

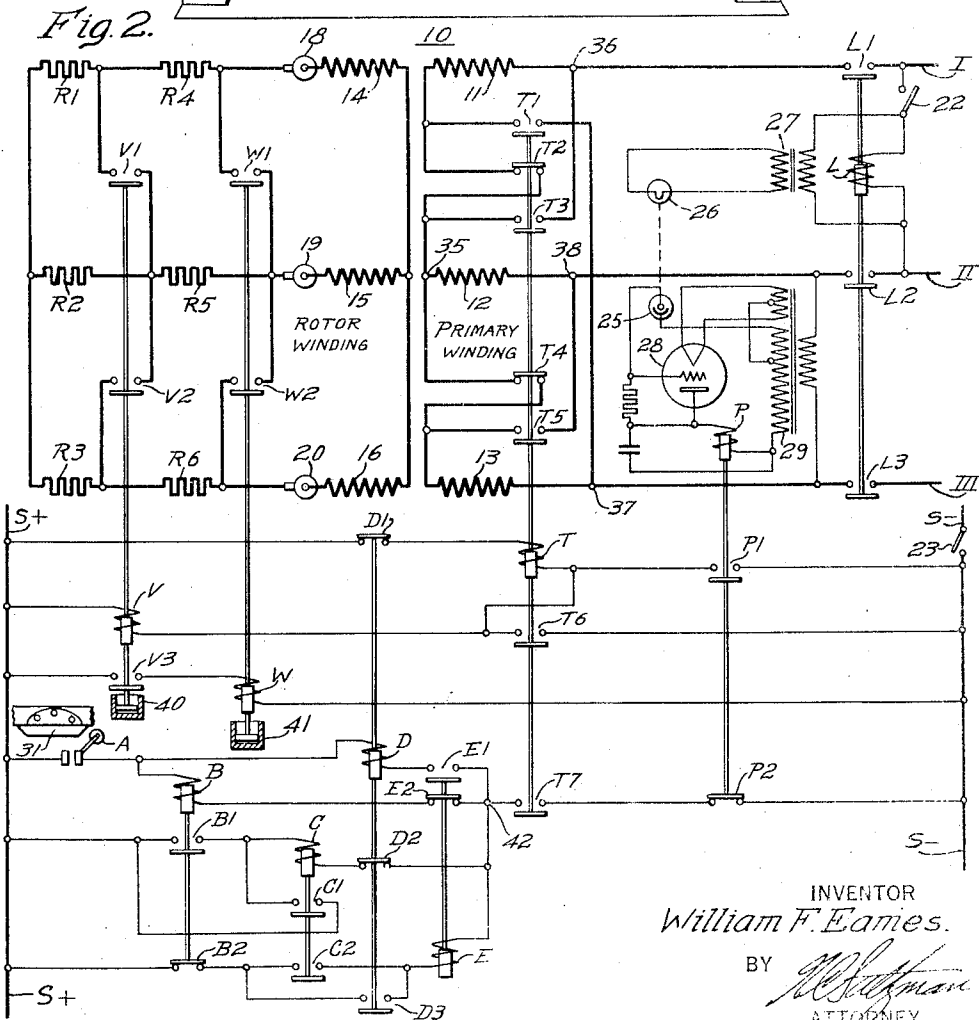
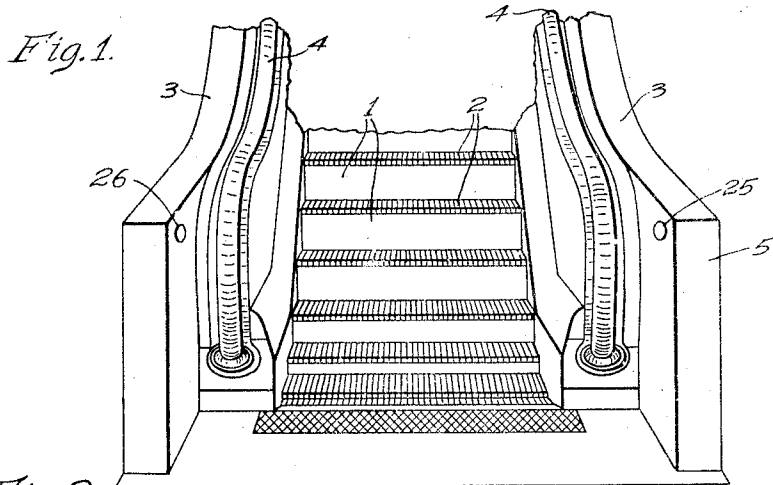
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MOVING STAIRWAY

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MOVING STAIRWAY

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My invention relates to moving stairways, and more particularly to the electric motor and control systems usually provided for operating such stairways.

