United States Patent

[11] 3,621,970

[72] Inventors **Ernest D. Johnson Tallmadge; Kenneth D. Mitchell, Copley, both of Ohio**

[21] Appl. No. **865,723**
[22] Filed **Oct. 13, 1969**
[45] Patented **Nov. 23, 1971**

[73] Assignee **The Goodyear Tire & Rubber Company Akron, Ohio**

[54] **HANDRAIL DRIVE FOR PASSENGER CONVEYOR**
18 Claims, 10 Drawing Figs.

[52] **U.S. Cl.** **198/16,** 74/242.9
[51] **Int. Cl.** **B66b 9/12**
[50] **Field of Search** ..... 198/16, 17, 18, 208, 110; 74/242.9, 242.14 R

[56] **References Cited**

UNITED STATES PATENTS

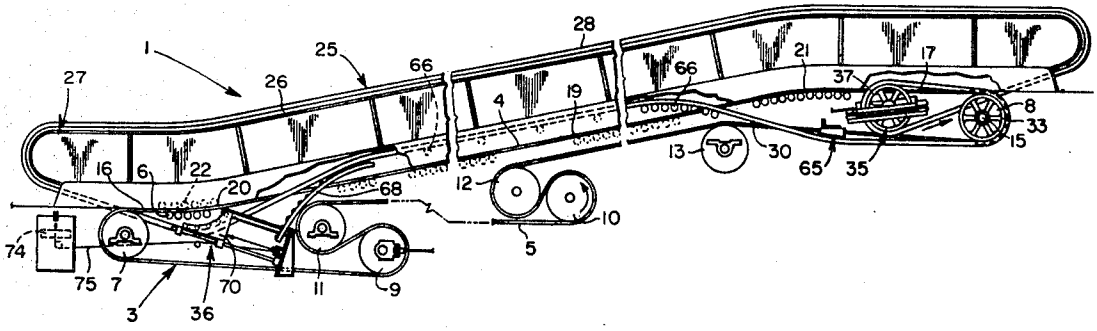
1,820,634	8/1931	Simmons et al.	198/16
976,115	11/1910	Bard	198/208 X
2,759,594	8/1956	Kleboe et al.	198/16 MS
2,929,483	3/1960	Jin	198/16
3,049,213	8/1962	Fabula	198/16
2,096,583	9/1937	Handy	198/16

FOREIGN PATENTS

265,119	12/1967	Austria	198/16
899,776	12/1953	Germany	198/208
193,992	1/1965	U.S.S.R.	198/208

Primary Examiner—Evon C. Blunk
Assistant Examiner—Hadd S. Lane
Attorneys—F. W. Brunner and Oberlin, Maky, Donnelly & Renner

ABSTRACT: A passenger conveyor system in which the driving force is applied to the handrail by means of a drive sheave mounted on a terminal pulley shaft for the conveyor, and the handrail is maintained under the minimum tension required to produce sufficient drive traction between the handrail and drive sheave for driving the handrail without slippage using a pair of takeup mechanisms, one on each side of the drive sheave. Takeup tension is applied to the handrail only by the takeup mechanism on the slack or exit side of the handrail drive sheave, which varies depending on the direction of rotation of the drive sheave; the takeup mechanism on the tension or entry side is pulled against a stop.



