rotation of the guide sprockets during opening and closing operation of the shutter. This type of shutter, however, is devoid of any safety switch for emergency stop of the shutter operation. Therefore, if the upper limit switch fails to operate the lowermost panel is raised beyond the predetermined open stop position, resulting in a breakdown of the panel. Such a problem would be overcome by providing an emergency stopping safety switch which is known per se. The lowermost panel usually has the same elongated sheet-like form as those of other panels. Therefore, in order that an ordinary safety switch is used satisfactorily, it is necessary that a projection or a lug for actuating the emergency stop switch is provided on the front face of the lowermost panel. Unfortunately, however, such a projection or lug impairs the appearance of the shutter curtain, which is quite undesirable from commercial and design points of view. Under these circumstances, there is an increasing demand for an emergency stop safety switch capable of operating without causing any deterioration of the appearance of the shutter curtain.

Another problem is that, when the panels are transferred from the accommodation rails onto the guide rails as a result of the reversing of the guide sprockets during closing of the shutter curtain, the panels tend to oscillate back and forth due to inertia when the direction of movement is changed from the lateral direction to the vertical direction. There is a risk that, when the amplitude of the oscillation is large, the panels are not safely transferred to the guide rails, with the result that the panels cannot move downward and, in the worst case, the panels are damaged. This in turn gives rise to the demand for a safety switch which is capable of stopping the shutter operation whenever the downward movement of the panel fails.

Still another problem encountered by the panel-type shutter curtain is as follows. In this type of shutter, the series of panels constituting the shutter curtain are connected to both chains at a constant interval in the vertical direction. Thus, all the panels of the shutter curtain are suspended from the chains which in turn are borne by the guide sprockets, particularly immediately after the opening operation is started and immediately before the closing operation is completed. Thus, the entire weight of the panels constituting the shutter curtain is carried by the chains, causing a risk

should the chains be cut during opening or closing of the shutter. Therefore, an increase in the size of the shutter curtain requires the strengths of the sprockets and chains to be increased correspondingly, as well as the power of the motor for driving the guide sprockets. Unfortunately, however, there is a practical limit in increasing the strengths of the guide sprockets and the chain and the motor capacity. For these reasons, it has been impossible to use a panel shutter in such buildings that the opening to be closed by the shutter has a large height of, for example, 20 metres which is twice as large as that of the building openings to which this type of shutter is normally applied.

Any breakage of one of the chains is dangerous because the panels are inclined such that their ends connected to the broken chain are suspended from the other ends thereof. In addition, the repair of the broken chain requires the heavy panels suspended in this way to be lifted so as to bring the cut link of the chain into position. This inconveniently makes the repair work difficult to conduct.

Accordingly, the present invention seeks to eliminate the problems of the prior art by ensuring safety during opening and closing of the panel shutter.

According to the present invention there is provided a panel shutter having a plurality of panels each having roller shafts provided on upper portions of both ends thereof, said panels having their roller shafts connected in series to chains so as to form a shutter curtain, said shutter curtain being suspended from guide sprockets disposed in left and right end portions of a shutter case, the shutter case being located above substantially vertical guide rails disposed at the left and the right sides of an opening and along which the shutter curtain is arranged to be

movable, the shutter curtain also being movable along accommodation rails extending rearwardly along inner surfaces of the left and right side walls of said shutter case, whereby forward and backward rotation of said guide sprockets causes said shutter curtain to move progressively from said guide rails onto said accommodation rails and vice versa for opening and closing said opening, a safety device comprising a movable guide rail side portion within said shutter case, and a safety switch disposed in the vicinity of said movable side portion to be actuated by said movable side portion when said movable portion is moved in such a manner as to widen a guide passage formed in the guide rail.

In a first embodiment of the present invention, the panels, other than the lowermost panel are provided with engaging lugs, on both ends of their lower portions, while the lowermost panel is provided on both ends of its lower portion with a stopper roller shaft each having a shaft portion of a diameter greater than the diameter of the roller shaft connected to the chain.

Vertical upper guide rails disposed in the shutter case are connected to the upper ends of the lower guide rails standing upright both at the left and right sides of the opening. The upper guide rails are provided with vertical guide passages each having a width smaller than the width of a vertical guide passage formed in each lower guide rail, so that the vertical guide passages formed in the upper guide rails allow the roller shafts on both ends of the panels to pass therethrough but does not allow the large-diameter shaft portions of the stopper roller shaft of the lowermost panel to pass therethrough.