In many moving stairway installations, the load varies considerably throughout the day by reason of the fact that there may be periods at various times when no passengers use the stairways. This is particularly true in railway stations and in such cases the stairways often remain idle for considerable periods between the arrival and departure of trains. If the stairways are stopped entirely, the passengers think they are out of service and, after giving them a glance, make use of the stationary stairways. However, if the stairways are moving, even though slowly, the passengers see they are in operation and proceed to ride on them.

Therefore, it is an object of my invention to provide a moving stairway which will automatically respond to the variations in the periods when the stairways are not needed and to the periods when they are needed for the most economical operation consistent with good service.

Another object is to provide for operating moving stairways in a manner which will cause less noise than is usually caused by their operation.

Another object is to provide a motor and control system for operating moving stairways which will cause the stairways to operate at low speed when passengers are not being carried and to operate at high speed when passengers are being carried.

It is also an object to reduce the speed of moving stairways when they are not carrying passengers so as to reduce the wear and tear on the stairway mechanism and to also provide a motor and control system which will cause the stairways to be operated at a slow speed and low power consumption when passengers are not being carried, but to operate at high speed and full effectiveness with a normal consumption of power when passengers are being carried.

Other objects of the invention will be apparent from the following description taken in conjunction with the accompanying drawing, in which:

Figure 1 is a view, in perspective, of the lower landing of a moving stairway; and,

Fig. 2 is a diagram of the motor and control system for operating the stairway shown in Fig. 1 in accordance with my invention.

Although my invention is illustrated as applied to a moving stairway, it is equally applicable to conveyors of many kinds and for many other purposes and it is to be understood that the stair-

way illustrated is selected merely as one kind of conveyor. It may also be applied to conveyors for carrying any object other than individual passengers.

Referring more particularly to the drawing, I have illustrated the stairway as comprising a plurality of moving steps 1, provided with suitable treads 2 and disposed for operation between a pair of side balustrades 3 upon each of which is disposed a traveling handrail 4.

In practicing my invention, any suitable motive means may be utilized for driving the stairway but I usually prefer to employ a motive means such as an alternating current wound rotor motor 10 having a plurality of primary windings 11, 12 and 13 and a plurality of rotor windings 14, 15 and 16. A plurality of resistors R1, R2, R3, R4, R5 and R6 are connected to the rotor windings by a plurality of slip rings 18, 19 and 20. A resistance relay V is provided for connecting and disconnecting the resistors R1, R2 and R3 in circuit with the rotor windings, and a second resistance relay W is provided for connecting and disconnecting the resistors R4, R5 and R6 in circuit with the rotor windings.

The primary windings 11, 12 and 13 are arranged to be connected by a transfer relay T in either a "star" arrangement for slow speed or in a "delta" arrangement for high speed.

The motor may be connected to a source of alternating current electric energy represented by the supply conductors I, II and III by means of a line switch L disposed to be energized and operated by a control switch 22.

A separate control circuit is provided for controlling the motor and may be connected by a switch 23 to a suitable source of direct current electric energy represented by the conductors S+ and S—.

In accordance with my invention I have placed at the entrance to the stairway a means responsive to the presence of an object or a person for controlling the stairway to operate at different speeds. This means is shown as a light-sensitive device 25 disposed at one side of the entrance to the stairway in position to be illuminated by a pilot lamp 26 disposed at the other side of the entrance. The light-sensitive device and its pilot lamp should be disposed at such a height that any person entering the entrance to the stairway will interrupt the light rays from the pilot lamp to the light-sensitive device and thereby operate the light-sensitive device. In the present case they are shown as mounted in the lower ends of the balustrades 3 in such posi-

tion that the light from the pilot lamp is directed across the entrance to the stairway and upon the light-sensitive device. The pilot lamp 26 may be operated in any suitable manner as by a transformer 27 connected with the supply conductors I and II through the switch 22. The light-sensitive device 25 may be provided with an amplifier 28, and both are connected with the supply conductors II and III. The amplifier 28 is shown as connected for operating a passenger impulse relay P which is disposed to complete a circuit for energizing the transfer relay T when a passenger approaches the stairway to change the connections of the windings of the motor in such manner that the motor will accelerate from its normal low speed to its normal high speed for the purpose of quickly carrying that passenger to an upper floor.