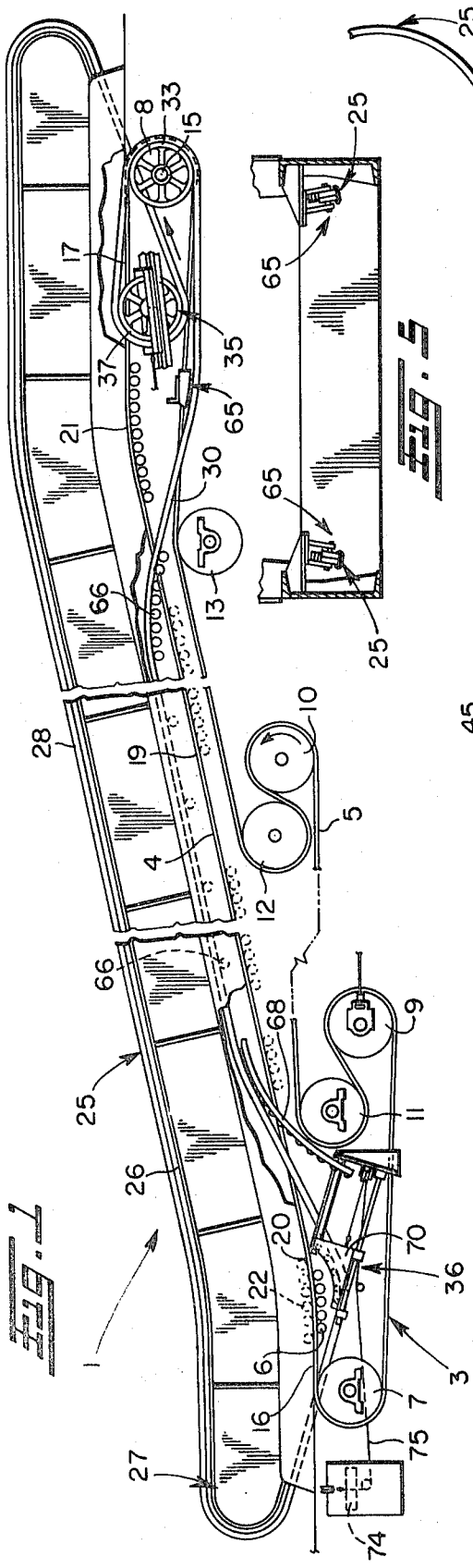


FIG. 1

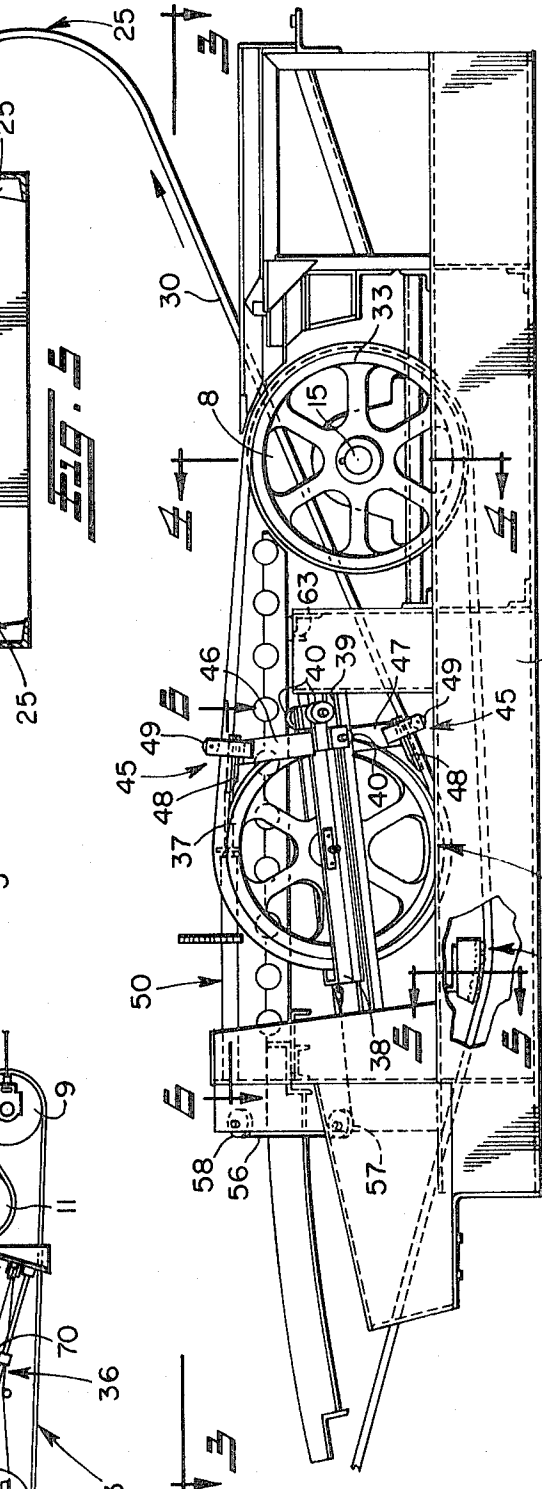


FIG. 2

FIG. 5

INVENTORS
ERNEST D. JOHNSON
KENNETH D. MITCHELL

BY
Oberlin, Maky, Donnelly & Renner
ATTORNEYS

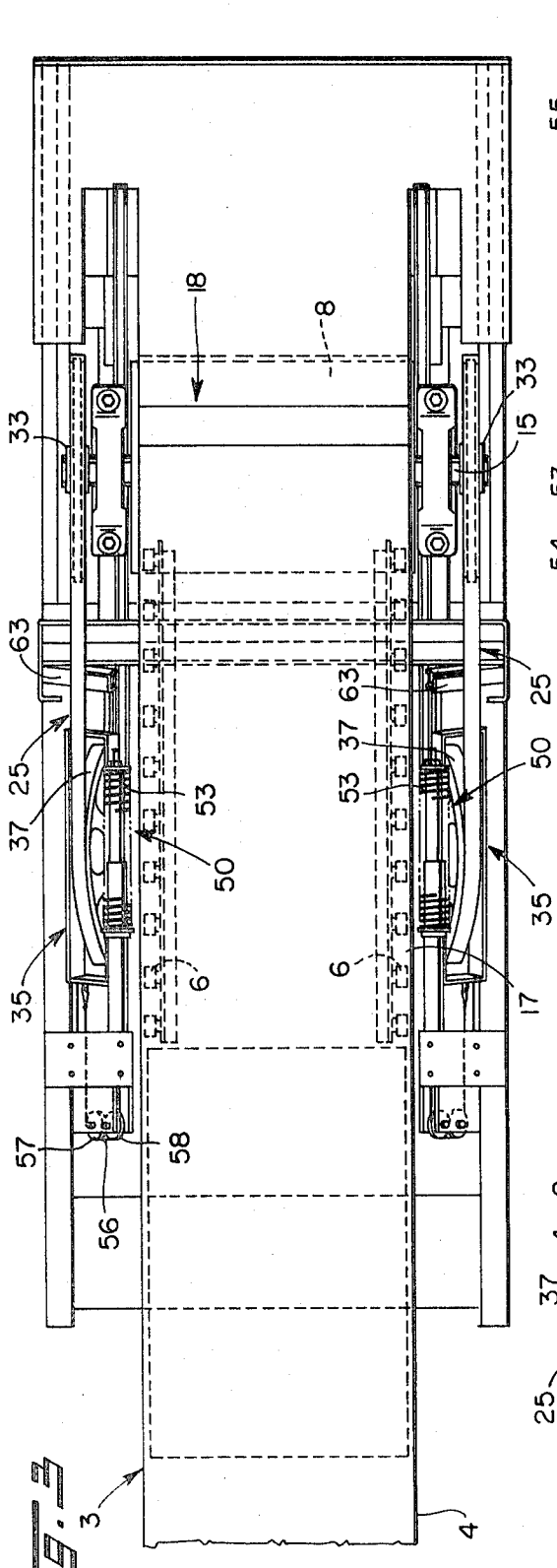


Fig. 4

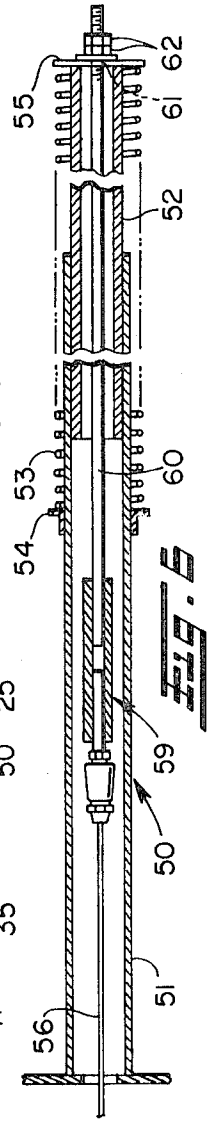


Fig. 5

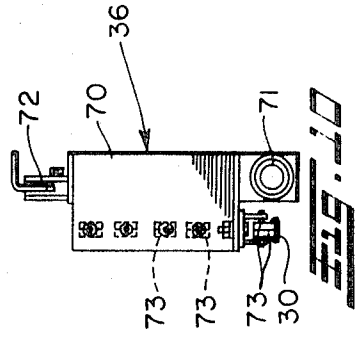


Fig. 6

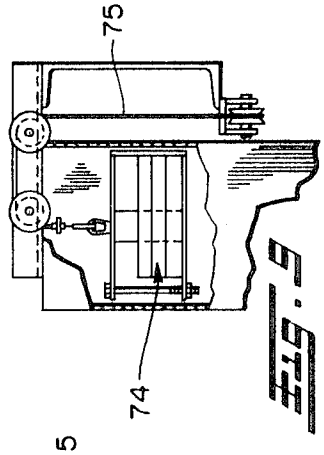