One side portion of each upper guide rail is hinged so that the width of the guide passage can be increased as desired. This side portion of the upper

guide rail is normally urged by springs such as to maintain a predetermined width of the guide passage. An emergency stop safety switch is disposed in the vicinity of the hinged side portion of the upper guide rail, such that the switch is operated by the side portion of the upper guide rail as this side portion is moved to increase the width of the passage. A mountain-shaped guide plate having an ascending slope and a descending slope when viewed in side elevation is disposed under the guide sprocket and in the vicinity of the lower portion of the upper guide rail. During closing operation of the shutter curtain, as the guide sprockets are driven, the panels first move laterally along the accommodation rails and then move downward towards the upper ends of the upper guide rails. The panels, when changing their direction of movement, tend to swing forward due to inertia about their roller shafts, failing to be smoothly guided into the upper guide rails with the result that the shutter curtain cannot be lowered. In such a case, the ascending slopes of the guide plates engage with the engaging lugs on the lower portions of both ends of the side panels so as to forwardly tilt the panel, causing the roller shafts on the upper portion of this panel to move the hinged portions of the upper guide rail thereby activating the safety switch.

The advantage of such an embodiment is that a single safety switch plays a double role: namely, a role as an emergency stop safety switch which stops the shutter opening operation without delay after detection of such a state that, due to a failure in the upper limit switch, the lowermost panel has been moved beyond a predetermined opening stop position, i.e., the position where the bottom surface of the lowermost panel becomes flush with the bottom surface of the lintel, and a role as an emergency stop switch which stops the closing operation without delay

whenever the downward movement of the shutter is impeded due to a failure in the transfer of a panel from the accommodation rails to the guide rails, thus preventing breakdown of the panel, the single safety switch being operable with a member which is not visible from the outside of the shutter so that the appearance of the shutter is not impaired.

In a second embodiment of the present invention, the pitch or distance of a selected pair of successive panels connected to the chains and constituting the shutter curtain is selected such that before one of the panels of the pair starts to move downward passing over the guide sprockets, the preceding panel stops its downward movement. The selection of the pitch between a pair of panels in this manner prevents the whole weight of the panels from applying to the chains suspended from the guide sprockets, thus avoiding accidental cutting of the chain. An advantage of such an embodiment is that it is possible to realise a large-sized panel shutter capable of opening and closing a large entrance opening of a large-sized building without requiring the strengths of the chains and guide sprockets to be increased to such a level that they can carry the whole weight of the panels.

In a third embodiment of the present invention, each of the panels connected to the chains and constituting the shutter curtain is composed of a front panel member and a rear panel member which are adjoined to each other leaving a predetermined gap therebetween, the front panel member being bent horizontally at its upper end so as to form an engaging tab directed inwardly, the rear panel member being provided at its lower end with an engaged tab which is symmetrical with the engaging tab. The panels are disposed such that the engaged tab of the

upper panel underlies the engaging tab of the lower panel. According to this arrangement, it is possible to prevent panels from hanging from one end due to, for example, breakage of one of the chains. In consequence, any breakage of parts on the ends of the panels can be avoided, and the repair work for connecting the severed parts of the chain is facilitated.

Brief Description of the Drawings

Fig. 1 is a schematic perspective view of a panel shutter;

Fig. 2 is a side elevational view of the interior of a shutter case employed in the panel shutter of a first embodiment;

Fig. 3 is an illustration of operation of the panel shutter of the first embodiment;

Fig. 4 is a plan view illustrating the state of engagement between the upper guide rails and running rollers provided on the upper end portions of both ends of each panel;

Fig. 5 is a perspective view of one side of a panel;

Fig. 6 is a plan view illustrating the state of engagement between upper guide rails and the rollers provided on the lower portions of both ends of the lowermost panel constituting a seating panel;

Fig. 7 is a perspective view of a lower end portion of the lowermost panel constituting the sealing panel;

Fig. 8 is a side elevational view of an essential portion of a panel shutter in accordance with a second embodiment;

Fig. 9 is an illustration of operation of the panel shutter in accordance with the second embodiment;

Fig. 10 is a vertical sectional view of an essential portion of a panel shutter in accordance with a third embodiment of the present invention; and

Fig. 11 is an illustration of operation of the third embodiment.

The Best Mode For Carrying Out The Invention

The invention will be more fully understood from the following description taken in conjunction with the accompanying drawings.

Figs. 1 to 7 in combination show a first embodiment of the present invention. A panel shutter 1 is constituted by lower guide rails 3 standing upright both at the left and right sides of an entrance opening 2 of a building, a shutter case 4 connected to the upper ends of the lower guide rails 3, and a shutter curtain 5 adapted to move up and down while being guided by guide passages 3a in the lower guide rails 3 so as to open and close the opening 2.

The shutter curtain 5 has a plurality of elongated slat-shaped panels 6, and a lowermost panel 7 constituting a sealing panel. Each panel is provided on both ends of their upper portions with roller shafts 9 carrying running rollers 8. The panels are connected in series at their roller shafts 9 to chains 11 through connecting members 10 at constant intervals. The remaining part of the chains 11 are suspended from a pair of guide sprockets 12 provided in the shutter case 4 at left and right end portions of the shutter case 4. The end extremities of the chains 11 are connected to the rear panel 4a of the shutter case 4.

An electric motor 13 is mounted in the shutter case 4. The electric motor 13 has an output sprocket 14 which is drivingly connected through a first transmission chain 15 to a first intermediate sprocket 16 coaxial with a second intermediate sprocket 17 which in turn is drivingly connected through a second transmission chain 18 to a final stage sprocket 19 which is coaxial with the guide sprockets 12. Reference numeral 20 denotes a

tension sprocket for tensioning the second transmission chain 18.

A pair of accommodation rails 21 are laid along the inner surfaces of left and right side walls 4b, 4b of the shutter case 4 immediately behind the guide sprockets 12, so as to extend backwards and forwards. When the shutter curtain 5 is opened, the accommodation rails 21 hold the rollers 8 on both ends of the panels 6 so that the panels 6 are accommodated by the shutter case 4 in a vertical position in a side-by-side fashion.

As will be seen from Fig. 5, engaging lugs 22 are provided on lower portions of both ends of each panel 6. The lowermost panel 7 constituting the seating panel is provided on lower portions of both ends thereof with stopper roller shafts 25 mounting rollers 24 which have shaft portions 23 of a diameter greater than the diameter of the roller shaft 9 of the panel 6, as will be seen from Figs. 6 and 7.

Upper guide rails 3' are connected to the upper ends of the lower guide rails standing upright on the left and right sides of the opening 2. Each lower guide rail 3 is provided with a vertical guide passage 3a of a width large enough to permit the passage of both the roller shafts 9 on both ends of the panels 6 and the large-diameter shaft portions 23 on the lower portions of both

ends of the lowermost panel constituting the seating panel. Each upper guide rail 3' is provided with a vertical guide passage 3a' of a width which is large enough to permit the roller shafts 9 on the panels 6 to pass therethrough but too small to pass the large-diameter shaft portion 23 of the stopper roller shaft 25 of the lowermost panel 7. A tapered portion 3b' is provided in the transient region between the guide passage 3a of the lower guide rail 3 and the guide passage 3'a of the upper guide rail 3'.

As will be seen from Figs. 4 and 6, one side portion 3'c of the upper guide rail 3' is hinged as at 26 so as to permit the width of the guide passage 3'a to be opened and closed. Normally, the side portion 3'c is urged by a spring 27 so as to keep a predetermined width of the guide passage 3'a. An emergency stop safety switch 28 is disposed in the vicinity of the hinged side portion 3'a of the upper guide rail 3', such that the safety switch 28 is actuated by the side portion 3'a as the latter is moved in the direction for widening the guide passage.

A mountain-shaped guide plate 29 having an ascending slope 29a and descending slope 29b, which are adapted to be engaged by the engaging lugs on the lower portions of both ends of the panel 6 is disposed in the vicinity of

lower portion of each upper guide rail 3' under the adjacent guide sprocket 12.

According to this invention, when the lowermost panel 7 of the shutter curtain 5 is moved beyond a predetermined position during the opening operation of the shutter curtain, the large-diameter shafts 23 on the lower portions of both ends of the lowermost panel 7 are brought into contact with the hinged side portions 3'c of the upper guide rails 3'. Since the large-diameter shafts 23 have a diameter which is too large to pass through the guide passage 3'a, the side portion 3'c is moved in such a direction to widen the guide passage, so that the emergency stop safety switch 28 is activated so as to stop the opening operation of the shutter curtain without delay.