Also in accordance with my invention, I provide a novel means for causing the motor to decelerate from its normal high speed to a low speed when no passengers are using the stairway. This means comprises a slowdown switch A disposed for operation by a cam 31 and a plurality of counting or slowdown sequence relays B, C, D and E. The cam 31 may be attached to any portion of the stairway, such as the underside of one of the steps or to one of the step chains (not shown) in such manner that it will temporarily close the switch A when it is brought in engagement therewith once during each round trip or revolution of the stairway. The sequence relays B, C, D and E are so arranged that the first momentary closing of the switch A will effect energization of the relay B, and thereby prepare the decelerating circuits for operation. When the switch A is closed the second time by the stairway completing one revolution while it is operating at high speed, energization of the sequence relay D will be caused to effect deceleration or stopping of the stairway. It is to be understood that the deceleration may be carried to zero speed or the stopping point if desired.

The passenger operated impulse relay P also operates to reset the sequence relays B, C, D and E for another counting operation whenever a second passenger follows the first passenger past the light-sensitive device before the first passenger has been carried to the upper floor. This arrangement is provided so that the stairway will not stop when the second passenger has been carried only midway, but will insure the operation of the stairway at high speed for at least one complete revolution or more after the latest passenger enters it. Hence, the stairway will operate at high speed for a distance somewhere between one complete revolution and two complete revolutions each time a passenger passes the light-sensitive device 25.

It is believed that the following assumed operation of the apparatus and wiring diagram illustrated in the drawing will enable the invention to be understood better.

It will be assumed that the switches 22 and 23 are closed to place the stairway in operation. The closing of the switch 23 connects the control circuit to its source of electric energy. The closing of the switch 22 energizes the line switch L by a circuit leading from the supply conductor I through switch 22 and coil L to the supply conductor II. The energized switch L closes its contact members L1, L2 and L3, thereby energizing the motor 10 for low speed operation, which causes the stairway to run at what may be termed its "normal low speed". The rotor wind-

ings of the motor 10 are now so arranged that the resistors R1 and R4 are connected in series circuit through the slip ring 18 with the winding 14; resistors R2 and R5 are connected in series circuit through the slip ring 19 with the winding 15; and the resistors R3 and R6 are connected in series circuit through the slip ring 20 with the winding 16, because the resistance relays V and W have not been energized to close their contact members. The rotor windings are now connected in star arrangement with the resistors included in their circuit. At this stage of the operation, the primary windings are also connected in star connection and their circuit extends, one branch from the supply conductor I through contact members L1, winding 11 and contact members T2 to a junction point 35; another branch from supply conductor II through the contact members L2 and winding 12 to the junction point 35; and another branch from supply conductor III through the contact members L3, winding 13 and contact members T4 to the junction point 35.

With the primary winding and the rotor winding connected as described, the motor starts in operation and accelerates to what may be termed its "normal low speed". At this speed, the stairway is in operation and ready to receive passengers, although at this speed it will not carry them very quickly to their destination. The stairway and motor may be designed to operate at any desired normal low speed when it has no passengers and at any normal high speed when it has passengers. One satisfactory normal high speed for the motor would be approximately 500 revolutions per minute and the normal low speed might be set at 125 revolutions per minute. This is a matter of choice for the designing engineer. Ordinarily, it may be said that the normal low speed should be about one-fourth of the normal high speed. While the stairway is operating, the cam member 31 closes the slowdown switch temporarily once every revolution of the stairway, but the closing of the switch has no effect while the stairway is operating at low speed, because the transfer relay T is in a deenergized condition with its contact members T7 standing open. Hence when the switch A is closed by the cam while operating at low speed, the counting relays are not placed in operation.