Fig. 7

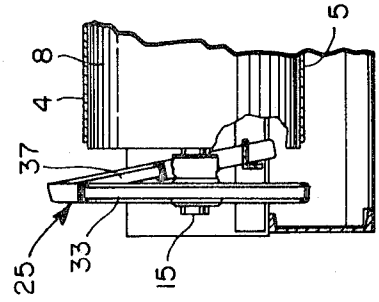


Fig. 8

INVENTORS
ERNEST D. JOHNSON
KENNETH D. MITCHELL

BY
Oberlin, Maky, Donnelly & Renner
ATTORNEYS

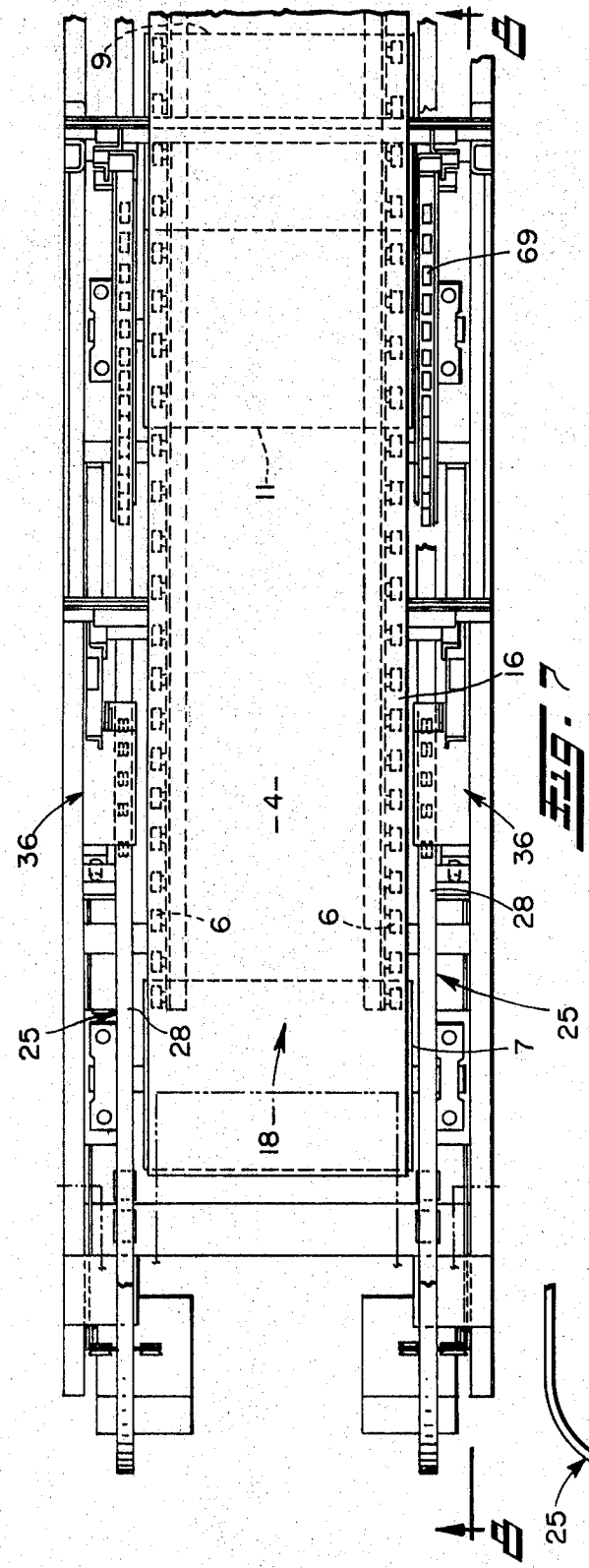


FIG. 7

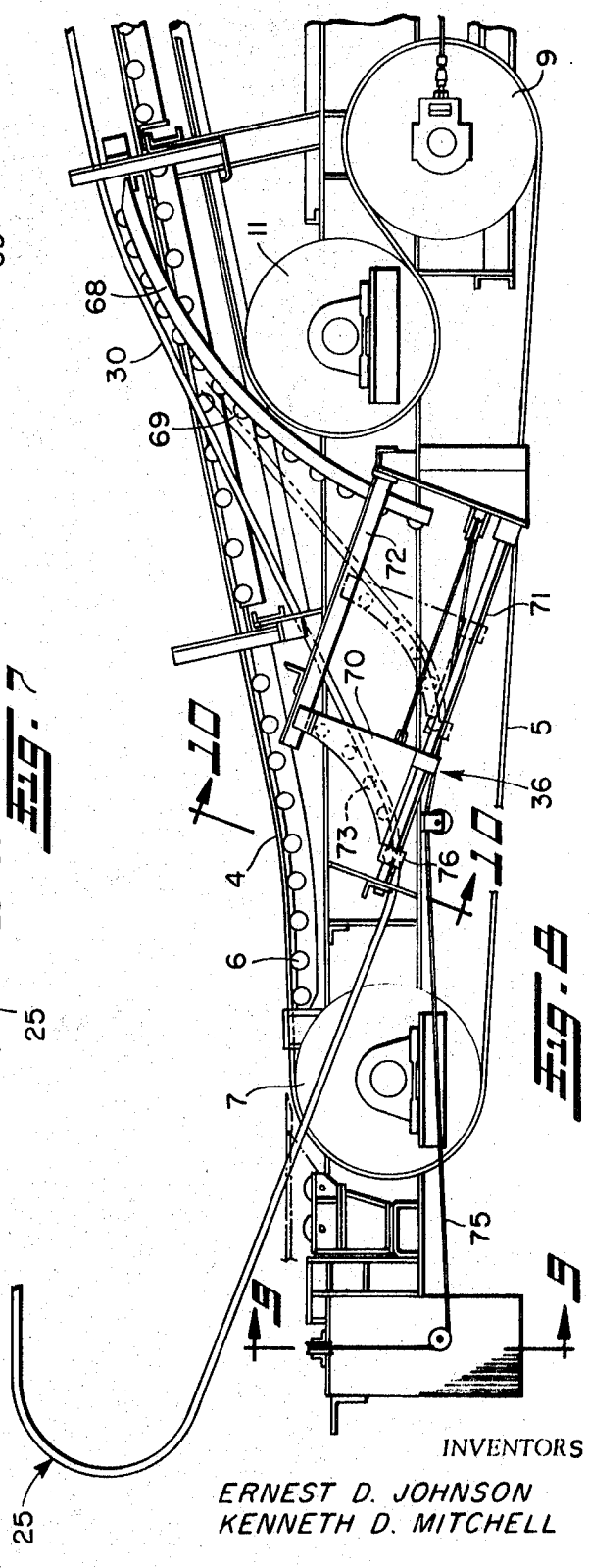


FIG. 8

INVENTORS
ERNEST D. JOHNSON
KENNETH D. MITCHELL

BY
Oberlin, Maky, Donnelly & Renner
ATTORNEYS

HANDRAIL DRIVE FOR PASSENGER CONVEYOR

This invention relates generally to a handrail drive for passenger conveyor systems, and, more particularly, to a simplified drive arrangement for driving the handrail in synchronism with the passenger-supporting conveyor, and a dual takeup system for proper tensioning of the handrail to apply the minimum force required to obtain the minimum required drive traction for driving the handrail in either direction.