During the closing operation of the shutter curtain 5, the panels 6 first move laterally along the accommodation rails 21 on which they have been stored and then move vertically towards the upper ends of the upper guide rails 3'. When the direction of movement of the panel is changed, the panel swings back and forth about the roller shaft 9 due to inertia. This may cause the panel to fail to smoothly move into the lower guide rails, with a result that the shutter curtain cannot move downward.

According to the invention, in such a case, the engaging

lugs 22 on the lower portions of both ends of each panel engage with the ascending slope 29a of the guide plate 29, thus tilting the panel 6 forwardly. At the same time, the roller shafts 9 on this panel 6 causes the side portions 3'c of the upper guide rails 3' to be moved in the direction for widening the guide passages, thus activating the emergency stop safety switch 28 thereby stopping the closing operation of the shutter curtain 5 without delay.

Figs. 8 and 9 show a second embodiment of the present invention. The second embodiment is distinguished from the first embodiment in that, while the pitch of the panels 6 connected to the chains 11 and constituting the shutter curtain 5 adapted to be moved up and down by the chains 11 suspended from the guide sprockets 12 is constant in the first embodiment, the distance between a selected pair of adjacent panels 6,6 is selected such that, before one of the pair of the panels starts to move downward past the guide sprockets, the other panel 6 of the pair stops its downward movement.

A description will be made hereinafter with reference to the accompanying drawings.

In this embodiment also, a plurality of panels 6,6 are connected to the chains 11 adapted to be driven by

the guide sprockets 12 so as to form the shutter curtain 5. The distance between a selected pair of adjacent panels 6a,6b, located at an intermediate portion of the shutter curtain 5, is selected to be greater than such a distance that, before one 6a of the pair of the panels starts to move downward past the guide sprockets, the other panel 6b of the pair stops its downward movement. Other panels 6,6 are arranged at a pitch which is slightly greater than the height of the panel 6.

Thus, in the second embodiment, the distance between a selected pair of adjacent panels 6a,6b, located at an intermediate portion of the shutter curtain 5, is selected to be greater than such a distance that, before one 6a of the pair of the panels starts to move downward past the guide sprockets, the other panel 6b of the pair stops its downward movement. According to this arrangement, the shutter curtain 5 behaves as if it has an upper half portion 6A and a lower half portion 6B during opening and closing of the shutter curtain 5, so that the chains 11 and the guide sprockets are required only to bear about half the weight of the shutter curtain 5, so that the risk for the chains 11 to be accidentally broken is avoided. This in turn makes it possible to realize an extremely large panel shutter which can close the large-sized opening of a large building.

The selected pair of panels 6a and 6b need not always be located at the mid portion of the shutter curtain. For instance, the pair of panels may be the uppermost panel 6 and the adjacent panel 6. All that is required in this embodiment is that the whole weight of the panels 6,6 is not applied to the chains 11 immediately after the start of the opening operation and immediately before the completion of the closing operation.

Figs. 10 and 11 show a third embodiment of the present invention. The third embodiment is distinguished from the first and the second embodiments in that, while in the first and the second embodiments the panels 6 have an elongated slat-like form, the panels in the third embodiment have the following features. Namely, in the third embodiment, each of the panels 6 is composed of a front panel member and a rear panel member which are adjoined to each other leaving a predetermined gap therebetween, the front panel member being bent horizontally at its upper end so as to form an engaging tab directed inwardly, the rear panel member being provided at its lower end with an engaged tab which is symmetrical with the engaging tab, the panels being disposed such that the engaged tab of the upper panel underlies the engaging tab of the lower panel, when these panels are connected in series through the chains.

According to this arrangement, it is possible to prevent panels from hanging down from one end due to breakdown of one of the chains because in such a case the lower panel can be retained by the upper panel so as not to hang from one end thereof.

To explain in more detail with reference to the drawings, each of the panels 6,6 constituting the shutter curtain 5 is composed of an elongated front

panel member 6' and a rear panel member 6" which are adjoined to each other by, for example, spot welding such as to leave a predetermined gap therebetween. The upper end of the front panel 6' is bent horizontally inwardly so as to form an engaging tab 30. The extreme end of this engaging tab 30 is further bent upward so as to form an upward projection 30a which serves as a seal against any rain water from coming inside when the opening 2 is closed by the shutter.

On the other hand, the rear panel member 6" is provided at its lower end with an engaged tab 31 which is symmetrical to the engaging tab 30 formed on the front panel member 6'. Thus, the front panel member 6' and the rear panel member 6" have an identical form. When the _____

panels 6,6 are connected to the chains 11 in series in the vertical direction, the engaged tab 31 of each panel underlies the engaging tab 30 of the adjacent lower panel 6, leaving a small gap therebetween. In the event that a chain 11 is accidentally cut during opening and closing of the shutter curtain 5, the engaging tab 30 of the lower panel 6 rests on the engaged tab 31 of the upper panel 6 so that the lower panel 6 is prevented from hanging down from one end. In consequence, the electric motor 13 is stopped without delay, thereby stopping the opening or closing operation of the shutter curtain.

A description will be made hereinafter as to first to third embodiments having the described construction.

Referring to the first embodiment, for the purpose of closing the entrance opening 2 of a building by the shutter curtain 5 of the panel shutter 1, the operator presses the shut button for controlling the motor 13.

As a result, the motor 13 operates in the reverse direction (closing direction) so that torque is transmitted from the motor 13 to the guide sprockets 12 through the output sprocket 14, first transmission chain 15, first intermediate sprocket 16, second intermediate sprocket 17, second transmission chain 18 and the final stage sprocket 19. As the guide sprocket 12 rotates,

the lowermost panel 7 is suspended and moved downward along the lower guide rails 3. Meanwhile, the panels 6,6 which are held on the accommodation rails 21 within the shutter case 4 in a vertical position and in side-by-side fashion with the chains 11 slack are pulled one by one as the chain sections are successively tensed so as to be moved laterally along the accommodation rails 21. Then, as the roller shafts 9 reach a position immediately above the guide sprockets 12, the panels are moved downward along the circumference of the roller shaft 9, so that the running rollers 8 are transferred into the upper guide rails 3'. At the same time, the engaging lugs on lower portions of both ends of the panel 6 engage with the descending slopes 29b of the guide plates 29 so as to introduce the lower portion of the panel 6 into the upper end of the lower guide rails 3 disposed in a lower portion of the shutter case 4. Thus, the succeeding panels 6 are introduced from the accommodation rails 21 into the upper ends of the lower guide rails 3 past the upper guide rails 3 and are moved downward along the lower guide rails 3 so as to be disposed in a vertical plane thereby closing the opening 2. When the opening 2 is completely closed, the lower limit switch (not shown) connected to the electric motor 13 is operated so as to stop any further movement of the shutter curtain 5.

During this closing operation, the panels 6 which are held on the accommodation rails 21 in a vertical position and in side-by-side fashion are successively extracted laterally each time the successive chain sections are tensed, and are then guided by the guide sprockets 12 so as to start to move in the vertical direction. When the direction of movement is changed, the panel 6 is swung back and forth about the roller shaft 9. When the amplitude of this swinging movement is large, the running rollers 8 moving downward reach the upper guide rails 3' before the engaging lugs 22 on the lower portions of both ends of the panel 6 reaches the descending slope 29b of the guide plate 29. In consequence, the lower portion of the panel 6 may fail to be introduced into the lower guide rails 3 beneath the shutter case 4. In such a case, the engaging lugs 22 on the lower portions of both ends of the panel 6 engage with the ascending slopes 29a of the guide plates 29 and then move down along the ascending slopes 29a of the guide plates 29, in accordance with the movement of the running rollers 8. As a result, the panel 6 is declined forwardly as indicated by the dashed line in Fig. 3, so that the roller shaft 9 pushes the side portion 3'c of the upper guide rail 3' in the opening direction so as to activate the safety switch 28, thereby stopping the

downward movement of the shutter curtain without delay, whereby breakage of the panel 6 is avoided.

For opening the shutter curtain 5 which is closing the opening 2 of the building, the operator pushes an open button connected to the electric motor 13. As this button is pressed, the motor 13 is rotated in the opening direction (forward direction) so that the shutter curtain 5 is raised. The uppermost panel 6 and then the following panels are moved upward while being guided along the lower guide rails 3 and the upper guide rails 3'. When the successive panels 6,6 reach the tops of the guide sprockets 12, the panels which have been moved vertically start to move horizontally, with their running rollers 8 rolling from the upper guide rails 3' into the accommodation rails 21, so that the panels 6,6 are successively stored on the accommodation rails 21 in a vertical position and in a side-by-side fashion. When the bottom surface of the lowermost panel 7 has reached a predetermined stop position A shown in Fig. 3, i.e., to the same level as the bottom surface of the lintel 32, so as to fully open the opening 2, an upper limit switch (not shown) of the electric motor 13 is operated to stop further operation of the shutter curtain 5.

In the event that the upper limit switch fails to operate during the opening operation explained above, the _____

lowermost panel 7 reaches a position B shown in Fig. 3 beyond the stop position A. In such a case, since the large-diameter portion 23 of the stopper roller shaft 25 of the lowermost panel 7 cannot move through the guide passages 3'a in the upper guide rails 3', the side portions 3'c of the upper guide rails are moved in the opening direction so as to activate the safety switch 28, whereby the upward movement of the lowermost panel 7 is stopped without delay.

It is not always necessary that the combination of the safety switch 28 and the pivoted side portion 3'c of the upper guide rail is provided in each side of the shutter case 4. Namely, the combination may be provided only in one side of the shutter case 4. This means that the large-diameter shaft 23 on the lowermost panel 7 may be provided on only one end of the panel 7 adjacent to the upper guide rail 3' which is provided with the movable pivoted side portion.

The operation of the second embodiment will be described hereinunder. In this embodiment, the shutter curtain 5 is constituted by a plurality of panels connected to chains 11. The distance between a selected pair of panels 6a, 6b adjacent to each other is determined to be not smaller than a distance which enables the panel 6 to stop its downward movement before

the other panel 6a commenced its downward movement past the guide sprocket 12. According to this arrangement, the chains 11 suspended from the guide sprockets 12 are not required to bear the whole weight of the shutter curtain, so that accidental cutting of the chains 11 is prevented. This means that a large-sized panel shutter capable of opening and closing a large-sized opening of a large building can be realized without enhancing the strengths of the chains 11 and the guide sprockets 12 to levels capable of bearing the whole weight of the shutter curtain 5.

The operation of the third embodiment will be now described. In this embodiment, each of the panels 6,6 constituting the shutter curtain 5 is composed of a front panel member 6' and a rear panel member 6". The upper end of the front panel member 6' is bent horizontally so as to provide an engaging tab 30, while the rear panel member 6" is provided with an engaged tab 31 symmetrical with the engaging tab 30. Therefore, even when one of the chains 11 is cut accidentally during the opening or closing operation, the engaging tab 30 of the lower panel 6 rests on the engaged tab 31 of the upper panel 6, so that the risk of the lower panel hanging from one end thereof is avoided without fail. In addition, the

repair work for connecting the broken sections of the chain 11 can be facilitated.

As will be understood from the foregoing description, the present invention offers the following advantages.

(1) A single safety switch 28 can play a double role: namely, a role for stopping the shutter closing operation without delay whenever the downward movement of a panel is impeded because of failure in the transfer to the upper guide rails 3' due to inertia which is produced as a result of change in the direction of movement from lateral direction to vertical direction due to reversing of the guide sprockets 12 during closing operation; and a role for stopping the opening operation without delay whenever the lowermost panel 7 has been moved beyond a predetermined position due to a failure in the upper limit switch during its upward movement along the guide rails 3 as a result of forward rotation of the guide sprockets 12 during the opening operation of the shutter curtain 5, thus protecting the panels 6 and the lowermost panel 7 against breakage. Since these protecting functions are performed by a single safety switch 28, the construction is very much facilitated and the production cost is remarkably reduced. In addition, since the safety switch 28 is activated by members which are not

visible from the outside, the appearance of the shutter curtain 5 is never impaired, so that the commercial value of the shutter curtain is very much improved.

(2) The chains 11 suspended from the guide sprockets need not bear the whole weight of the shutter curtain 5 during opening and closing operations, so that breakage of the chains 11 is advantageously avoided. This in turn eliminates any necessity for the strengths of the chains 11 and the guide sprockets 12 to be increased, and also the necessity for increasing the capacity of the electric motor 13 for driving the guide sprockets 12. In consequence, the installation cost and the power cost are remarkably decreased, thus realizing a large-sized shutter capable of closing a large-sized opening of a large building.

(3) In the event that one of the chains 11 suspending the panels 6,6 of the shutter curtain 5 is accidentally cut during the opening or closing operation, the lower panel 6 is securely held by the upper panel 6, thus preventing any tendency for the lower panel to hang from its one end, as well as any breakage of the parts, thereby ensuring safety. In addition, the repair work can be conducted without difficulty because there is no need for the heavy panels 6 to be raised to enable the severed sections of the chain to be connected.

Industrial Applicability

The safety device of the invention for panel shutters can be used in panel shutters installed on openings of various types of buildings such as factories, storehouses, ordinary houses, shops and so forth. In general, panel shutters which do not produce unpleasant noise are suitable for use in underground shops in which resonance of the sound tends to take place, as well as in shops in residential areas where noises are preferably eliminated. The safety device of the present invention can be effectively utilized in panel shutters installed in such shops, in order to ensure the safety during opening and closing operation of the shutters.



CLAIMS:-

1. A panel shutter having a plurality of panels each having roller shafts provided on upper portions of both ends thereof, said panels having their roller shafts connected in series to chains so as to form a shutter curtain, said shutter curtain being suspended from guide sprockets disposed in left and right end portions of a shutter case, the shutter case being located above substantially vertical guide rails disposed at the left and the right sides of an opening and along which the shutter curtain is arranged to be movable, the shutter curtain also being movable along accommodation rails extending rearwardly along inner surfaces of the left and right side walls of said shutter case, whereby forward and backward rotation of said guide sprockets causes said shutter curtain to move progressively from said guide rails onto said accommodations rails and vice versa for opening and closing said opening, a safety device comprising a movable guide rail side portion within said shutter case, and a safety switch disposed in the vicinity of said movable side portion to be actuated by said movable side portion when said movable portion is moved in such a manner as to widen a guide passage formed in the guide rail.

2. A panel shutter according to claim 1, wherein a movable guide rail side portion and associated safety switch are arranged on each side of the shutter case.



3. A panel shutter according to claim 1, wherein the lowermost panel of the shutter is provided with a stopper roller shaft on a lower portion of at least one end thereof, the stopper roller shaft having a diameter greater than the diameter of the roller shafts of the other panels.

4. A panel shutter according to claim 3, wherein the width of the guide passage formed in the guide rails within the shutter case is smaller than the width of the guide passage formed in the guide rails under the shutter case, the width being determined such that the guide passage within the shutter case permits the roller shafts of the panels to pass therethrough but prevents the large-diameter shaft portions of the stopper roller shafts from passing therethrough, whereby, when the lowermost panel is moved into the guide rails within the shutter case the large-diameter shaft portions of the stopper roller shafts move the movable side portions of the guide rails thereby actuating the safety switch.

5. A panel shutter according to claims 1, 2, 3 or 4, wherein the movable guide rail side portion within the shutter case is hinged to allow the width of the associated guide passage to be increased, and spring means presses against the movable side portion for maintaining a predetermined width of said guide passage.

6. A panel shutter according to claim 1 or 2, wherein each panel of the shutter curtain, except the lowermost panel, is provided with engaging lugs at both ends of the lower portions thereof, and wherein guide plates are disposed within the shutter case beneath the guide sprockets, each guide plate having a



descending slope adapted to be engaged by the engaging lugs during closure of the shutter curtain whereby the lower portion of the panel is guided into the portion of the guide rail under the shutter case, and an ascending slope adapted to be engaged by said engaging lug, whereby when the panel is not introduced into the guide rail under the shutter case, the panel tilts forward thus enabling the roller shaft of the panel to move the movable guide rail side portion, thus activating the safety switch.

7.. A panel shutter according to claim 1 or 2, wherein the distance between a selected pair of adjacent panels amongst the panels constituting the shutter curtain is selected to be greater than a distance which enables one of the pair to stop its downward movement before the other of the pair commences its downward movement past the guide sprocket.

8. A panel shutter according to claim 1 or 2, wherein each of the panels of the shutter curtain is composed of a front panel member and a rear panel member, the panel members being adjoined to leave a predetermined gap therebetween, the front panel member being bent horizontally and inwardly at its upper end to provide an engaging tab, the rear panel member being provided at its lower end with an engaged tab symmetrical to the engaging tab, and the panels being arranged such that the engaged tab of an upper panel underlies the engaging tab of the lower adjacent panel.

9. A panel shutter substantially as herein described with reference to the accompanying drawings.