It will be assumed now that an intending passenger, seeing the stairway in operation, approaches and enters the stairway entrance. In doing this, the passenger intercepts the light rays passing from the pilot lamp 26 to the light-sensitive device 25, and thereby operates the light-sensitive device so that current flows through it to the amplifier 28 which effects energization of the impulse relay P to cause the stairway to immediately accelerate to its normal high speed for the purpose of quickly carrying the passenger to the upper floor.

The energization of the relay P closes its contact members P1, thereby energizing the transfer relay T through a circuit extending from the supply conductor S+ through the contact members D1, coil T and contact members P1 to the supply circuit S-. The energized relay T closes its contact members T1, T3, T5, T6 and T7 and opens its contact members T2 and T4. The opening of the contact members T2 and T4 and the closing of the contact members T1, T3 and T5 changes the connection of the primary winding of the motor from star connection to delta connection. The delta connection extends from junction point 36 through winding 11, contact

members T1, junction point 37, winding 13, contact members T5, junction point 38, winding 12 and contact members T3 to junction point 36, and the supply conductors I, II and III are connected, respectively, to the corners of the windings represented by the junction points 36, 37 and 38. The change for star connection to delta connection increases the exciting current of the motor 10 to its normal value so that it will be able to develop power to its normal rated capacity.

The closing of the contact members T6 of relay T energizes the time delay resistance relay V to close its contact members V1, V2 and V3. This relay is provided with a dashpot 40 which delays its operation for approximately one-half second, and then the closing of the contact members V1 and V2 short circuits the resistors R1, R2 and R3 from the rotor windings 14, 15 and 16. The closing of the contact members V3 energizes the time delay resistance relay W to close its contact members W1 and W2. The relay W is also provided with a dashpot 41 which delays the operation of the relay for approximately one-half second. The closing of the contact members W1 and W2 short circuits the resistors R4, R5 and R6 and thereby excludes them from the circuit of the rotor windings 14, 15 and 16 so that the motor 10 will now operate at its normal high speed, and maintain that speed at an approximately constant value regardless of load and thereby cause the stairway to carry the passenger quickly to the upper floor.

As the stairway travels along its course, the cam 31 passes the switch A, thereby closing it momentarily and energizing the sequence relay B by a circuit extending from the supply conductor S+ through the contact members of switch A, coil B, the contact members E2, junction point 42, and contact members T7 and P2 to the supply conductor S-. The energization of the relay B prepares circuits for effecting deceleration of the stairway when there are no passengers for it. This is effected by the energized relay B closing its contact members B1 and opening its contact members B2. The closing of the contact members B1 energizes the sequence relay C by a circuit extending from the supply conductor S+ through the contact members B1, coil C, contact members D2, junction point 42 and contact members T7 and P2 to the supply conductor S-.

The energized relay C closes its contact members C1 to provide a self-holding circuit for itself after the temporary energization of the relay B. The energized relay C also closes its contact members C2 and, as soon as the cam 31 passes off switch A and thereby deenergizes relay B to reclose its contact members B2, the closing of the contact members C2 energizes the relay E by a circuit extending from the supply conductor S+ through the contact members B2 and C2, coil E, junction point 42 and contact members T7 and P2 to the supply conductor S-. The energized relay E opens its contact members E2 and closes its contact members E1 to prepare a circuit for energizing relay D to effect deceleration of the stairway when the stairway completes the revolution it is now making. The opening of the contact members E2 will prevent reenergization of relay B when switch A is again operated upon the completion of the revolution the stairway is now making.

It will be assumed now that the stairway completes one revolution since its cam 31 operated the switch A and that the cam 31 again tem-

porarily closes the switch A and thereby energizes the sequence relay D by a circuit extending from the supply conductor S+ through the switch A, coil D, contact members E1, T7 and P2 to the supply conductor S-. The energized relay D now effects deceleration of the stairway by opening its contact members D1 and D2 and closing its contact members D3. The opening of the contact members D1 deenergizes the transfer relay T, thereby causing it to open its contact members T1, T3, T5, T6 and T7 and close its contact members T2 and T4. The closing of the contact members T2 and T4 and the opening of the contact members T1, T3 and T5 change the primary windings from delta connection to star connection. The opening of the contact members T6 deenergizes the relay V to reinsert the resistors R1, R2 and R3 in the rotor windings. The opening of the contact members V3 deenergizes the relay W to open its contact members W1 and W2 and thereby reinsert the resistors R4, R5 and R6 in the rotor windings. The change in the primary windings and the inclusion of the resistance in the rotor windings conditions the motor 10 to again operate at a slow speed, thereby operating the stairway at slow speed and thus avoiding the wear and tear which would otherwise be occasioned by the stairway operating continuously at high speed.