Passenger conveyor systems, whether of the moving belt type or moving stairway type, are ordinarily provided at each side with an endless moving handrail driven in synchronism with the passenger supporting conveyor for grasping by the conveyor passengers. The upper run of each handrail is supported by suitable guides associated with a balustrade, and the return run and friction drive for the handrail may either be enclosed within the balustrade or located therebeneath depending on whether or not the balustrade is light transmissive.

To obtain sufficient drive traction for driving the handrail, the handrail must be placed under tension, and it has been common practice to use a single takeup mechanism for that purpose. However, this requires that the takeup tension be maintained at full tight side tension if the conveyor is to be capable of being driven in either direction, and under such high tension, the rate of deterioration of the handrail and associated support and drive complements is much greater. Moreover, such high tension generally requires heavier and more expensive handrail drive components to be used. The usual drive mechanism for the handrail also generally requires the use of secondary belts, chains, or gears to transmit power from the main conveyor drive to the handrail, which further adds to the cost and complexity of the system and increased maintenance costs.

With the foregoing in mind, it is a principal object of this invention to provide such a passenger conveyor system with a simplified drive for driving the handrail at the same speed as the passenger supporting conveyor without the use of chains, gears, secondary belts and other power transmissions.

Another object is to provide such a conveyor system with a dual takeup system for maintaining the handrail takeup tension at the minimum force required to produce sufficient drive traction for driving the handrail in either direction.

These and other objects of the present invention may be achieved by a passenger conveyor system in which the driving force is applied to the handrail by means of a drive sheave mounted on a pulley shaft for the passenger supporting conveyor. The handrail drive sheave is of the same diameter as the conveyor pulley, whereby rotation of the pulley shaft either directly or by the main conveyor will cause the conveyor and handrail to move at the same speed.

The handrail is maintained under the minimum tension required to produce sufficient drive traction between the handrail and drive sheave for driving the handrail without slippage by a pair of takeup mechanisms, one on each side of the drive sheave. Slack in the handrail is taken up only by the take up mechanism on the slack side of the handrail drive sheave; the other takeup mechanism on the tension side is pulled up against a stop where it is retained until the handrail drive is either stopped or reversed to drive the handrail in the reverse direction, in which event the other takeup mechanism takes up the slack and the first takeup mechanism is pulled up against a stop.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, 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 drawings:

FIG. 1 is a schematic side elevation view of a passenger conveyor system including a preferred form of handrail drive constructed in accordance with this invention;

FIG. 2 is an enlarged side elevation view of the handrail drive and takeup mechanism of FIG. 1 for taking up the slack in the handrail when driven in a counterclockwise direction as viewed in FIGS. 1 and 2;

FIG. 3 is an enlarged top plan view of the right or head end of the conveyor system of FIG. 1;

FIG. 4 is a vertical transverse section through the handrail drive sheave adjacent one side of the passenger supporting conveyor, taken on the plane of the line 4—4 of FIG. 2;

FIG. 5 is a vertical transverse section through the lower guide rolls for both handrails adjacent the head end takeup mechanisms;

FIG. 6 is an enlarged fragmentary longitudinal section through the spring tension device for the head end takeup mechanism of FIG. 2, taken on the plane of the line 6—6;

FIG. 7 is an enlarged top plan view of the left or tail end of the conveyor system of FIG. 1;

FIG. 8 is a side elevation view of the left or tail end of the conveyor system of FIG. 7, including the tail end takeup mechanism for taking up slack in the handrail when driven in a clockwise direction;

FIG. 9 is a fragmentary vertical section through the force applying means for the takeup mechanism of FIG. 8, taken on the plane of the line 9—9; and

FIG. 10 is an enlarged end elevation view of the takeup mechanism of FIG. 8 as seen from the plane of the line 10—10.

Referring now in detail to the drawings and first especially to FIG. 1, there is shown a conveyor system 1 for conveying passengers and also objects on a conveyor 3 which desirably comprises an endless belt having an upper run 4 on which the passengers and objects are supported for movement from one end of the conveyor to the other, and a lower or return run 5. Rollers 6 suitably spaced along both sides of the upper run 4 as shown in FIGS. 3 and 7 provide the necessary support for the upper run, and terminal pulleys 7 and 8 are provided adjacent opposite ends of the conveyor system 1 about which the conveyor 3 extends for travel of the conveyor between the upper and lower runs.

Intermediate the terminal pulleys 7 and 8 below the upper run 4 there are a plurality of additional pulleys which are engaged by the lower run 5. One of the additional pulleys 9 may be a tensioning device for providing proper tension in the conveyor 3, and another of the pulleys 10 may be the main drive pulley for the conveyor. Associated with each of the tensioning and drive pulleys 9 and 10 are idler pulleys 11 and 12 for increasing the angle of wrap around the tensioning and drive pulleys, and additional idler support pulleys 13 may also be provided where required. If desired, the main drive pulley 10 and associated idler pulley 12 may be eliminated and the conveyor 3 driven by driving the shaft 15 of one of the terminal pulleys 8.

