United States Patent [19]

Johnson

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[54] **SAFETY SWITCHING FOR PASSENGER CONVEYOR**

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[73] Assignee: **Westmont Industries,** Santa Fe Springs, Calif.

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[52] **U.S. Cl.**..... **198/16 R;** 192/129 A; 198/232

[51] **Int. Cl.**[2]..... **B65B 9/12**

[58] **Field of Search**..... 198/232, 16 R, 110; 192/129 A, 130

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[57] **ABSTRACT**

A passenger conveyor apparatus includes a safety switching system for sensing the conveyor condition and stopping operation thereof upon occurrence of an unsafe condition, such as a foreign object entering between the moving conveyor and the landing plate assembly therefor. An emergency stop, jog-reverse switch then permits reverse conveyor movement until the unsafe condition is terminated, and the conveyor may only be restarted thereafter by a key-operated start switch.

14 Claims, 6 Drawing Figures

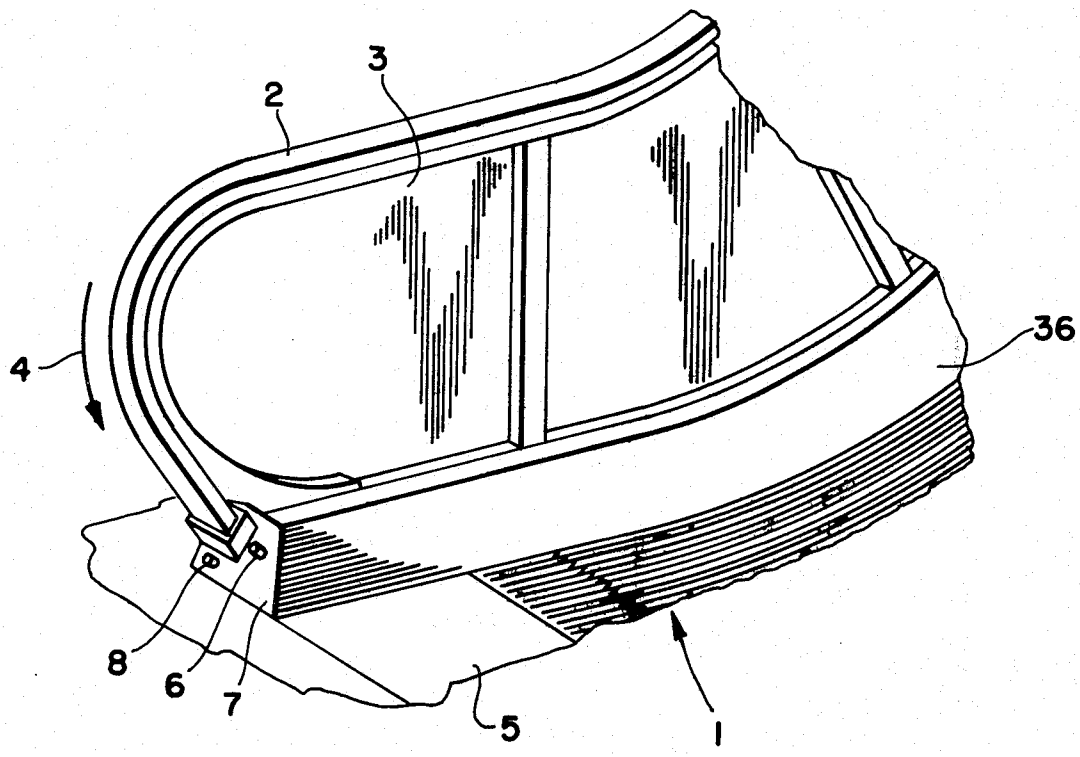
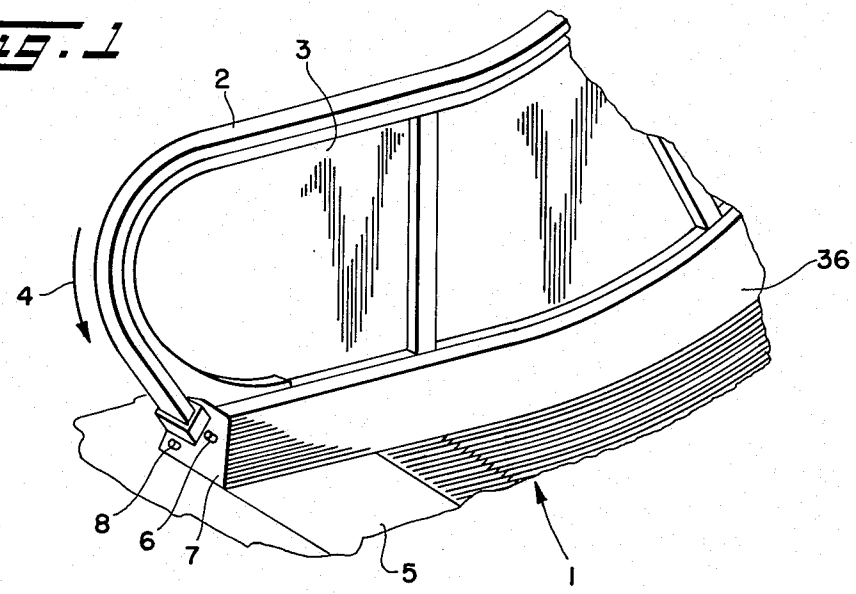


Fig. 1



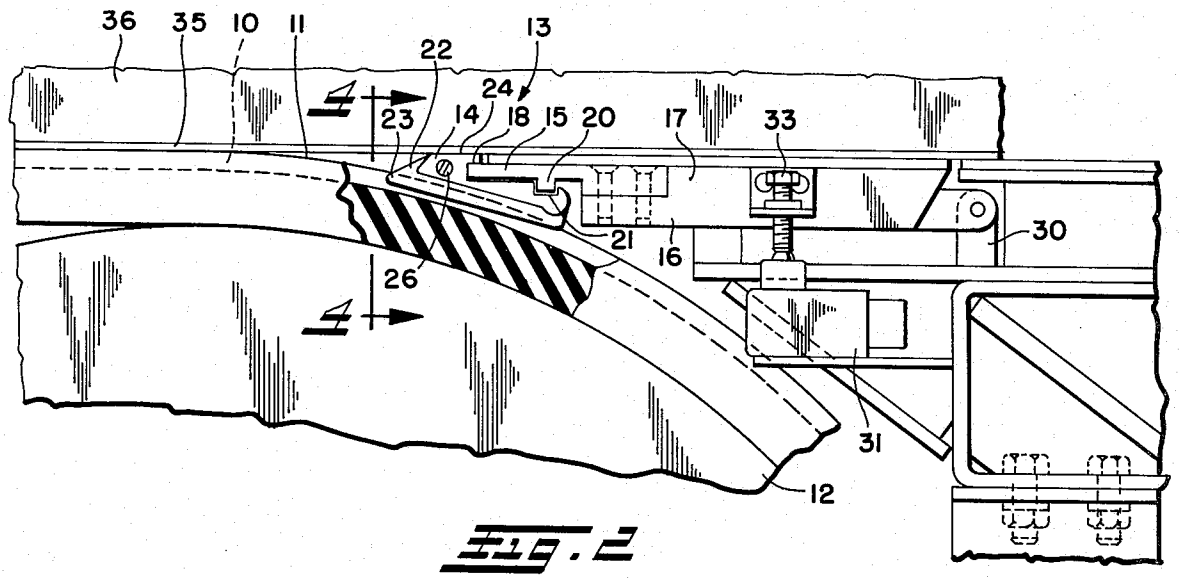


Fig. 2

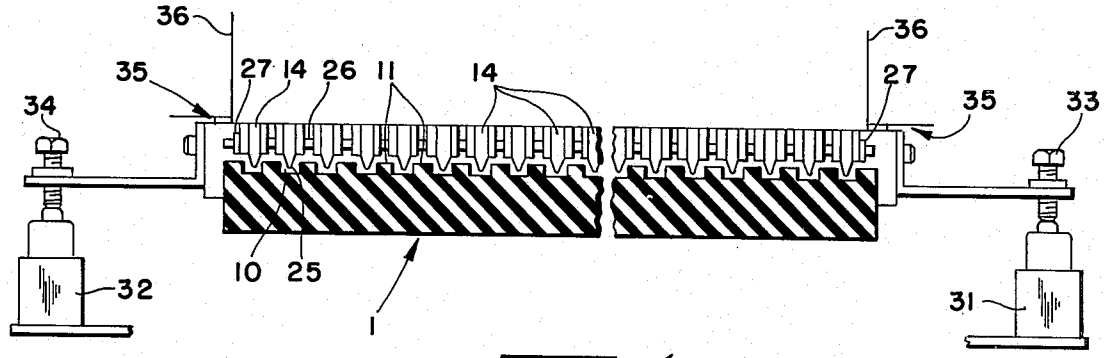


Fig. 4

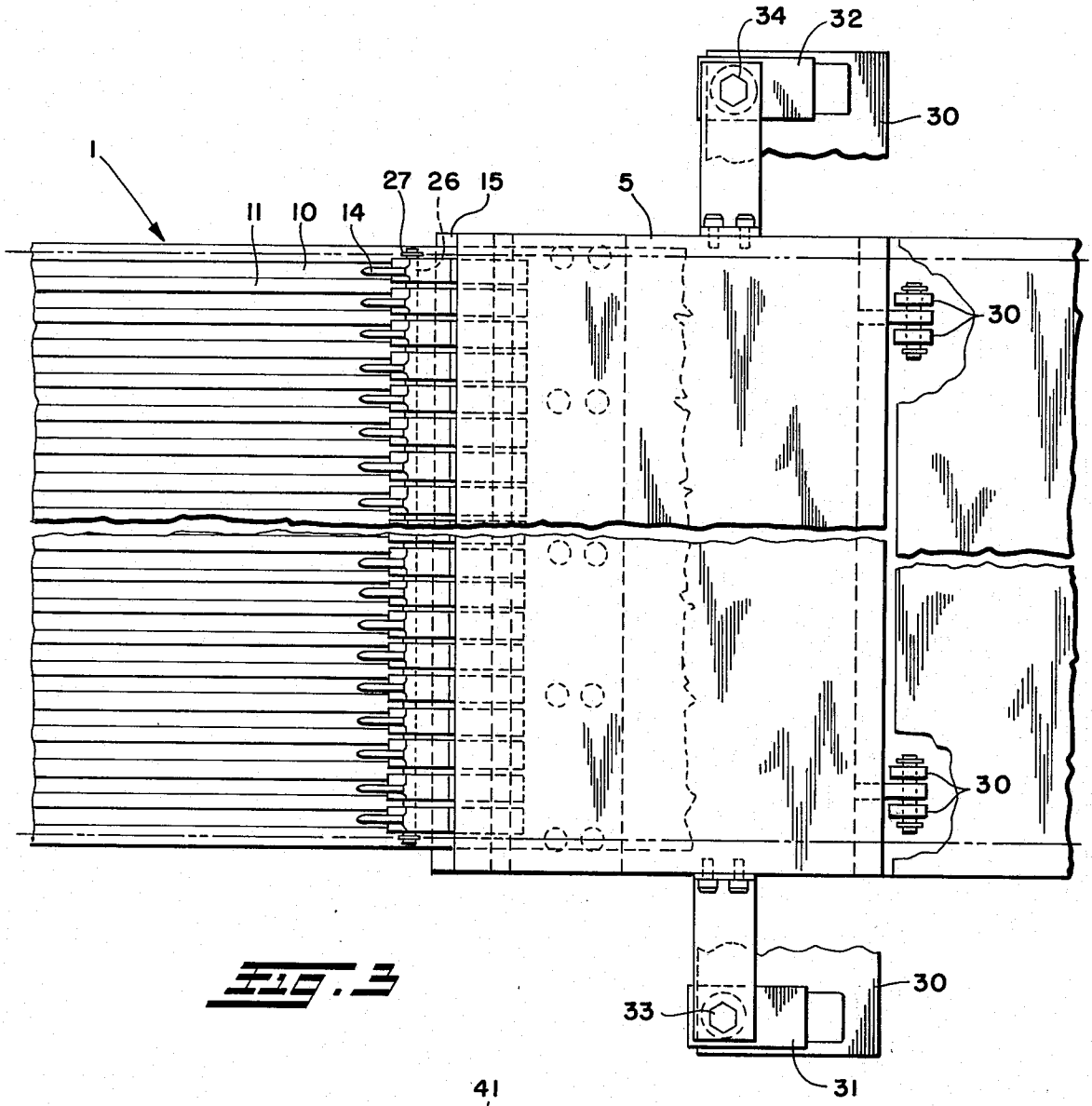

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Fig. 3

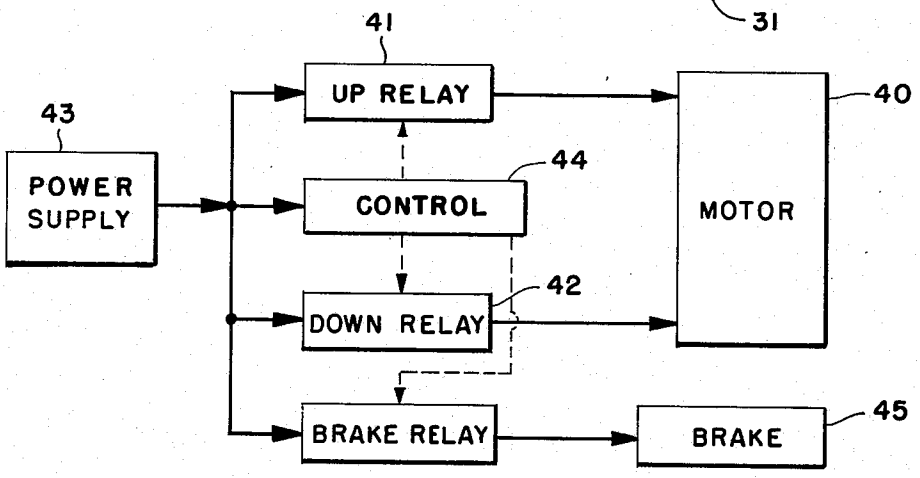

41
UP RELAY
40
43
POWER SUPPLY
44
CONTROL
MOTOR
42
DOWN RELAY
BRAKE RELAY
BRAKE
45

Fig. 5

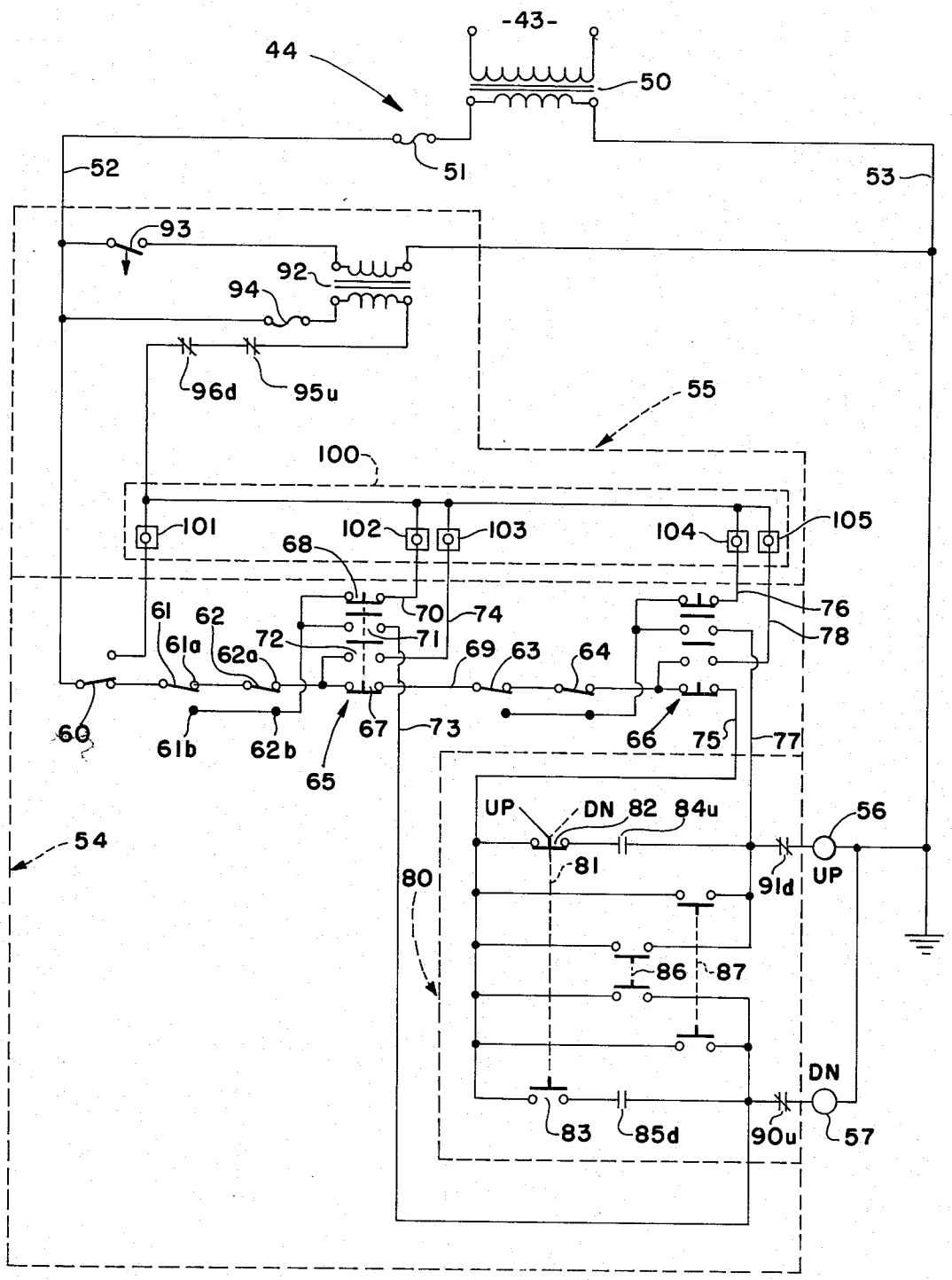

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85d
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Fig. 6

SAFETY SWITCHING FOR PASSENGER CONVEYOR

This invention relates to a safety switching system for controlling a passenger conveyor, and more particularly to such a switching system which provides both for emergency stopping of the conveyor when a foreign object enters between the landing plate and the conveyor, and permits reverse movement of the conveyor until the landing plate is clear of the foreign object.

In the past passenger conveyor systems for example, passenger conveyor walkways and escalators of either the endless belt or moving stairway type, have been subject to damage due to the wedging of foreign objects such as a piece of clothing between the conveyor and the landing plate assembly therefor. Although close tolerances are maintained between the conveyor and the landing plate, it has been found necessary to include safety sensing switches for stopping conveyor movement upon the determination of entry of a foreign object. A disadvantage of prior art safety switching systems using such safety switches is the inability to provide for immediate reverse conveyor movement without the assistance of maintenance person having a special key for activating a reverse conveyor movement switch; and when the wedged object is an article of clothing worn by a person, that person must remain in position until the maintenance person actuates the reverse switch to free the stranded rider. In some prior art passenger conveyor systems, emergency stop and reverse switches are provided for actuation without a key, but such switches are accessible to vandals and may be improperly used by untrained persons causing damage to the conveyor. Also, it is advisable to have a maintenance person inspect the conveyor after an emergency stop to assure that all foreign objects are removed prior to restarting the system in order to avoid damage to the equipment.

Accordingly, a primary object of the invention is to provide a safety switching system for a passenger conveyor and the like.

Another object of the invention is to provide a safety switching system for stopping a passenger conveyor and the like upon occurrence of an unsafe condition such as the lifting of the landing plate.

An additional object of the invention is to provide a safety switching system that stops movement of the passenger conveyor and the like upon occurrence of an unsafe condition and permits reverse operation of the conveyor until the unsafe condition is terminated.

A further object of the invention is to provide a safety switching system for stopping and reversing movement of a passenger conveyor and the like upon occurrence of an unsafe condition and for preventing restart of the conveyor in the normal direction until the unsafe condition is terminated and a key-operated switch or the like is actuated.

Still another object of the invention is to provide a safety switching system for sensing an unsafe condition, stopping and temporarily reversing direction of movement of a passenger conveyor and the like capable of movement in either direction.

Still an additional object of the invention is to provide a safety switching system for controlled operation of a passenger conveyor and the like in which a single emergency safety switch functions both as an emergency stopping switch and as a jog-reverse switch.

Still a further object of the invention is to provide a safety switching system that stops movement of a passenger conveyor and the like upon sensing an unsafe condition and provides both emergency stop and jog-reverse switching functions, whereby after the passenger conveyor has been stopped due to occurrence of an unsafe condition, such as the wedging of a foreign object between such conveyor and the landing plate therefor, actuation of the jog-reverse switch provides reverse movement of the conveyor until the unsafe condition is terminated at which time the conveyor is automatically stopped.

These and other objects are realized in the instant invention which comprises a sensing safety switch for determining the occurrence of an unsafe condition in a passenger conveyor, an emergency stop and jog-reverse switch for stopping conveyor movement at any time and for providing reverse conveyor movement upon occurrence of a sensed unsafe condition, such reverse movement continuing until the unsafe condition is terminated, and appropriate circuitry for facilitating adaptation of the safety switching system to passenger conveyors capable of operation in either direction.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described, the following description and the annexed drawings setting forth in detail a certain illustrative embodiment of the invention, this being indicative, however, of but one of the various ways in which the principles of the invention may be employed.

In the annexed drawing:

FIG. 1 is a fragmentary view in perspective of the lower end of a belt type passenger conveyor showing the balustrade with the handrail, conveyor, landing plate, and threshold comb;

FIG. 2 is a fragmentary schematic side elevational view of the upper end of the conveyor showing the threshold comb, landing plate and conveyor as well as the safety switch at one side of the landing plate;

FIG. 3 is a fragmentary top plan view of the threshold comb and conveyor of FIG. 2;

FIG. 4 is a section view taken along the plane of line 4—4 of FIG. 2 showing the safety switches on both sides of the landing plate and threshold comb structure;

FIG. 5 is a block diagram of the safety switching system of the invention; and

FIG. 6 is a schematic electric circuit diagram of the system shown in FIG. 5.

Referring now in more detail to the drawings wherein like reference numerals refer to like elements in the several figures, there is shown in FIG. 1 a conveyor system including a conventional moving conveyor portion 1 for passenger conveyance from one point to another. A moving handrail 2 is mounted on a balustrade 3 and travels in the direction shown by the arrow 4 in synchronism with the moving conveyor portion 1. A conventional landing plate 5 is located at the lower end of the conveyor run with a similar landing plate at the upper end thereof, such landing plates being positioned at close tolerance with respect to the conveyor portion 1 to provide a smooth transition from the moving to the stationary portions of the conveyor system. An emergency stop, jog-reverse switch 6 is located in a support casing 7 proximate the landing plate 5 and may be actuated to stop the conveyor portion 1 in case of any emergency as well as to provide for reverse conveyor movement when a foreign object has become wedged be-

tween the moving conveyor portion and the landing plate 5 as will become more apparent below. A key-operated start switch 8 also may be located in the casing 7 or in another convenient location for starting the conveyor system, actuation of such key-operated switch being required to start the conveyor for normal operation.

Referring now more specifically to FIGS. 2 and 4, the moving conveyor portion 1 of the conveyor system has a plurality of closely spaced longitudinal grooves 10 in the upper load supporting surface thereof separated by longitudinal ribs 11 integral with the conveyor portions. The conveyor belt of the moving conveyor portion 1 is of an endless nature and extends around terminal pulleys 12 at opposite ends of the conveyor system for travel between the terminal ends of the conveyor run. It should be understood, however, that the moving conveyor portion may be of any other suitable structure, such as moving stairway plates or a smooth conveyor load supporting surface, if desired.

The stationary landing plates 5 located adjacent each end of the moving conveyor portion 1 provide generally planar surfaces onto which passengers and other objects are discharged from the moving conveyor portion or from which the passengers and objects move onto the conveyor portion, depending upon the direction of the movement thereof. To assist in making a smooth transition from the moving conveyor portion 1 to the stationary landing plate 5 and vice versa, a threshold comb 13 is disposed between the moving conveyor portion and the landing plate and is carried by the forward end of the latter, although in the event that a smooth type conveyor is used, then the threshold comb arrangement may be eliminated.

The conveyor and threshold comb arrangement are shown and described in more detail in my U.S. Pat. No. 3,687,257, patented Aug. 29, 1972. The threshold comb includes a plurality of individual comb teeth 14 cooperating with the grooves 10 in the conveyor portion 1 and are supported on a slider bar 15 for limited lateral movement and self-centering of the teeth within the grooves. The slider bar 15 is securely fastened to a flange 16 on the undercarriage support 17 for landing plate 5 and extends a short distance beyond the forward end of the landing plate for receipt in a generally rearwardly opening groove 18 in each of the individual comb teeth 14. A downwardly depending rib 20 extends transversely across the width of the slider bar 15 for receipt in a second upwardly opening groove 21 in the teeth 14, the sliding connection between the slider bar and the teeth permitting free movement of the teeth laterally of the former when a downward load is applied.

Each of the comb teeth 14 has an inclined leading edge 22 with a rounded lower surface 23 extending forwardly of the main body thereof for directing objects upwardly to the top flat surface 24 generally co-planar with the landing plate 5. As best seen in FIG. 4, the leading edge 22 of each of the comb teeth 14 has a relatively narrow longitudinally extending rib portion 25 projecting downwardly from the main body portion of the tooth and having a width somewhat less than the width of the grooves 10 for receipt therein without contacting the sides thereof.

A constraining rod 26 for eliminating racking or binding of the slider bar 15 during any lateral movement of the comb teeth 14 extends through aligned openings in the latter and is maintained in position by snap rings 27. The vertical clearance between the leading edges 22 of the comb teeth 14 and the adjacent surfaces of the moving conveyor portion 1 should be sufficient to allow for some deflection of the comb teeth when a load is applied thereto without being forced into frictional engagement with the tops of the conveyor ribs and the bottoms of the grooves thereof. Preferbly, such vertical clearance is approximately one-thirty-second inch with a maximum deflection of the comb teeth 14 and associated support structure being no more than one-sixty-fourth inch when a six-hundred pound load is applied thereto.

During movement of the conveyor portion 1 toward the right as viewed at the lower end shown in FIG. 1 and the upper end shown in FIGS. 2 through 4, any objects carried on the top of the conveyor ribs 11 or within the conveyor grooves 10 will be effectively transferred from the moving conveyor portion to the flat surface of the comb teeth 14 or the landing plate 5 by the lifting action of the leading edges 22 of the comb teeth. In the event that a smooth conveyor portion is used, no comb teeth would be required, and the landing plate assembly or a structure immediately preceding the same would be located proximate the terminal portions of the conveyor run in close proximity to the moving conveyor portion using similar tolerances as noted above in order to provide a smooth transition from the moving to the stationary portions of the conveyor system and to remove foreign objects therefrom.

Although the likelihood of an object becoming lodged in the conveyor grooves 10 and caught between the comb teeth 14 and moving conveyor portion 1 is slight, nevertheless, in the event that such should occur, the undercarriage support 17 for the landing plate 5 and slider bar 15 is pivotally connected to a fixed support 30 at each side of the landing plate 5 for effecting de-energization of the conveyor system by stopping the movement of the conveyor portion to prevent damage to the object and conveyor system, as will be described in more detail below. Although the switching system would be operative using a single limit switch, preferably two limit switches 31, 32 are used for added safety in the event that only one side of the landing plate assembly is lifted. The extent of travel of the comb teeth 14 to actuate one of the limit switches 31, 32 may be controlled by adjustment of respective screws 33, 34 on the undercarriage support 17 which engage the limit switches. Preferably, a one-sixteenth inch vertical movement of the comb teeth 14 is sufficient to trip the limit switches 31, 32 to stop the conveyor movement for safety purposes, and the total permissible vertical movement of the comb teeth is desirably limited to approximately one-quarter inch by the clearance space 35 between the edges of the landing plate 5 and the trim plates 36 at the sides of the conveyor to guard against large objects being pulled into the space between the conveyor portion 1 and the comb teeth.

For convenience of description the moving conveyor portion 1 will be referred to hereinafter as having upper and lower ends at which passengers exit and enter the same, such ends representing the extremes of an escalator or moving walkway which is normally driven by one or more drive motors 40 schematically shown in FIG. 5. The drive motors 40 are controlled by respective up and down relay systems 41, 42 providing power from a power supply 43 for energizating the motor to move

the conveyor in the proper direction. A control circuit 44 includes controls for actuating the respective up and down relay systems as well as for providing for actuation of a brake relay and associated brake apparatus 45, for example, an inductive brake for the motor, for rapidly stopping the latter. The up and down relay systems 41, 42 determine drive motor and conveyor direction, for example, up and down in the case of an inclined moving walkway or left or right in the case of a horizontal moving walkway.

Referring now more specifically to FIG. 6, the control circuit 44 is shown receiving power from the power supply 43 through a transformer 50. The secondary winding of the transformer 50 is coupled on one side through a fuse 51 to the power line 52 of the control circuit and at the other side to a ground line 53 with a control switching portion 54 and an annunciator portion 55 being coupled across the two lines. A plurality of switches in the control switching portion 54 provide for energization of respective up and down relays 41, 42 that control the drive motor 40 in the proper direction, and the annunciator portion 55 provides an indication of conveyor system operation.

The control switching portion 54 of the control circuit 44 includes a drive belt tension sensing switch 60 responsive to drive belt tension and opening a circuit to the up and down relays 41, 42 when an abnormal belt condition exists. A plurality of safety switches 61 through 64, corresponding, for example, to the limit switches 31, 32, are positioned with the first two switches 61, 62 at the left and right sides of the upper landing plate and the latter two switches 63, 64 at the left and right sides of the lower landing plate. The emergency stop, jog-reverse switches 65, 66, corresponding to the emergency stop switch 6, may be located as shown, for example, in FIG. 1 at the respective upper and lower ends of the conveyor system.

The safety swtiches 61, 62 are normally in the positions shown with the switch blades thereof contacting the fixed contacts 61*a*, 62*a*, and in the event that the upper landing plate assembly is raised, one or both of the respective switch blades are moved to the contacts 61*b*, 62*b*. The upper emergency stop, jog-reverse switch 65 is a multiple contact switch, which may be spring biased, having a first pair of normally closed contacts 67, 68 that complete a circuit on the line 69 providing power to the up and down relays 41, 42 and on the line 70 to the annunciator portion 55. A second pair of normally open contacts 71, 72 of the upper emergency stop, jog-reverse switch 65 may be actuated to close a circuit to the line 73 for providing reverse drive motor energization in the appropriate circumstance, as will become more apparent below, and a circuit on the line 74 to the annunciator portion 55. The safety switches 63, 64 and the lower emergency stop, jog-reverse switch 66 are similar to the above-described switches 61, 62, 65 and provide corresponding circuits on the lines 75 through 78.

A direction control and starting portion 80 of the control switching portion 54 includes a direction control switch 81 having a first contact 82 for providing a circuit to the up relay 41 and a second contact 83 for providing a circuit to the down relay 42.

Each of the key-operated start switches 86, 87 is spring biased to a neutral position and may be actuated in known manner to provide a bypass of, for example, the normally open contacts 84u to energize the up relay 41, such energization effecting closure of the contacts 84u to provide a closed circuit to the up relay to maintain conveyor energization and movement when the key-operated switch is returned to its neutral position. Normally closed lockout contacts 90*u*, 91*d*, assure that when one of the up and down relays 41, 42 is energized, the other is incapable of energization. While the control circuit 44 may comprise the plural relays and contacts described above, it is, of course, contemplated that equivalent solid state switching arrangements may be easily substituted therefor.

The annunciator portion 55 is energized by a transformer 92 having a primary coupled across the line 52, 53 with a switch 93 in series with the transformer primary. The switch 93 may be operated, for example, by a time delay relay responsive to power off condition of the up and down relays 41, 42, for example, to energize the annunciator power circuit upon occurrence of such power off condition and to open such circuit shortly thereafter to avoid false annunciator signals and possible damage to the annunciator. The secondary of the transformer 92 is coupled through a fuse 94 to the power line 52 and through normally closed contacts 95*u*, 96*d* to a conventional flagdrop annunciator terminal box 100, which has a plurality of annunciator flags 101 through 105 for indicating conveyor operation and control circuit connections. Thus, the annunciator flag 101, when energized by the drive belt tension sensing switch 60, indicates an abnormality in the drive belt. Energization of the flag 102 indicates that the upper landing plate assembly has been raised above a preset limit. Energization of flag 103 indicates that the upper emergency stop button 65 has been pressed. Actuation of the flags 104, 105 is similar to actuation of the former pair but are referenced to the lower landing plate assembly and emergency stop, jog-reverse switch 66.

In normal operation of the conveyor system, assuming each of the switches 60 through 66 is set as shown in FIG. 6 and the direction control switch 81 is set, for example, in the up direction such that the contacts 82 are closed and the contacts 83 are open, an actuation of one of the upper or lower key-operated switches 86, 87 closes a circuit to the up relay 41. Energization of the relay 41 effects closure of its contacts to effect proper drive motor 40 energization for driving the conveyor portion 1 in the up direction. Energization of the up relay 41 also effects closure of the normally open contacts 84*u*, so that when the key-operated switch is released to its neutral position, the drive motor 40 continues to be energized and the conveyor portion 1 continues to move. Also, normally closed contacts 90*u* are opened to assure that the down relay 42 cannot be energized, and the normally closed contacts 95*u* are opened to assure no energization of the annunciator portion 55.

As the conveyor portion 1 moves in the upward direction, the comb teeth 14 tend to deflect any foreign object caught in the groove 10 or riding on the rib 11 of the conveyor belt removing such object from the moving part of the conveyor system. If a foreign object should begin to pass beneath one or more of the comb teeth 14 a lifting effect causes the comb teeth, slider bar 15, support surface 17, and landing plate 5 of the landing plate assembly to move upward opening the limit switch 31 corresponding, for example, to the safety switch 61 and/or 62 shown in FIG. 6, which opens the circuit to the up relay 41 de-energizing the

same and the drive motor **40** stopping conveyor movement. At this time the contacts **90***u* and **95***u* are again closed, the latter contacts providing power to the annunciator **55** and the flag **102** is dropped.

A reverse movement of the conveyor portion **1** will normally clear the foreign object, whether a small article or a piece of clothing, from beneath the comb teeth **14.** Such reverse movement may be effected by actuation of the emergency stop, jog-reverse switch **65** opening contacts **67, 68** and closing contacts **71, 72** to effect energization of the down relay **42** by a circuit formed from the line **52,** through the switches **60, 61, 62,** contacts **71** of the emergency switch **65,** line **73,** and contacts **90***u* to energize the down relay **42.** As long as the emergency switch **65** is actuated and the switch blade of the safety switch **62** is in connection with the contact **62***b* thereof, the conveyor portion **1** will move in the reverse direction, and when the landing plate **5** is cleared of all foreign objects and drops back into the position shown in FIGS. **2** and **4,** the safety switch **62** reverts to its contact **62***a* opening the down relay **42** energization circuit.

The conveyor system cannot again be restarted until the emergency switch **65** is released and one of the key-operated switches **86, 87** is actuated in the proper direction to energize the appropriate up or down relay **41, 42** as described above. Of course, when the conveyor portion **1** is moving in the down direction, one or both of the safety switches **63, 64** will be opened as described above with reference to safety switch **62** when a foreign object begins to pass beneath lower landing plate assembly, and actuation of the lower emergency switch **66** will effect temporary energization of the up relay **41** until the lower landing plate is cleared.

Thus, the provision of the emergency stop, jog-reverse switches **65, 66** at the terminal portions of the conveyor system permits any one person who has become stranded on the conveyor by having an article of clothing caught under one or more of the comb teeth **14** to be extricated therefrom by any person actuating the appropriate emergency switch **65, 66.** Since continued reverse conveyor movement is undesirable for well known reasons, the conveyor system automatically stops after the foreign object is cleared from beneath the comb teeth and cannot be restarted until a maintenance person with the appropriate key actuates one of the key-operated start switches **86, 87,** affording the maintenance person an opportunity to determine that the conveyor system is safe for continued operation prior to starting the same.

While certain representative embodiments and details have been shown for the purpose of illustrating the invention, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit or scope of the invention.

I, therefore, particularly point out and claim as my invention:

1. A safety switching system for passenger conveyors and the like, comprising means responsive to the condition of a conveyor for stopping the same upon occurrence of an unsafe condition, said means responsive comprising switch means for normally establishing a first circuit for conveyor energization to effect movement thereof in a first direction and for establishing upon occurrence of such unsafe condition a second circuit for conveyor energization to effect movement thereof in a reverse direction, and selectively operable means coupled to said means responsive for restarting said conveyor in reverse direction after said means responsive has sensed occurrence of such unsafe condition.

2. A safety switching system for passenger conveyors and the like as set forth in claim **1,** wherein said switch means comprises plural switch means positioned proximate respective ends of said conveyor.

3. A safety switching system for passenger conveyors and the like as set forth in claim **1,** wherein said conveyor comprises a moving part and a normally relatively stationary part, and said switch means being positioned proximate said stationary part and being responsive to a foreign object entering between said stationary part and said moving part.

4. A safety switching system for passenger conveyors and the like as set forth in claim **3,** wherein said moving part comprises a moving conveyor portion, and said stationary part comprises respective landing plate assemblies positioned at opposite ends of said conveyor portion, said switch means comprising first and second switch means positioned on opposite sides of a first one of said landing plate assemblies and third and fourth switch means positioned on opposite sides of the other one of said landing plate assemblies, said switch means being responsive to a lifting of said respective landing plate assemblies for stopping conveyor movement upon sensing such lifting.

5. A safety switching system for passenger conveyors and the like as set forth in claim **4,** wherein said means coupled comprises emergency switch means for controlling conveyor energization and movement thereof, said emergency switch means being connected for interrupting conveyor movement upon actuation during normal operation of said conveyor.

6. A safety switching system for passenger conveyors and the like as set forth in claim **1,** wherein said means coupled comprises emergency switch means for controlling conveyor energization, said emergency switch means being connected for interrupting conveyor movement upon actuation during normal operation of said conveyor.

7. A safety switching system for passenger conveyors and the like as set forth in claim **6,** further comprising key-operated switch means coupled to both said means responsive and said means coupled for effecting starting of said conveyor in said first direction.

8. A safety switching system for passenger conveyors and the like as set forth in claim **7,** further comprising annunciator means coupled to said emergency switch means for indicating operative condition of said conveyor.

9. A safety switching system for passenger conveyors and the like as set forth in claim **1,** wherein said means responsive stops reverse conveyor movement upon sensing termination of such unsafe condition.

10. A safety switching system for passenger conveyors and the like comprising means responsive to the condition of a conveyor for stopping the same upon occurrence of an unsafe condition, said means responsive comprising switch means for normally establishing a first circuit for conveyor energization to effect movement thereof in a first direction and for establishing upon occurrence of such unsafe condition a second circuit for conveyor energization to effect movement thereof in a reverse direction, means coupled to said

means responsive for restarting said conveyor in reverse direction after said means responsive has sensed occurrence of such unsafe condition, said means coupled comprising emergency switch means for controlling conveyor energization, said emergency switch means being connected for interrupting conveyor movement upon actuation during normal operation of said conveyor, and further comprising first and second relay means for effecting energization of said conveyor respectively in said first and reverse directions, said relay means being coupled to said emergency switch means, whereby said emergency switch means normally provides one circuit for energizing said first relay to effect conveyor movement in said first direction and interrupting said one circuit upon actuation thereof to de-energize said first relay means stopping such normal conveyor movement, said emergency switch means providing upon actuation another circuit for energizing said second relay means to effect conveyor reverse movement when said means responsive has sensed the occurrence of such unsafe condition.

11. A safety switching system for passenger conveyors and the like as set forth in claim **10,** further comprising first and second pairs of normally closed contacts, each such pair being coupled in series with a respective one of said first and second relay means and controlled by the other one of such relay means, whereby upon energization of one of said relay means the other of said relay means is disabled from energization.

12. A safety switching system for passenger conveyors and the like as set forth in claim **10,** further comprising first and second normally open contact means respectively coupled in said one and another circuits in series with said first and second relay means and controlled thereby, first and second normally open start switch means respectively coupled across said first and second normally open contacts for providing upon actuation a short circuit across such contacts to effect energization of a respective one of said first and second relay means, whereby actuation of one of said start switch means effects energization of the respective ones of said first and second relay means which in turn closes its associated contacts to continue energization thereof upon release of said start switch means.

13. A safety switching system for passenger conveyors and the like as set forth in claim **12,** wherein said start switch means comprises key-operated switch means.

14. A safety switching system for passenger conveyors and the like as set forth in claim **13.** wherein said conveyor comprises a moving conveyor portion adaptable for movement in either of two directions and respective first and second landing plate assemblies positioned at the respective ends of the former, said switch means being positioned with respect to said first and second landing plate assemblies to detect the lifting thereof, and said emergency switch means comprises a plurality of the same, one located proximate each end of said moving conveyor portion.

* * * * *