The opening of the contact members T7 deenergizes the sequence relay D so that the sequence relays B, C, D and E are again reset for another counting operation.

It will also be noted that if a second passenger follows the first passenger closely and passes the light-sensitive device 25 before the stairway completes the revolution at high speed resulting from the entry of first passenger, the impulse relay P will be given a second temporary operation and will open its contact members P2, thereby deenergizing the sequence relays. With the sequence relays deenergized, the cam 31 upon striking the switch A at the end of the first revolution will energize the relay B instead of the relay D. Hence the stairway will make a second complete revolution, when the cam 31 will again open the switch A thereby deenergizing the relay D and consequently decelerating the motor to slow speed.

Although only four sequence relays have been shown to provide a sequence whereby the motor will be decelerated when the switch A is operated the second time while the stairway is running at high speed, it is to be understood that additional sequence relays can be added to cause the stairway to travel additional revolutions before it decelerates.

From the foregoing, it will be seen that I have provided a motor and control system for operating a moving stairway in such manner as will cause the stairway to slow down to a low speed when it is not needed for carrying passengers which will immediately cause it to accelerate to a high speed when it is provided with passengers. It will also be seen that the operation of the stairway at low speed when it is not needed for carrying passengers will not only save wear and tear on the stairway and cause less noise, but, by reason of the change in the connection of the windings of the motor, will also cause the motor to operate with a much lower current consumption than it would if operating continuously at high speed. From this, it will be apparent that the savings will include considerable savings in current as well as in wear and tear on the

machine and yet the stairway will always be in operation and immediately responsive to the approach of a passenger or passengers for giving the highest degree of service.

5 Although I have illustrated and described only one specific form of my invention, it is apparent that many changes therein and modifications thereof may be made without departing from the spirit and scope of the invention.

10 I claim as my invention:

1. In a conveyor system, a motor for operating the conveyor, means for connecting the motor to a source of electrical energy, means for controlling the motor to operate the conveyor at a low speed or at a high speed, means responsive to the pres-
15 ence of an object at the entrance of the conveyor for causing the controlling means to effect operation of the motor at said high speed, and means responsive to movement of the conveyor for more than a predetermined distance for causing said
20 controlling means to effect deceleration of the motor to said low speed.

2. In a conveyor system, a motive means for operating the conveyor, means for connecting the
25 motive means to a source of electrical energy, control means for the motive means, means responsive to the presence of an object at the entrance of the conveyor for operating the control means to effect acceleration of the motive means
30 to a predetermined speed, and means responsive to movement of the conveyor for at least a predetermined distance for operating the control means to effect deceleration of the motive means from said predetermined speed.

3. In a conveyor system, a motive means for operating the conveyor, means for connecting the
35 motive means to a source of electrical energy, control means for the motive means, means responsive to the presence of an object at the entrance of the conveyor for operating the control means to effect acceleration of the motive means to a
40 predetermined speed, a cam disposed on the conveyor, and means responsive to a predetermined movement of the cam by the conveyor for operating the control means to effect deceleration of the
45 motive means from said predetermined speed.

4. In a conveyor system, a motive means for operating the conveyor, means for connecting the
50 motive means to a source of electrical energy, control means for the motive means, means responsive to the presence of an object at the entrance of the conveyor for operating the control means to effect acceleration of the motive means
55 to a predetermined speed, a cam disposed on the conveyor, and a switch disposed in the control means and responsive to operation of the cam for causing the control means to effect deceleration of the motive means from said predetermined speed.

5. In a conveyor system, a motive means for operating the conveyor, means for connecting the
60 motive means to a source of electrical energy, control means for the motive means, a light sensitive device disposed at the entrance of the conveyor, means responsive to operation of the light
65 sensitive device for causing the control means to effect acceleration of the motive means to a predetermined speed, and means responsive to a predetermined movement of the conveyor for causing the control means to effect deceleration of the
70 motive means from said predetermined speed.

6. In a moving stairway, a motive means for operating the stairway, means for connecting the
75 motive means to a source of electric energy, control means for the motive means, a light sensi-

tive device disposed at the entrance of the stairway, means responsive to operation of the light sensitive device for causing the control means to effect acceleration of the motive means to a predetermined speed, and means responsive to a complete revolution of the stairway for causing the control means to effect deceleration of the motive means from said predetermined speed.

7. In a moving stairway, a motive means for operating the stairway, means for connecting the
10 motive means to a source of electric energy, control means for the motive means, a light sensitive device disposed at the entrance of the stairway, means responsive to operation of the light sensitive device for causing the control means to effect
15 acceleration of the motive means to a predetermined speed, and means responsive to more than a complete revolution of the stairway for causing the control means to effect deceleration of the motive means from said predetermined speed.

8. In a moving stairway, a motive means for operating the stairway, means for connecting the
20 motive means to a source of electric energy, control means for the motive means, a light sensitive device disposed at the entrance of the stairway, means responsive to operation of the light sensitive device for causing the control means to effect acceleration of the motive means to a predetermined speed, means responsive to a complete
25 revolution of the stairway for causing the control means to effect deceleration of the motive means from said predetermined speed, and means responsive to another operation of the light sensitive device before the stairway completes said
30 revolution for causing a second revolution of the stairway before deceleration of the motive means.

9. In a conveyor system, a motor for operating the conveyor, said motor having a primary winding and a rotor winding, a plurality of resistors
35 connected with the rotor winding, control means for connecting the primary winding in star connection or in delta connection and for connecting the resistors in the rotor winding for low speed and disconnecting them from the rotor winding
40 for high speed, means responsive to operation of the light sensitive device for causing the control means to change the primary winding from star connection to delta connection and for disconnecting the resistors from the rotor winding to
45 accelerate the motor from low speed to high speed, and means responsive to at least a predetermined operation of the conveyor for causing the control means to change the primary winding from delta connection to star connection and to re-insert the resistors in the rotor winding to cause the
50 motor to decelerate from said high speed to said low speed.

10. In a conveyor system, motive means for operating the conveyor, means for connecting the
55 motive means to a source of electrical energy, means for controlling the motive means to operate the conveyor at a low speed or at a high speed, means responsive to the presence of an object at the entrance of the conveyor for causing the controlling means to effect operation of the motive
60 means at said high speed, a switch, a switch-actuating device disposed for operation by the conveyor to effect operation of the switch once for each revolution of the conveyor, and means responsive to more than one operation of the switch
65 while the conveyor is operating at high speed for effecting deceleration of the motive means from its high speed.

11. In a conveyor system, motive means for operating the conveyor, means for connecting the
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motive means to a source of electrical energy, means for controlling the motive means to operate the conveyor at a low speed or at a high speed, means responsive to the presence of an object at the entrance of the conveyor for causing the controlling means to effect operation of the motive means at said high speed, a switch, a switch operating device disposed for operation by the conveyor to operate the switch once each revolution, a sequence device operable by an operation of the switch when the conveyor is running at high speed, and additional means operable by the sequence device and a subsequent operation of said switch for decelerating the motive means.

12. In a conveyor system, motive means for operating the conveyor, means for connecting the motive means to a source of electrical energy, means for controlling the motive means to operate the conveyor at a low speed or at a high speed, means responsive to the presence of an object at the entrance of the conveyor for causing the controlling means to effect operation of the motive means at said high speed, a switch, a switch-

actuating device disposed for operation by the conveyor to momentarily operate the switch once each revolution, a sequence relay disposed to be operated by the first operation of the switch when the conveyor operates at high speed, and an additional sequence relay responsive to operation of said first named relay and to subsequent operation of the switch while the conveyor is operating at said high speed for effecting deceleration of said motor from said high speed.

13. In a conveyor system, motive means for operating the conveyor, means for connecting the motive means to a source of electrical energy, means for controlling the motive means to operate the conveyor at a low speed or at a high speed, means for causing the controlling means to effect operation of the motive means at said high speed, and means responsive to movement of the conveyor for more than a predetermined distance for causing said controlling means to effect deceleration of the motor to said low speed.

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