The upper run 4 of the conveyor 3 may either be flat for conveying passengers and objects horizontally from one place to another, or the upper run 4 may be inclined as shown intermediate its ends 16 and 17 for vertical movement as well. However, the ends 16 and 17 of the conveyor upper run 4 are still desirably substantially level to facilitate entry onto and exit from the conveyor, and floating combs 18 are provided at each end of the conveyor upper run (see FIGS. 3 and 7), as well known in the art. Such ends 16 and 17 of the conveyor upper run 4 are connected to the intermediate conveyor upper run portion 19 by a concave portion 20 and convex portion 21, respectively, and holddown rolls 22 may be provided in the region of the concave portion 20 to maintain the upper run in engagement with the underneath support rollers 6 in that region.

To assist passengers, a handrail 25 in the form of an endless flexible narrow belt is provided adjacent each side of the conveyor 3 for grasping by the passengers. Each handrail 25 is desirably generally C-shape in section for support by the upper edge 26 of the balustrades 27 adjacent the sides of the conveyor 3, and such upper edge 26 is desirably shaped to

provide a guide surface for the upper run 28 of the handrail 25 which is substantially parallel to the upper run 4 of the conveyor 3. The ends of the balustrades 27 are desirably rounded for guiding the handrail 25 between the upper and lower runs, and the lower run 30 of the handrail 25 and guide rollers therefor are desirably located beneath the balustrades 27, thus permitting light-transmissive or transparent panels to be used for the balustrades.

For driving each handrail 25, there is provided a drive sheave 33 mounted on each end of the terminal shaft 15 as shown in FIGS. 1–4 which the lower run 30 of the handrail 25 extends. By making the diameter of each drive sheave 33 approximately equal to the diameter of the terminal pulley 8 for the passenger-supporting conveyor 3, rotation of the terminal pulley 8 by driving the conveyor 3 through the main drive pulley 10 or by driving the terminal pulley shaft 15 directly will cause the drive sheaves 33 and thus the handrails 25 to move at the same speed as the conveyor 3 without having to use secondary belts, chains, or gears to transmit power from the main conveyor drive to the handrail drive sheaves, thus substantially simplifying the drive for the handrail.

Any slack which occurs in the handrails 25 due to stretching and the like is taken up and the handrails maintained under proper tension to provide sufficient drive traction between the drive sheaves 33 and each handrail 25 for driving the handrails in either direction by a pair of tension takeup mechanisms 35 and 36, shown schematically in FIG. 1 and in greater detail in FIGS. 2 and 8. Preferably, the takeup mechanisms 35 and 36 for each handrail are located adjacent opposite ends of the conveyor system. In any event, the takeup mechanisms 35 and 36 are positioned so that one takeup mechanism is located on the slack side of the drive sheave 33 and the other takeup mechanism is located on the tension side or vice versa depending on the direction of rotation of the drive sheave, the tension of course always being greater at the point where the handrail first engages the drive sheave and less where the handrail leaves the drive sheave.

Thus, for example, when the drive sheaves 33 are rotated in a counterclockwise direction as viewed in FIG. 1 to move the upper run of the handrails 25 down the inclined balustrade support 26, the portion of the handrail engaged by the tail end takeup mechanism 36 is under tension and the slack in the handrail is taken up by the head end takeup mechanism 35. Conversely, when the drive sheaves 33 are rotated in a clockwise direction as viewed in FIG. 1 to move the handrail upper run up the incline, the handrail portion engaged by the head end takeup mechanism 35 is under tension and the slack in the handrail is taken up by the tail end takeup mechanism 36.

By proper selection of the tensioning force applied by each of the takeup mechanisms 35 and 36, the slack side driving tension in the handrail may be maintained at the minimum force required to produce sufficient drive traction between the drive sheaves 33 and handrails 25 for driving the handrail without slippage. This tension force is substantially less than the high side tension in the handrail 25, and accordingly, the takeup mechanism on the high tension side is pulled into engagement with a travel stop in a manner to be subsequently fully described. Where a single takeup mechanism is employed as is conventional practice, considerably higher tension must be exerted on the handrail since a single takeup mechanism must be capable of taking up slack even at full tight side tension, and such higher tension causes more rapid handrail deterioration and requires generally heavier handrail drive components than when two takeup mechanisms are used in accordance with the present invention.

For a more clear understanding of the details of construction and operation of each takeup mechanism 35, reference may be had to FIGS. 2, 3, 4 and 6 of the drawings. As shown, each takeup mechanism 35 consists of an idler sheave 37 mounted on a carriage 38 supported on guide rails 39 for limited sliding movement of the carriage 38 toward and away from the associated drive sheave 33 for decreasing and increasing the path of travel of the handrail. Guide rollers 40 and 41 may be provided on the carriage 38 for engagement with the guide rails 39, and the guide rails 39 are desirably supported by the main support frame 42 of the conveyor system 1 at an angle approximating the angle of inclination of the intermediate conveyor portion 19 for movement of the carriage 38 in either direction along the incline.

As best seen in FIGS. 3 and 4, the idler sheave 37 is canted at an angle of approximately 5½° **with respect to the normal plane of the drive sheave** 33 **so that the bottom portion of the idler sheave** 37 **is out of the plane of the drive sheave** 33 **and the top portion thereof is in the plane of the top portion of the drive sheave. This facilitates wrapping of the handrail lower run** 30 **from the right or head end of the conveyor system first around the idler sheave** 37 **from bottom to top and then around the drive sheave** 33 **from top to bottom without having to flex the handrail in the reverse direction. Thus, the same side of the handrail** 25 **that engages the upper edge** 26 **of the balustrade** 27 **also engages the drive sheave** 33 **and idler sheave** 37.

Undue flexing of the handrail 25 in the reverse direction may cause substantial tension forces in the handrail edges, and also cause the exterior surface of the handrail to be contacted by guide members and the like which might unduly crack, pit or scuff the exterior surface. However, a pair of guide members 44 and 45 supported by brackets 46 and 47 on the carriage 38 are desirably provided adjacent the top and bottom peripheries of the idler sheave 37 (see FIG. 2) and each guide member 44 and 45 consists of an elongated slide member 48 for engagement with the inner surface of the handrail 25 and a roller member 49 which makes light contact with the exterior surface.

A tension force of the desired magnitude is applied to the carriage 38 for maintaining the handrail 25 under tension by means of a spring tension device 50, the details of which are clearly shown in FIG. 6. The spring tension device 50 comprises a fixed cylindrical housing 51 in which is telescopically received a tubular sleeve 52, with a compression spring 53 interposed between flanges 54 and 55 on the cylindrical housing 51 and tubular sleeve 52, respectively, for urging the tubular sleeve 52 outwardly of the cylindrical housing 51. A cable 56 having one end attached to the carriage 38 extends around a pair of idler sheaves 57 and 58 and into the end of the cylindrical housing 51 opposite the tubular sleeve 52, where the cable 56 is connected to the tubular sleeve 52 by means of a suitable coupling 59 and rod 60 extending through an opening 61 in the flange 55. A pair of jam nuts 62 threaded onto the outer end of the rod 60 permit adjustment of the effective length of the rod 60 for varying the tension force applied to the idler sheave 37 by the spring 53, which tension force is selected to provide sufficient tension in the slack side of the handrail 25 for driving the handrail in a counterclockwise direction through frictional contact with the drive sheaves 33. Upon reversing the direction of rotation of the drive sheave 33, the slack side becomes the high tension side, and the carriage 38 for the takeup mechanism 35 is pulled up against a stop 63 on the main support frame 42 (see FIGS. 2 and 3).

From the drive sheave 33 the handrail lower run 30 extends around a plurality of guide rolls to the tail end of the conveyor system. The interior surface of the handrail lower run 30 adjacent the drive sheave 33 is engaged by a guide roller assembly 65 shown more clearly in FIGS. 2 and 5, and the exterior surface is engaged by a series of spaced apart drive roller assemblies 66 shown schematically in FIG. 1 along the length of the handrail lower run. Adjacent the tail end takeup mechanism 36 and forwardly thereof is a concave guide roller support assembly 68 for mounting of a plurality of guide rollers 69 thereon against which the exterior side of the handrail lower run 30 is urged upon application of a tension load to the opposite or interior side of the handrail by the tail end takeup mechanism 36 in a manner to be subsequently explained.

As clearly shown in FIGS. 7, 8 and 10, the tail end takeup mechanism 36 consists of a rack 70 slidably mounted on a pair of vertically spaced supports 71 and 72 which are inclined in a

direction substantially perpendicular to the guide roller support assembly **68** for increasing and decreasing the path of the handrail. Mounted on the rack **70** are a plurality of roller bearings **73** for engagement with the interior surface of the hand rail lower run **30**. A tension force is applied to the handrail **25** through the tail end takeup mechanism **36** by a weight **74** of the desired magnitude (see FIG. **9**) attached to the rack **70** by a cable **75** and reeved around a plurality of sheaves in such a manner as to urge the rack **70** toward the fixed guide roller support assembly **68** as shown in phantom lines in FIG. **8**. By proper selection of the weight **74**, the slack in the handrail **25** when driven in a clockwise direction is taken up and the minimum tension force required to produce sufficient drive traction between the handrail and drive sheave **33** is maintained for driving the handrail in that direction. Upon rotation of the handrail in the reverse direction, the tail end takeup rack **70** is forced or pulled up against a stop **76** on the support **71** as shown in solid lines in FIG. **8** and the head end takeup mechanism **35** supplies the takeup tension to the slack side of the drive sheave **33**, in the manner previously described.

From the foregoing, it can now be seen that the handrail drive of the present invention effectively drives the handrail at the same speed as the conveyor surface without the use of secondary belts, chains, or gears, thereby eliminating the inherent problems and expenses normally associated with such handrail drives. The handrail drive also utilizes a dual takeup system which permits driving of the handrail in either direction from one location while maintaining the handrail takeup tension at the minimum force required to produce sufficient drive traction between the drive sheave and handrail to preclude slippage, thereby reducing handrail deterioration and permitting lighter drive components to be used than previously required.

Although the handrail drive of the present invention is primarily designed for use with belt conveyors, it will be appreciated that it could also be used with moving stairways if desired.

We, therefore, particularly point out and distinctly claim as our invention:

1. A handrail and drive mechanism for a passenger conveyor system comprising an endless handrail belt, support means for supporting said handrail belt adjacent one side of a conveyor, said handrail belt having an upper run for grasping by passengers and a lower slack run, traction drive means for driving said handrail belt in opposite directions, and separate self-compensating takeup means on opposite sides of said traction drive means each adjacent an end of said system and each operative to independently apply sufficient tension and cause selective movement to said belt on the slack side of said traction drive means to permit driving of said handrail belt by said traction means in either direction with a proper tension in said upper run.

2. The mechanism of claim **1** wherein one of said takeup means comprises an idler sheave engaged by said handrail belt, a carriage on which said idler sheave is mounted for movement in opposite directions in response to change in tension in said belt for increasing and decreasing the path of travel of said handrail belt, and tension means for urging said carriage in a direction increasing the path of travel of said handrail belt to apply a tension force thereagainst.

3. The mechanism of claim **2** wherein said traction drive means comprises a drive sheave associated with said idler sheave, said handrail belt lower run extending from one end first around said idler sheave from bottom to top and then around said drive sheave from top to bottom, said carriage being movable toward and away from said drive sheave.

4. The mechanism of claim **3** wherein said idler sheave is canted with respect to the plane of said drive sheave so that the bottom of said idler sheave is out of the plane of said drive sheave and the top of said idler sheave is in the plane of said drive sheave.

5. The mechanism of claim **4** further comprising guide means on said carriage for guiding said handrail belt around said idler sheave.

6. The mechanism of claim **2** wherein said tension means comprises a spring for urging said carriage in a direction increasing the path of travel of said handrail belt, and means for varying the tension force applied by said spring to provide the minimum force required to produce sufficient drive traction for driving said handrail belt in one direction.

7. The mechanism of claim **6** wherein said tension means further comprises a fixed cylindrical housing, a tubular sleeve telescopically received in said cylindrical housing, said spring urging said tubular sleeve outwardly of said cylindrical housing, and a cable having one end connected to said carriage and the other end connected to said tubular sleeve.

8. The mechanism of claim **7** wherein said means for varying the tension force applied by said spring comprises a rod interconnecting said cable and tubular sleeve, and means for adjusting the effective length of said rod.

9. The mechanism of claim **1** further comprising means for varying the tension force applied by said takeup means to provide the minimum force required in the slack side of said handrail belt to produce sufficient drive traction for driving said handrail belt in either direction.

10. The mechanism of claim **1** wherein one of said takeup means comprises a rack, means mounting said rack for movement to increase and decrease the path of travel of said handrail belt, and means for urging said rack in a direction increasing the path of travel of said handrail belt to apply a tension force to said handrail belt.

11. The mechanism of claim **10** wherein said last-mentioned means comprises a weight having a cable connection with said rack, said weight being selected to provide the minimum force required to produce sufficient drive traction for driving said handrail belt in one direction.

12. The mechanism of claim **10** wherein said rack has a plurality of rollers thereon for engagement with the interior surface of said handrail belt.

13. The mechanism of claim **12** further comprising a concave guide roller support assembly adjacent said takeup means, and a plurality of rollers on said support assembly, said takeup means urging the exterior side of said handrail belt into engagement with said rollers on said support assembly.

14. The mechanism of claim **1** wherein said traction drive means comprises a drive sheave driven at the same speed as said conveyor.

15. The mechanism of claim **1** wherein said means for supporting said handrail belt includes a balustrade adjacent one side of said conveyor, said balustrade having means thereon for supporting the upper run of said handrail belt, and means for supporting the lower run of said handrail belt below said balustrade.

16. The mechanism of claim **1** further comprising stop means against which said takeup means are pulled when on the high tension side of said traction drive means.

17. A conveyor system comprising an endless conveyor belt, support means for supporting said conveyor belt for movement, said support means including terminal pulleys mounted on shafts adjacent opposite send of said conveyor system about which said conveyor belt extends to provide upper and lower runs, and means for driving said conveyor; an endless handrail belt, support means for supporting said handrail belt adjacent one side of said conveyor, said handrail belt having an upper run for grasping by passengers and a lower slack run, said support means for said handrail belt including a drive sheave engaged by said handrail belt, said drive sheave being mounted on the shaft of one of said terminal pulleys for driving said drive sheave through rotation of said one pulley shaft, said drive sheave being of the same diameter as said one terminal pulley, whereby said handrail belt is driven at the same speed as said conveyor belt, and separate, self-compensating takeup means on opposite sides of said drive sheave, each adjacent one of said terminal pulleys and each operative to inde-

pendently apply sufficient tension and cause selective movement to said belt on the slack side of said drive sheave to permit driving of said handrail belt by said drive sheave in either direction with a proper tension in said upper run.

18. The conveyor system of claim 17 wherein the upper runs of said conveyor belt and handrail belt are inclined intermediate their ends for vertical movement between their ends, and the ends of said conveyor belt are substantially level to facilitate entry onto and exit from said conveyor belt.

* * * * *

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,621,970 Dated November 23, 1971

Inventor(s) Ernest D Johnson and Kenneth D Mitchell

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 28, after "sheave 37" insert --for guiding the handrail 25 around the idler sheave 37--.

Signed and sealed this 2nd day of May 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents