

[54] **VARIABLE SPEED SIDEWALK**

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[51] Int. Cl.....B65g 65/06

[58] **Field of Search** 198/16 MS, 16, 17, 110;
104/25

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Primary Examiner—Richard E. Aegerter

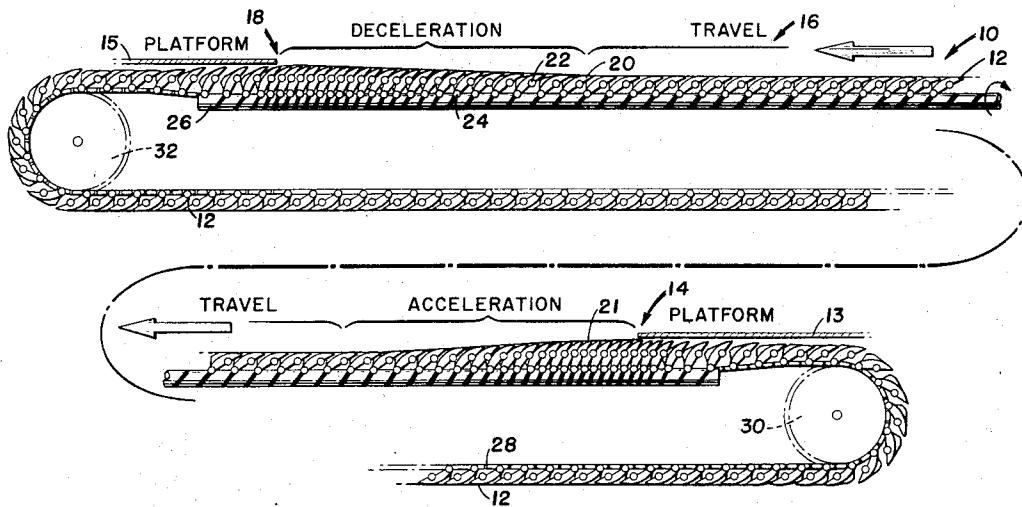
Assistant Examiner—Douglas D. Watts

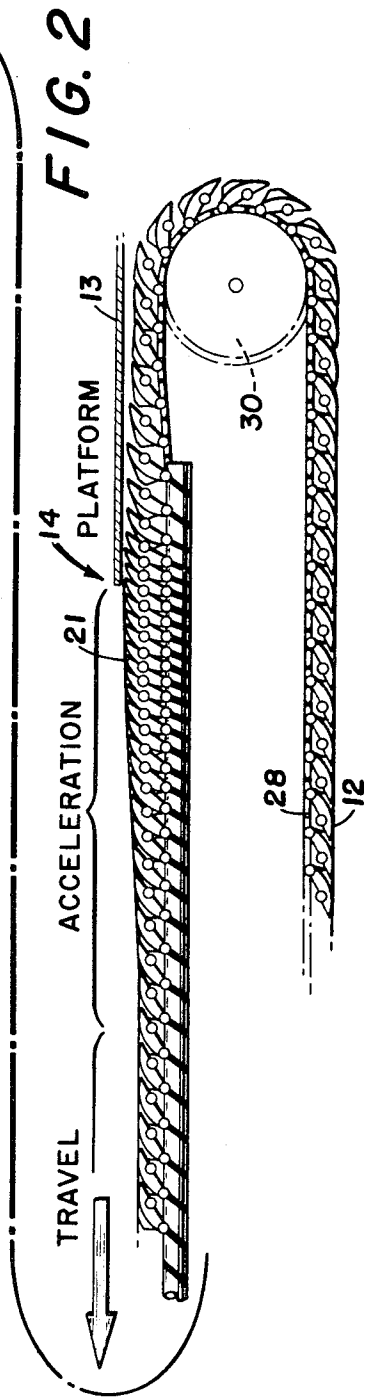
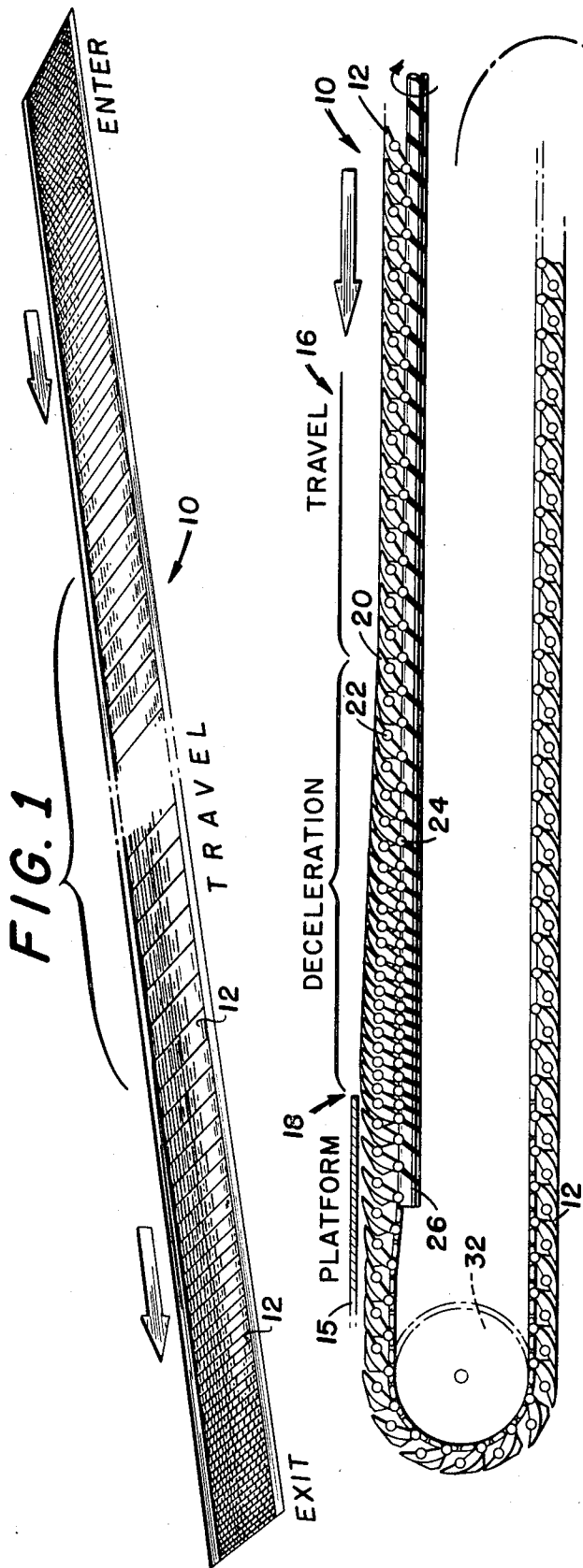
Attorney—John S. Lacey

[57] ABSTRACT

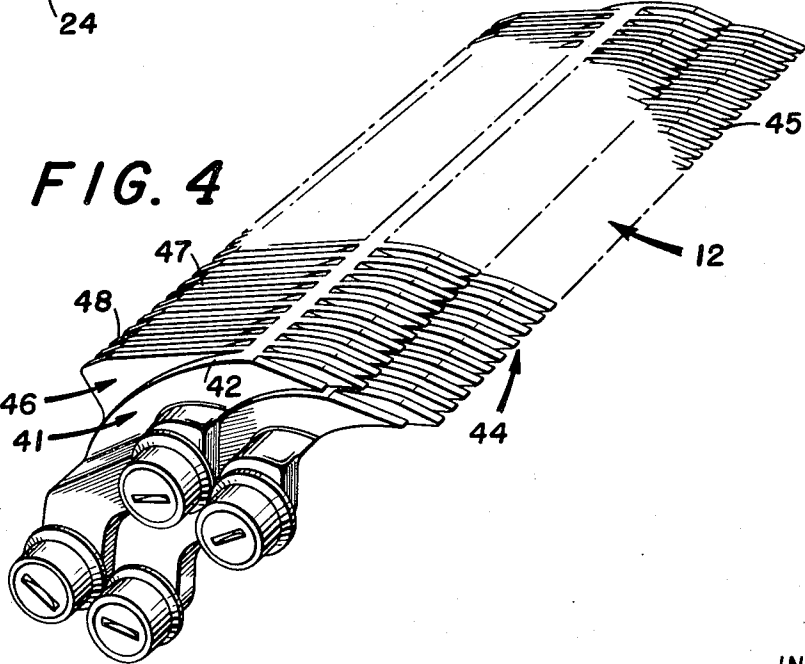
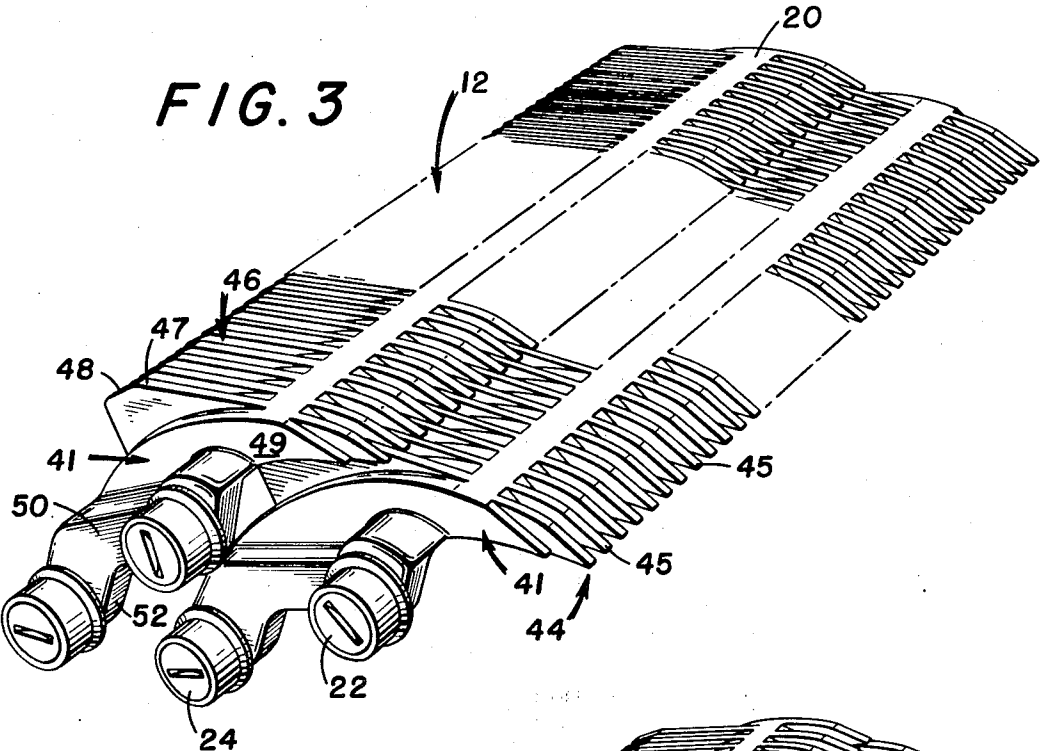
The invention relates to a moving sidewalk or article conveyor comprising a continuous belt capable of differential speeds along a portion of the surface of the belt. Discrete arcuate units forming the continuous belt tilt relative to the plane of the belt and mutually overlap in interdigitating fashion over a variable portion of the surface areas of the units to provide a level surface, the end portions of which surface travel at a constant first rate of speed while the intermediate portions therebetween accelerate to and decelerate from a second, more rapid constant rate of speed.

12 Claims, 16 Drawing Figures



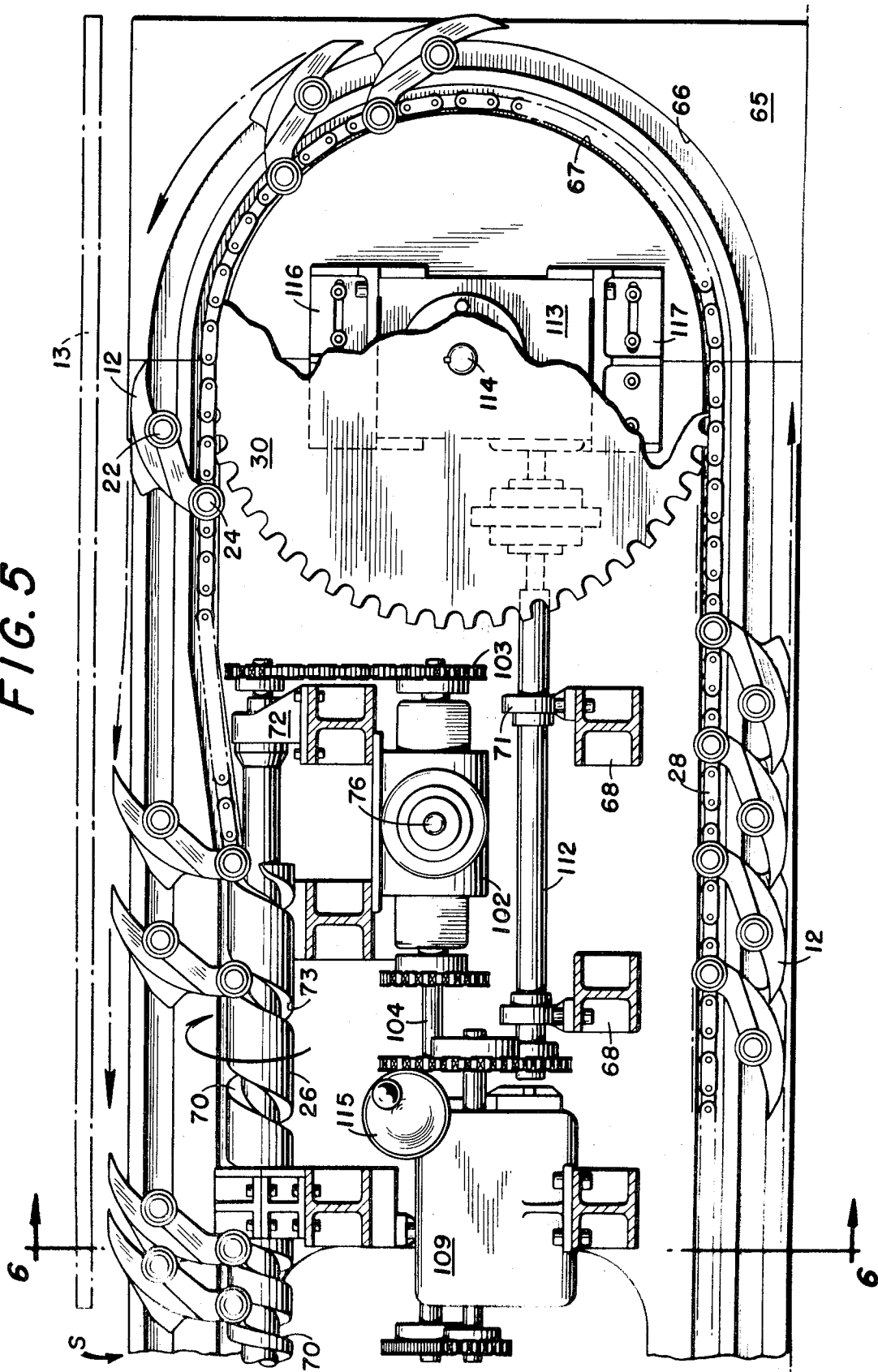


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FIG. 5



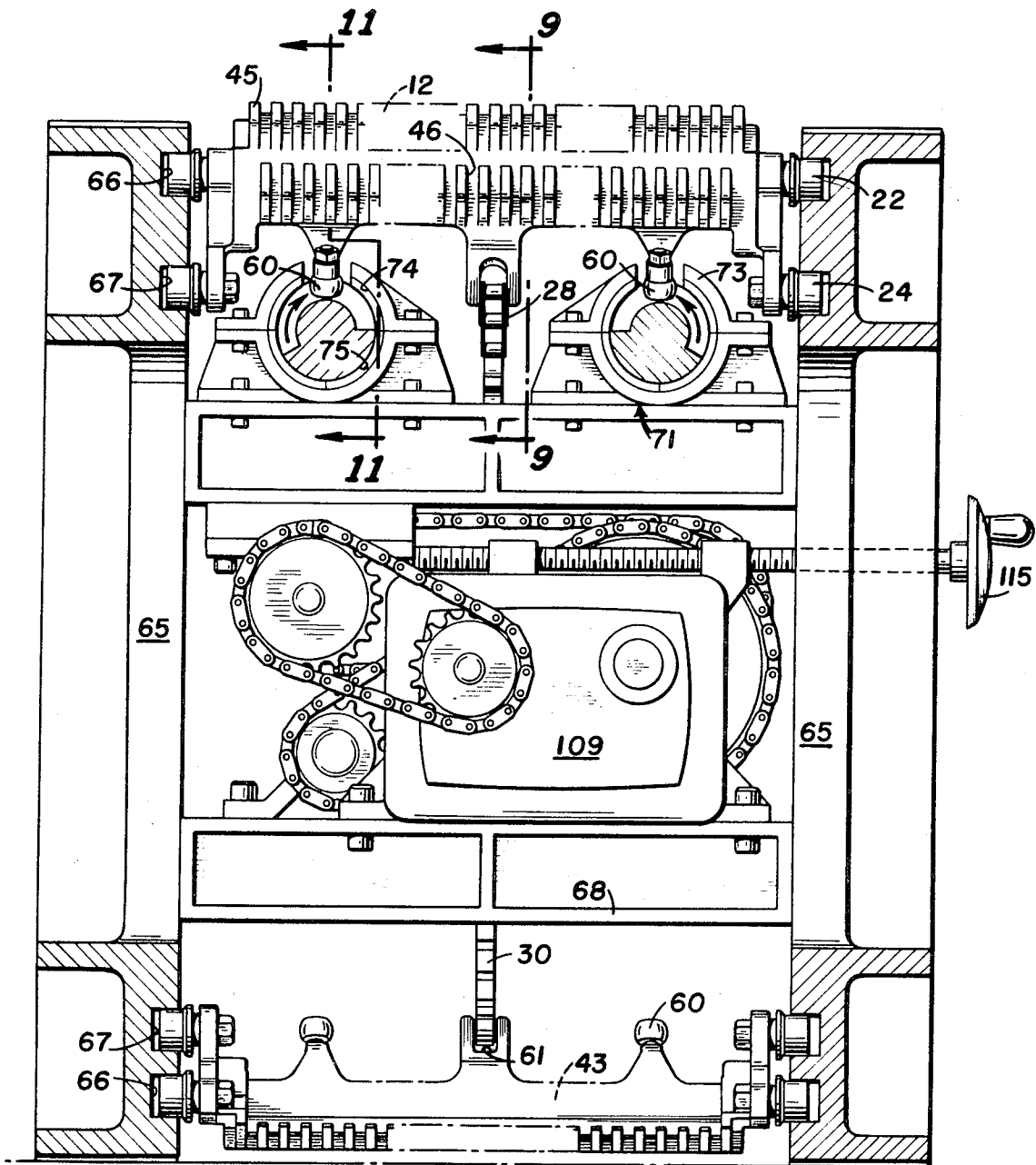


FIG. 6

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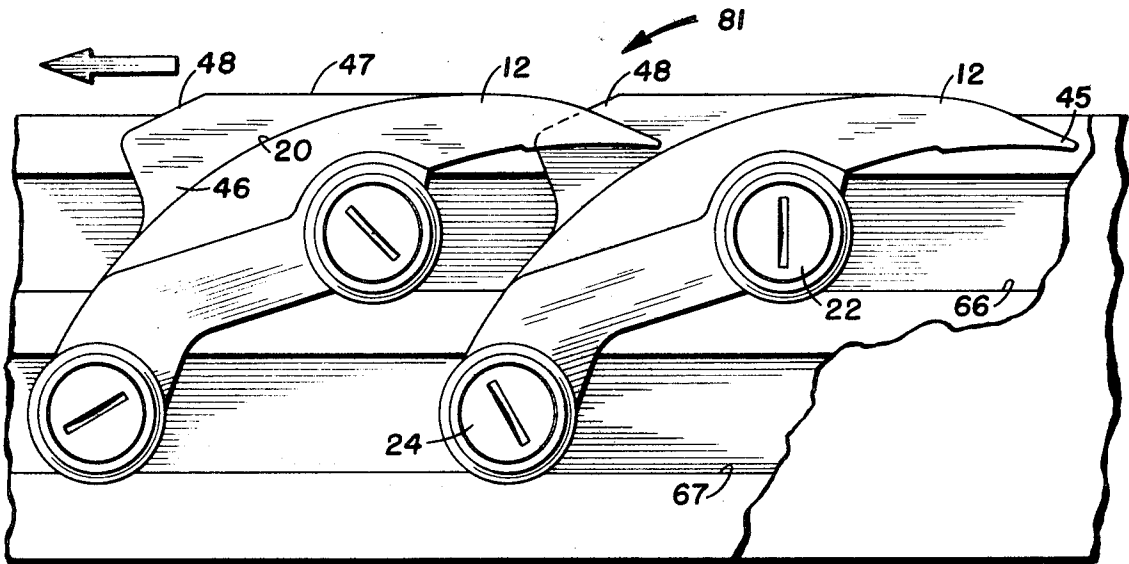


FIG. 7

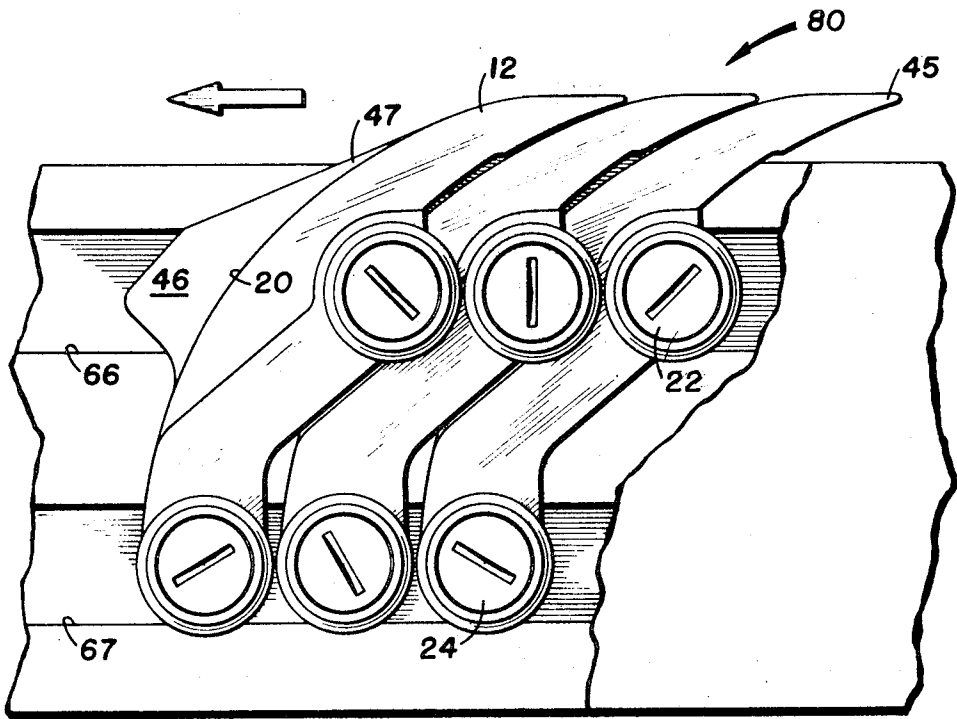


FIG. 8

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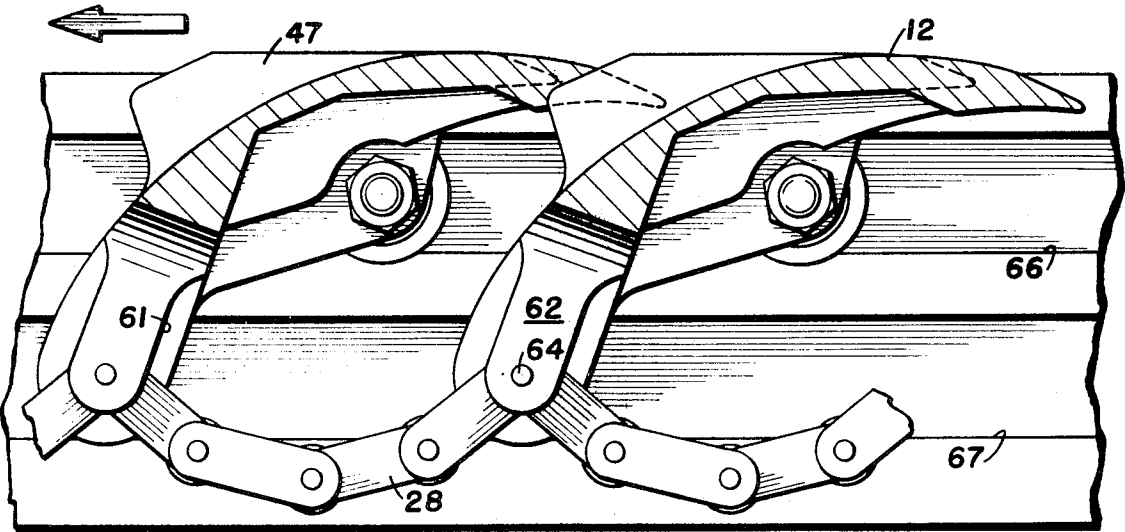


FIG. 9

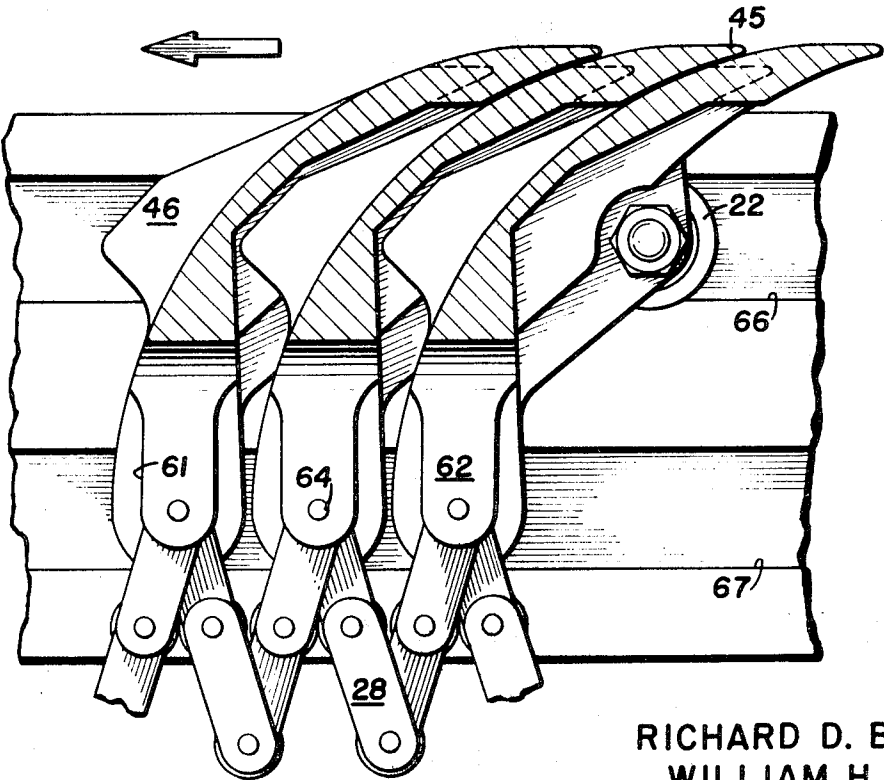
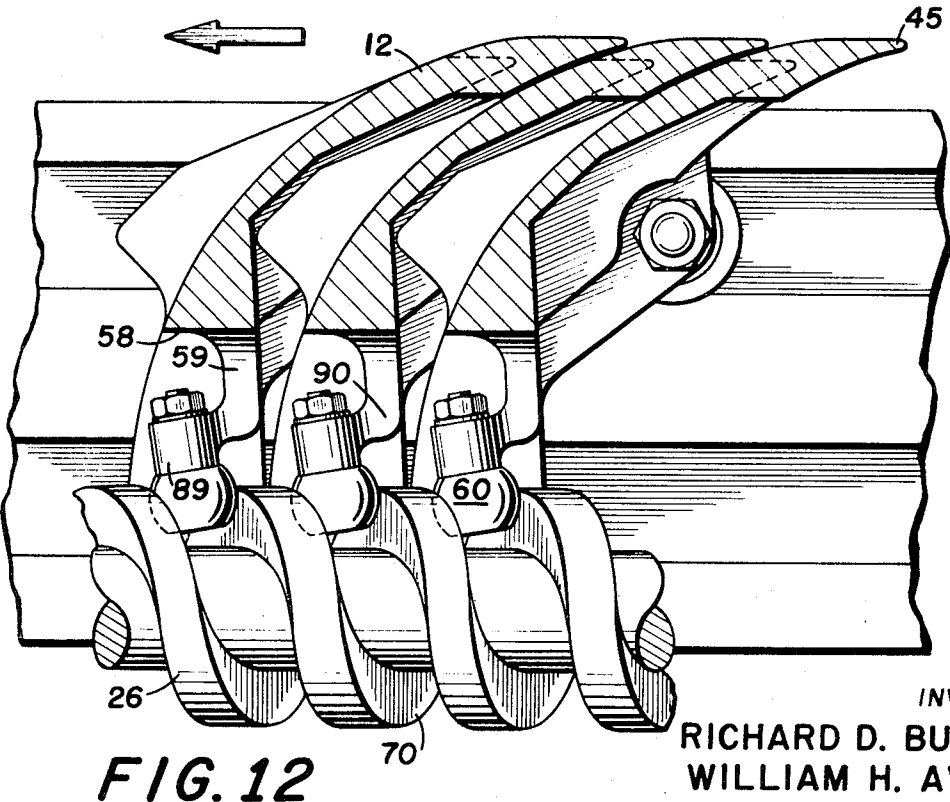
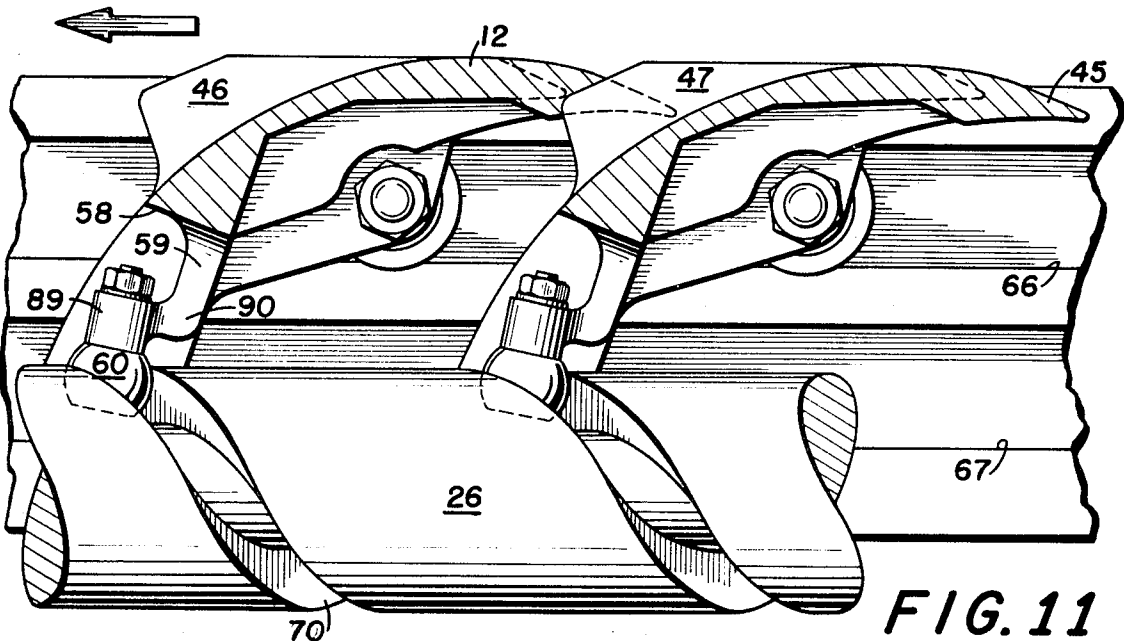


FIG. 10

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FIG. 13

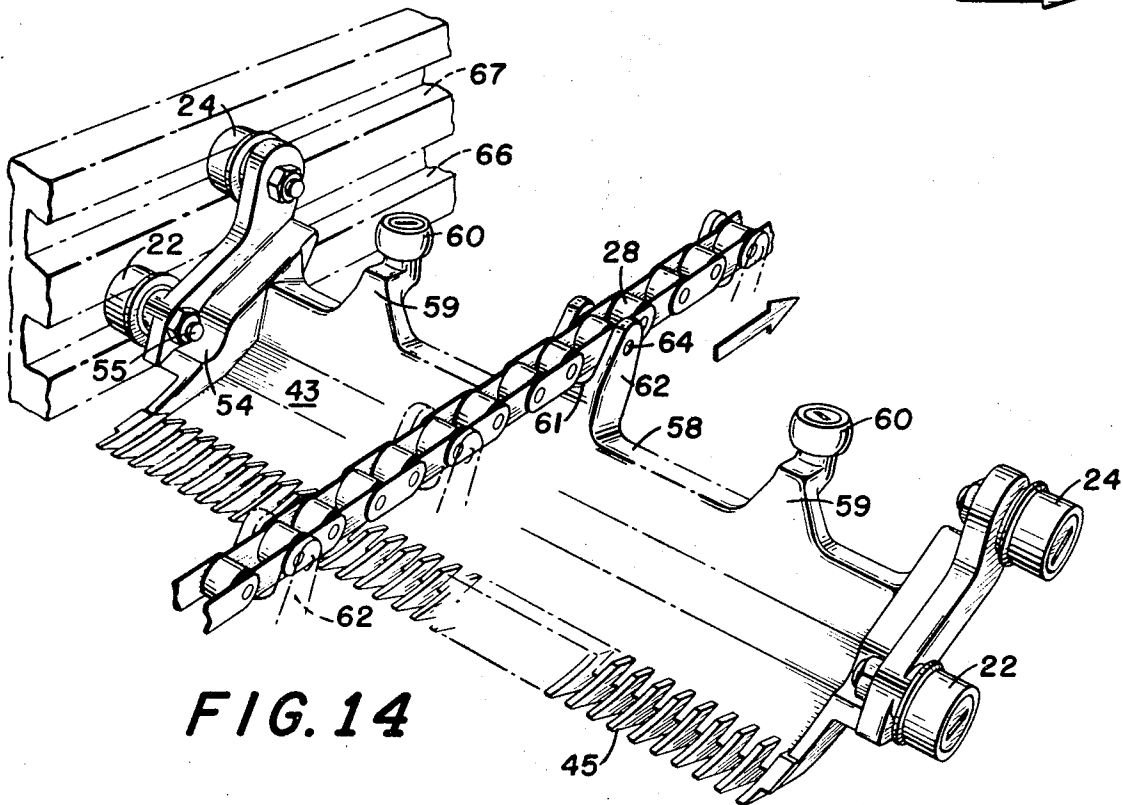
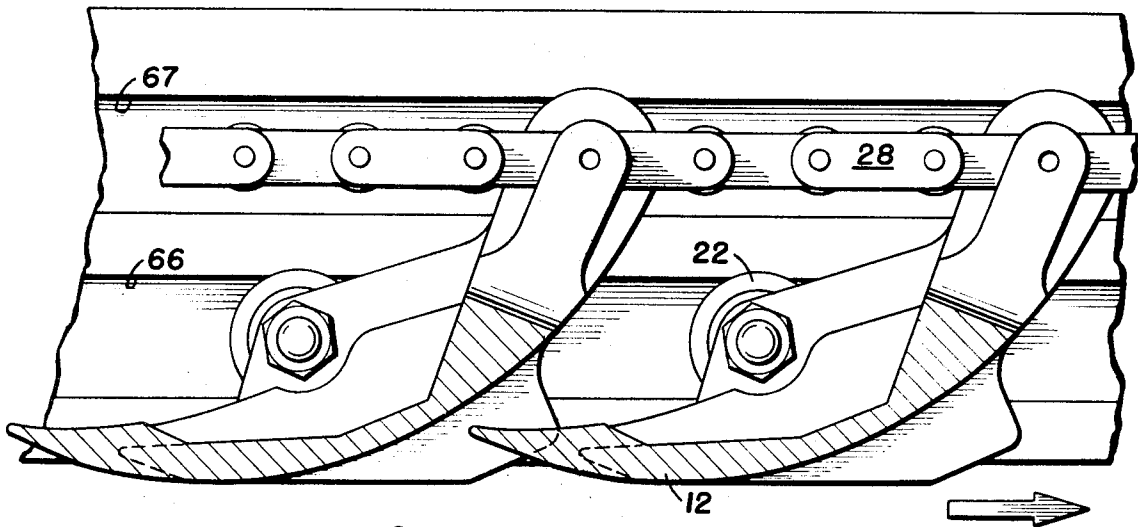
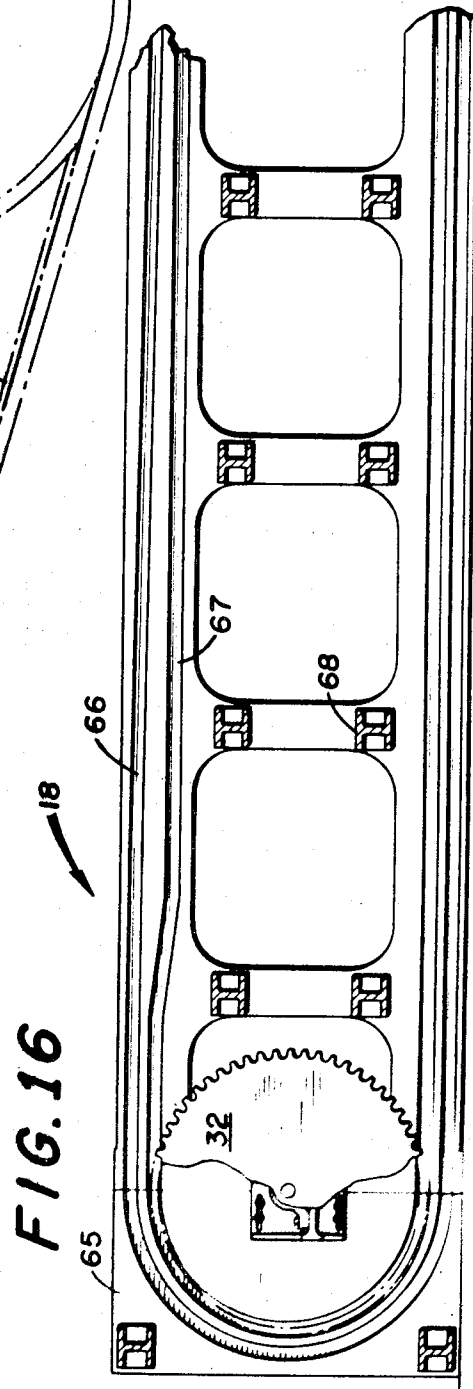
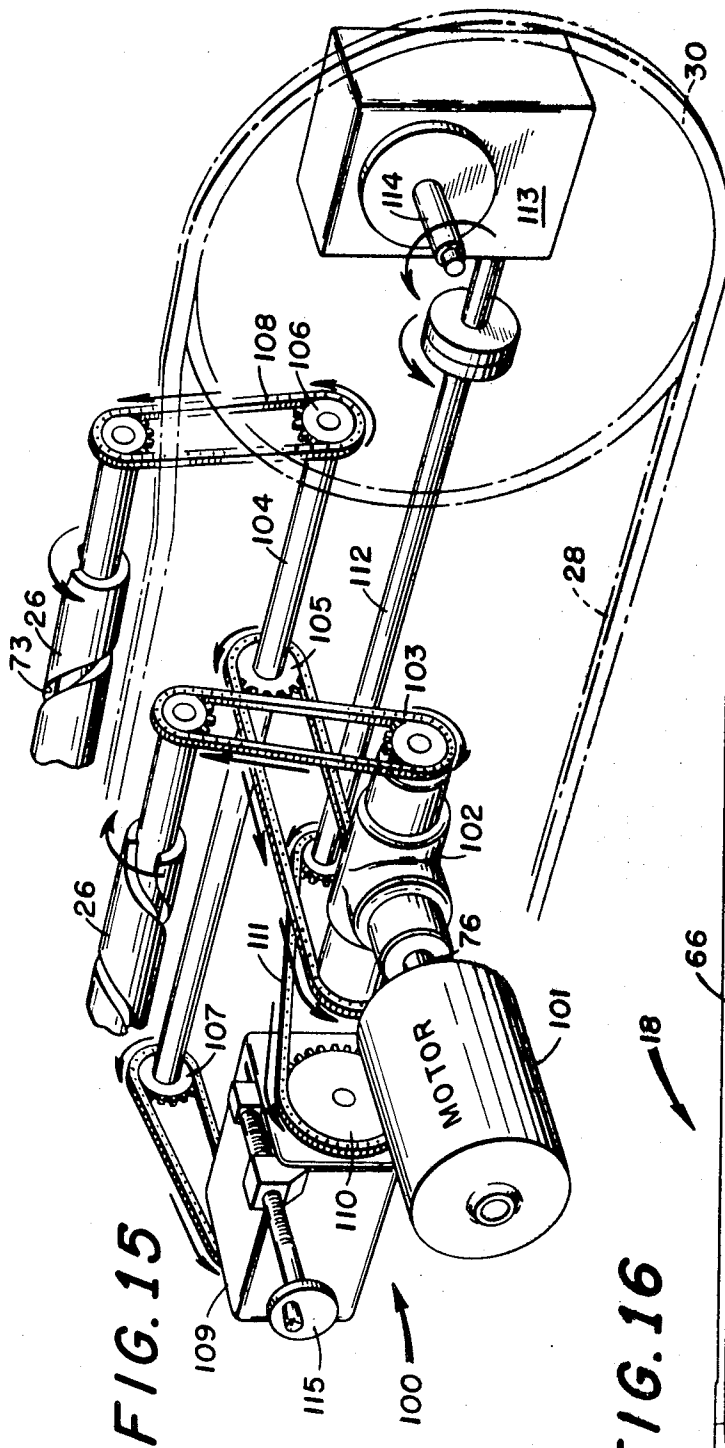


FIG. 14

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VARIABLE SPEED SIDEWALK

The invention herein described was made in the course of or under a contract or subcontract thereunder, with the Department of the Navy.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to the art of moving conveyors which are particularly useful as sidewalks or article conveyors and which have the capability of providing a variable speed surface for receiving an object at a relatively low travel rate and accelerating it to a relatively high travel rate.

2. Description of the Prior Art

The invention is primarily directed to solution of the mass transportation problem within congested areas. Since the bus replaced ambulation as the most rapid intra-urban form of transportation, congestion within present urban centers has virtually returned the status of pedestrian to its former rank as the most efficacious means for urban movement. A variable speed walkway, operated either as an integral part of a full-scale urban transportation system or utilized independently over relatively short distances, offers perhaps the greatest potential for reversing this discouraging trend.

Mechanized sidewalk surfaces movable at constant speeds have long been proven useful due to the high capacity per unit width of such devices. The provision of a variable speed capability in a moving sidewalk has been recognized as a desirable means by which the capacity and utility of such devices could be materially increased. However, previous attempts to introduce a variable speed capability into a moving sidewalk have proven fruitless for a number of reasons, chief among them being material fatigue failure under the extreme operating conditions generally imposed by various prior art designs or the unacceptable openings in the sidewalk surface commonly encountered in prior art approaches. In particular, stretchable belts, such as is disclosed by Parloungue in U. S. Pat. No. 1,671,207, or variable width belts, such as is disclosed by Ayres et al in U. S. Pat. No. 3,465,689, share these deficiencies. Parloungue is of particular interest due to his use of a variable pitch helix, commonly referred to hereinafter as a variable pitch screw, to drive transverse rods which are closely spaced and held within a stretchable belt. As the rods are accelerated by the action of a pair of the helices, the belt stretches to provide a continuous accelerating surface. However, the device is impractical due not only to material failure of the stretchable belt after only a short period of operation, but also because of the relatively unsupported spacings between the rods which develop on acceleration thereof.

L'Heritier in U. S. Pat. No. 1,793,498 and Bouladon et al in U. S. Pat. No. 3,352,250 also utilize variable pitch screws to drive transverse supportive members along a fixed loop. However, the prior art does not disclose the tilting, mutually overlapping "leaf" structure which comprises the present invention. Of particular note is the fact that the present leaf structure presents a sturdy flat surface to the feet of a user not only during the constant low and high-speed travel phases of its operation, but also is essentially flat during the acceleratory and deceleratory phases thereof.

SUMMARY OF THE INVENTION

The invention comprises a variable speed continuous belt primarily intended for use as the exposed walkway surface of a variable speed sidewalk. The continuous belt of the invention is itself comprised of a plurality of interdigitated discrete units, or "leaves", which tilt and mutually overlap over varying portions of their individual surfaces in a predetermined fashion. Thus, a relatively smooth, level surface is presented to a user for safe entry onto the sidewalk at a constant, relatively slow rate of travel. The surface is maintained during a smooth and even acceleration of a user to a constant, relatively high rate of travel and also, if dictated by the design parameters of a particular application, during a similar deceleration to a safe, relatively slow disembarkation speed. The invention effects the necessary acceleration and deceleration phases both smoothly and gradually without "stepwise" discontinuities, thus lending its safe use to individuals of all ages and of most physical conditions.

Generally, the moving sidewalk of the invention is comprised of a variable speed continuous belt, at least two longitudinal supporting structures having fixed closed loop tracks formed therein for the belt to follow, and motive power means for driving the belt around the tracks. The individual units, or leaves, comprising the belt are fitted with upper and lower rollers on each end thereof, which rollers respectively engage outer and inner lanes of the track formed in each of the supporting structures. Generally, that portion of the outer lane in which the "exposed" portion, or passenger carrying portion, of the belt is running gently slopes downwardly from horizontal during acceleration of the belt and gently slopes upwardly from horizontal during deceleration. The inner lane and that portion of the outer lane in which the constant, high-speed portion of the belt runs are substantially horizontal throughout that portion of the closed loop in which the belt is exposed for use. The leaves are additionally fitted with two screw followers which engage the threads of two variable pitch screws longitudinally disposed along the sidewalk. The screws are synchronously driven at a constant rotational speed by a suitable motor and gearing arrangement.

In light of the structure briefly described, the operation of the present sidewalk may be understood. The screws drive each individual leaf at a constant slow (boarding) speed, accelerate the leaf to a constant higher (travel) speed, and decelerate each said leaf to a constant slow (exit) speed. During these sequential velocity changes, the outer lane of the track causes each leaf to tilt either toward or away from the vertical (depending on the particular velocity phase), thus progressively exposing a varying surface area of each leaf. Since the leaves are maintained in a contiguous, overlapping relation, the above described movements of the individual leaves produce a total effect of presenting a smooth, relatively flat variably accelerating surface to a user. The leaves, in tilting toward or away from the vertical, progressively overlap over either a smaller or greater portion of their upper surfaces to present the varying surface area, thus a variable velocity, to a user or to an object being moved along the continuous belt.

Thus, a principal object of the present invention is to provide a moving sidewalk having variable speed capability over its length, whereby speed changes may be accomplished smoothly and gradually without introducing open areas or discontinuities which could produce safety hazards or mechanical problems by trapping debris.

A further object of the invention is to provide a person or article conveyor wherein a locus on the boarding end of the conveyor may be accelerated from a relatively low speed to a relatively higher speed.

It is another object of the invention to provide a variable speed sidewalk in which a substantially flat surface is presented to a user.

Further objects and attendant advantages of the invention will become apparent in light of the following detailed description thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view showing that portion of the surface of the sidewalk of the invention which is presented for use, the relative surface areas of the discrete units exposed during various operational phases of the sidewalk being depicted;

FIG. 2 is a diagram illustrating the basic principles of operation of the sidewalk and particularly the relationship between the tilting interleaved plural units forming the continuous belt as they would appear at the several stages of acceleration, travel, and deceleration;

FIG. 3 is a perspective of two of the basic units, or leaves, which form the continuous belt, the leaves being shown in a tilted relation corresponding to the final phase of acceleration;

FIG. 4 is a perspective of two leaves shown in a constant, low-speed mode;

FIG. 5 is a longitudinal section of the sidewalk illustrating portions of the drive mechanism and selected leaves in various positions;

FIG. 6 is a section of the sidewalk on the line 6—6 of FIG. 5;

FIG. 7 is a detail end view illustrating two leaves in the high-speed mode;

FIG. 8 is a detail end view illustrating two leaves in the low-speed mode;

FIG. 9 is a detail section on the line 9—9 of FIG. 6, illustrating two leaves in the high-speed mode and the chain link connection therebetween;

FIG. 10 is a detail section illustrating two leaves in the low-speed mode and the chain link connection therebetween;

FIG. 11 is a detail section on the line 11—11 of FIG. 6, illustrating two leaves in the high-speed mode being driven by the variable pitch screw employed;

FIG. 12 is a detail section illustrating two leaves in the low-speed mode being driven by the variable pitch screw;

FIG. 13 is a detail section illustrating two leaves being returned around the unexposed portion of the continuous belt;

FIG. 14 is a perspective of one of the leaves of FIG. 13, the connection of other such leaves to the chain link return mechanism being shown in phantom;

FIG. 15 is a simplified perspective, with parts in broken lines, showing the drive mechanism used to operate the sidewalk; and,

FIG. 16 is an elevation in partial section showing a portion of the frame for the drive mechanism of FIG. 15.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The invention may be best understood by referring first to FIGS. 1 and 2. In FIG. 1, the surface of a moving sidewalk 10 is seen to be comprised of a plurality of individual, discrete elements, or leaves 12, having parallel longitudinal axes disposed transversely to the longitudinal axis of the sidewalk. Commencing immediately beyond an entrance platform 13, the sidewalk 10 has an entrance end 14 at which end the surface travels at a reduced speed. As the surface of the sidewalk 10 moves in the direction indicated, the leaves 12, under the motive influence of an associated drive mechanism, varies the surface area exposed to a user and accelerates said surface to a more rapid travel speed. After a predetermined length of high-speed travel, i.e., along a high-speed travel portion 16, the sidewalk surface then decelerates to a reduced exit speed at an exit end 18, whereupon debarkation onto an exit platform 15 may be accomplished. In actual practice, the inner ends of the platforms 13 and 15 would be formed with mating extensions capable of interdigitating with the leaves 12 as the leaves appear from under the platform 13 and disappear under the platform 15. According to the relative position of a leaf 12 on the surface of the sidewalk 10, each leaf 12 is seen to provide a varying proportion of the sidewalk surface per unit length thereof. For example, those leaves 12 traveling at the entrance end 14, are more closely spaced per unit length of the sidewalk surface than are those found in the high-speed travel portion 16. Effectively, each leaf 12 at the entrance end 14 presents a reduced area for formation of the total sidewalk surface area, the total sidewalk area at any point on the sidewalk 10 being the summation of the exposed surface areas of the individual leaves. At the high-speed portion 16, each leaf 12 presents an enlarged area as its contribution to the total sidewalk surface area.

FIG. 2 illustrates the manner by which the leaves 12 of FIG. 1 present varying individual surface areas to form the total sidewalk surface area. FIG. 2 essentially is a simplified diagrammatic elevation of the sidewalk 10. In this view, each leaf 12 is seen to have an upper surface 20 comprised of an essentially arcuate portion terminating in a flat portion 21. The leaf 12 has upper and lower rollers 22 and 24 disposed on each end thereof. The rollers 22 and 24 follow fixed tracks (not shown in this view) in a manner to be described hereinafter. A variable pitch screw 26 rotating in the direction shown drives each leaf 12 along the length of the sidewalk 10. The screw 26 accepts a cam follower on each leaf 12 immediately before the leaf appears at the entrance end 14. At this point, each said leaf 12 is disposed nearly vertically, only the small flat portion 21 of the upper surface 20 thereof being exposed, i.e., only the small portion 21 of the surface of the leaf 12 is horizontal in this position of the leaf and is available to contribute to the total surface area of the sidewalk 10. As the leaves 12 are accelerated by the screw 26, they tilt from the vertical under the influence of fixed upper and lower tracks (not shown) to be described and

shown hereafter. The rollers 22 and 24 follow a predetermined slope of the fixed tracks, thus causing each leaf 12 to expose an increasing portion of its upper surface 20. The leaves 12 are accelerated by the screw 26 at the same time as they are caused to tilt from the vertical. Thus, the surface of the sidewalk 10 is caused not only to accelerate along its length, but also to provide a smooth, continuous surface therealong.

Referring further to FIG. 2, the sidewalk 10 of the invention is seen to comprise a continuous belt, the belt being formed of a plurality of the individual leaves 12 joined by a driving chain 28. When the leaves 12 have been decelerated by the screw 26 and essentially returned to vertical positions, a motor-driven sprocket 30 (shown in phantom) pulls the linked leaves from the screw 26, around a passive sprocket 32 (also shown in phantom), and around a lower return loop of the sidewalk 10, whereupon the leaves are again accepted by the screw 26. The surface of the sidewalk 10 is essentially the summation of the individual upper surfaces 20 exposed on each of the leaves 12. The leaves 12 maintain a continuous surface by mutually overlapping in a fashion to be described in detail.

As seen from the preceding illustrations and description, the present sidewalk 10 has constant low speed, constant high speed, and acceleration and deceleration portions along its surface. A passenger must be able to board the sidewalk 10 at the constant low speed entrance end 14 with maximum safety. Thus, the constant low speed must be determined by safety considerations such as have been defined previously. The constant high speed to which the present sidewalk 10 may accelerate can be any reasonable multiple of the predetermined constant low speed at which the sidewalk is boarded, depending on the design parameters of each individual leaf 12. The embodiment of the invention shown and described herein is capable of a constant high speed which is three times greater than the constant low boarding speed.

FIGS. 3 and 4 most clearly illustrate the structure and operation of the leaves 12 and, with additional reference to FIGS. 6 and 14, may be conveniently referred to when describing in detail the unique structure of said leaves. The leaf 12 is seen to essentially comprise an arcuate body member 41 having the aforementioned arcuate upper surface 20 and a cut away under portion 43. The upper surface 20 is best seen in FIGS. 3 and 4, while the under portion 43 is best shown in FIG. 14. The body 41 tapers toward a trailing edge 44 and terminates along the edge 44 in a plurality of laterally and regularly disposed teeth 45. Slightly to the rear of and regularly offset from the teeth 45, a plurality of ridge-like combs 46 rise from the upper surface 20. Each comb 46 is seen to be defined by a gradually rising frontal surface 47 which angles to a reduced support surface 48. The surface 48 sharply drops off at the forward end of the body 41 to blend into the body of the leaf 12. Thus, virtually the entire upper surface 20 of each leaf 12 is comprised of or surmounted by the teeth 45 or combs 46.

Since each end of each leaf is identical, only one such end will be described. Referring particularly to FIGS. 3 and 14, the leaf 12 has an end wall 49 on which is formed a flange 50 terminating in an elongated tab

52. The surface of the end wall 49 is provided with an arcuate depression 54 for receiving a mounting bolt 55 for the upper track roller 22, the lower roller 24 being mounted in the tab 52. The rollers 22 and 24 are commercially available roller bearings of the rolling ball element type and support the leaf 12 within contoured tracks to be shown and described hereinafter.

The leaf 12 is provided with a forward wall 58 having spaced studs 59 on which are rotatably mounted cam followers 60. As best seen in FIGS. 6, 11 and 12, the cam followers are engaged by the thread of the screws 26 as the leaves move between the entrance and exit platforms 13 and 15.

Formed on the forward wall 58 between the studs 59 is a yoke 62 having a pin 64 extending therethrough which holds one of the links of the driving chain 28. As seen in phantom in FIG. 14, the yokes 62 of other leaves are connected to the chain 28 in a similar manner.

The leaves form a continuous belt, the upper portion of which presents a level, variable speed surface to a potential user. FIGS. 3 and 4 particularly illustrate the manner in which the leaves 12 interact to provide a continuous surface. In FIG. 3, two of the leaves 12 are shown as they are moving apart (accelerating) to form the constant traveling speed portion of the sidewalk. FIG. 4 illustrates the position of the leaves 12 from which this movement begins, i.e., the leaves 12 are shown in the position maintained along the constant low speed portions of the sidewalk. The teeth 45 on each of the leaves 12 are seen to be aligned and substantially overlapping. The forward under surface of each of the teeth 45 on the forward leaf 12 rides onto a small portion of the upper surface of the teeth 45 on the trailing leaf 12. As the leaves 12 are accelerated and caused to tilt by means to be shown and described hereinafter, the teeth 45 on the forward leaf 12 trace the contour of the upper surface 20 of the trailing leaf 12. In this fashion, the teeth 45 on the forward leaf 12 become enmeshed and interdigitated with the offset combs 46 on the trailing leaf 12. Coupled with the mutual tilting from the vertical which each leaf 12 is simultaneously undergoing, the teeth 45 of the forward leaf 12 and the combs 46 of the trailing leaf 12 substantially form a lengthening surface which remains locally flat throughout the movement of the leaves 12 from that position shown in FIG. 4 to the constant traveling speed position to which the leaves 12 of FIG. 3 have virtually reached. Each tooth 45 on the forward leaf 12 fits into a space between two of the combs 46 on the trailing leaf 12, thus eliminating sharp discontinuities in the walkway surface. In the constant traveling speed position, the frontal surfaces 47 of the combs 46 are exposed to constitute a substantial portion of the walkway surface presented to a user. The upper surfaces of the teeth 45 continue the exposed surface onto the adjacent leaf. The support surfaces 48 on each of the combs 46 remain hidden but perform a local support function between the leaves 12. In the constant low speed position of the leaves 12 shown in FIG. 4, virtually the entire upper surface of the trailing leaf fits into and within the previously mentioned under portion 43 of the forward leaf. As shown in FIG. 14, the under portion 43 may be formed into substantially the contour of the combs 46 to facilitate reception thereof into said portion 43.

A substantial portion of the operating mechanism of the sidewalk is illustrated in detail in FIG. 5. In this view, one of the sidewalk support structures 65 is seen to be provided with outer and inner continuous tracks 66 and 67, the tracks being essentially squarecut grooves which form a contoured path to receive the upper and lower track rollers 22 and 24. The support structures 65 are most easily formed by casting with stress relieving thereof and machining of the tracks 66 and 67 to insure dimensional stability. A numerically controlled mill is conveniently used to machine the tracks in order to obtain a desired track ordinate location to within 0.005 inch. The support structures 65 may conveniently be formed in sections and spaced apart by I-beam spacers 68, which spacers 68 also serve to support auxiliary shafting and bearings for the variable pitch screws 26. As seen in FIG. 5, the outer track 66 begins to slope toward the inner track 67 at S, the track 66 slightly curving in an S-shaped fashion throughout the acceleratory phase of the sidewalk travel. Referring briefly to FIG. 1, the slight curvature from a straight line which the upper rollers 22 follow along the outer track 66 (not seen for simplicity in FIG. 1) during the acceleration phase is easily detectable by following the curvature defined by the rollers 22. The curvature of the outer track 66 during the deceleration phase of the sidewalk is also apparent in FIG. 1, the slight curvature being essentially a reverse-S. A roller 22 traveling at a given instantaneous velocity along the acceleration portion of the sidewalk 10 is slightly higher relative to horizontal than a roller 22 traveling at the same instantaneous velocity along the deceleration portion. This extremely slight elevation differential is imposed by velocity factors involving the position of the roller 22 relative to the tilt axis of the leaf (i.e., through the lower roller 24) during the acceleration and deceleration portions of the sidewalk. This slightly curving slope of the outer track 66 toward the inner track 67 occurs during acceleration of the leaves 12 in order to cause said leaves to tilt rearwardly from the vertical, thus separating the leaves and exposing an increased portion of the upper surfaces thereof to a user. As the leaves 12 reach the constant high speed travel portion 16 (shown in FIG. 1), the outer track 66 levels and extends parallel to the inner track 67. At the point along the sidewalk where deceleration of the leaves 12 begins, the outer track 66 slopes in a curving fashion upwardly away from the inner track 67 as previously described.

As can be seen in FIG. 5, the inner track 67 slopes abruptly downward immediately aft of the sprocket 69. This abrupt slope is necessitated by the fact that the leaves 12 must be pulled from the sprocket 30 at a level sufficient to clear gearing and bearings at the ends of the screws 26 and then rapidly brought down to the level of the screws 26 for re-engagement therewith. The inner track 67 is level throughout the various acceleratory and travel phases of the sidewalk. However, as seen in FIG. 16, said inner track 67 slopes abruptly upwardly again at the return end of the sidewalk so that the leaves 12 will clear the bearings and gearing at the opposite end of the screws 26. As can be seen in FIGS. 7 through 12 and in FIG. 16, the distance between the tracks 66 and 67 varies in a predetermined fashion at different locations along the tracks.

The powered sprocket 30 is held between the support structures 65 and is driven in a manner to be described more fully hereinafter. The sprocket 30 pulls the leaves 12 along with the rollers 22 and 24 at the opposite ends thereof in the tracks 66 and 67 and around the semi-circular end portions thereof. The leaves 12 are pulled along by the sprocket and chain 28 to the point of engagement of said leaves with the screws 26. Since each leaf 12 is joined to its adjacent leaf by the chain 28, the last leaf accepted and driven by the screws 26 effectively pulls the next adjacent leaf 12 forwardly and into engagement with said screws. The length of the chain 28 between adjacent leaves 12 is greater than the maximum worm pitch of the screws 26 along the travel portions of the sidewalk. However, along those portions of the screws 26 which receive or discharge the leaves 12, the said portions not being exposed to a user, the pitch of the screws 26 is increased so that the leaves 12 will be spaced at a maximum as they approach the sprocket 30 or the sprocket 32.

The screws 26, as has been described briefly, have a predetermined pitch, or thread 70, machined into their surfaces, the cam followers 60 riding in the thread 70. The width of the thread 70 is increased at the point of engagement with the leaves 12 to provide easier acceptance of the cam follower 60 onto each expanded pitch portion of the screw 26. The pitch of the screw 26 is seen to be reduced immediately after two adjacent leaves 12 have been pulled onto the screws 26, the leaves being driven together to closely adjacent positions for subsequent exposure in the constant low speed mode.

The screws 26 are supported along their lengths by bearings 71, best seen in FIG. 6, and at their ends by thrust bearings 72. The bearings 71 must function with an opening at the top thereof to allow free passage of the cam followers 60 therethrough. Each bearing 71 is seen to comprise a slotted annular housing 73 having a channel 74 therethrough which receives arcuate oil-impregnated bearing inserts 75. Since destruction of the circular continuity of this type of bearing alters its self-lubricating ability, a lubrication reservoir (not shown) can be provided to prolong its useful life. As will be appreciated more fully when described with reference to FIG. 5 and also to FIG. 15, the screws 26 and sprocket 30 are driven by a motor 101 which is connected to an input shaft 76. The motor is connected through appropriate gearing to rotate the screws 26 in inwardly turning opposite senses and the sprocket 30 in counter-clockwise direction.

FIG. 6 best illustrates the several points of connection which a leaf 12 maintains with the support structure and driving mechanism of the sidewalk. Particularly, a leaf 12 is shown driven by the two variable pitch screws 26, a portion of the powered sprocket 30 also being shown. The leaf 12 is seen to be supported by four rollers, i.e., the two upper track rollers 22 and the two lower track rollers 24, which move in the outer and inner tracks 66 and 67 formed in the two support structures 65. As previously described, the predetermined contours of the tracks 66 and 67 control the tilt angle of the leaves 12, thereby providing a smooth and relatively flat sidewalk surface along the length of the exposed portion thereof. The cam followers 60 which move along the variably pitched thread 70 in the screws

26 enable the leaf to be driven at varying speeds to provide accelerating, decelerating, and constant speed portions along the exposed surface of the sidewalk.

FIGS. 7 through 12 clearly illustrate the operation of the leaves 12. FIGS. 7, 9, and 11 depict the leaves in the relative positions assumed along the constant high speed travel portion, i.e., the portion 16 of FIG. 1. FIGS. 8, 10, and 12 picture the leaves in their closely spaced low speed positions, such as at the end 14 shown in FIG. 1. Referring particularly to FIG. 8, three of the leaves 12 are shown traveling from the right to the left of the figure in the low speed mode. The surface 80 presented to a user is that surface essentially formed by the upper surfaces of the teeth 45. As the distance between the outer and inner tracks 66 and 67 is reduced, i.e., as the outer track 66 slopes toward the inner track 67, the leaves tilt from the vertical position of FIG. 8 toward the position shown in FIG. 7. While undergoing this tilting movement, the leaves also separate in relation to each other, the teeth 45 of each leaf following the arcuate upper surface 20 of its rearwardly adjacent leaf. Thus, each leaf rotates about an axis through the lower track rollers 24. Throughout the motions described, an essentially flat surface is continuously presented to a user. The surface 80 gradually gives way as the leaves tilt away from the vertical to expose the frontal surfaces 47 of the combs 46. Essentially, the surface 81 exposed to a user in the constant high speed travel of FIG. 7 is comprised of the frontal surfaces 47 of the combs 46 and small portions of the upper surfaces of the teeth 45 and the surfaces 48 of the combs 46 located between successive transverse rows of frontal surfaces 47. Spaces between the teeth 45 receive the combs 46 in a manner described previously.

FIGS. 9 and 10 more clearly illustrate the chain 28 at its point of attachment to each leaf 12, i.e., at the yoke 61. In both the constant low speed mode and the high speed travel mode, the chain 28 falls into a slack position below the leaves 12. However, as seen in FIGS. 13 and 14, the chain is stretched to its full length during the leaf return along the unexposed return portion of the sidewalk. As the leaves 12 move from the screws 26 at the opposite end of the sidewalk from which they engaged said screws, i.e., the end 18 shown in FIG. 16, they are brought around the passive sprocket 32 which essentially forms the semi-circular end of the sidewalk and are returned to the sprocket 30. During this return, the chain 28 maintains the leaves in a spaced, taut relationship, thereby completing the loop and reducing the number of leaves required to form said loop.

FIGS. 11 and 12 more clearly illustrate the variably pitched threads 70 of the screws 26. In the low speed mode of FIG. 12, the threads 70 have an instantaneous slope which is nearly vertical. In the high speed travel mode of FIG. 11, the slope of the threads 70 tends toward the horizontal. The slope of the threads 70 during the acceleration and deceleration phases gradually vary in a regular fashion between these two conditions. The cam followers 60 are best seen in these figures to be mounted on the extensions 59 which rise from the frontal edge 58 of each leaf 12. More specifically, the followers 60 are mounted on cylindrical hubs 89 spaced from the extensions 59 by arm supports 90.

Although the sidewalk may be powered by means other than the motor 101, a brief description of a prime mover including said motor is set forth hereinbelow. FIG. 15 illustrates the principal elements of a suitable power train 100. FIGS. 5 and 6 also show portions of the power train. The motor 101 has a shaft 76 connected to a 1:1 right angle gear box 102. The gear box 102 directly drives the screw 26 nearest the motor 101 in a clock-wise direction, the sense of rotation of said screw 26 being toward the longitudinal axis of the sidewalk. A simple gear and chain arrangement 103 provides mechanical connection between the gear box 102 and the screw 26. The opposite output end of the gear box 102 drives a jack shaft 104 through a gear 105 located along said shaft 104. Gears 106 and 107 on the shaft 104 are thus rotated in a counter-clockwise direction. A chain 108 connects the gear 106 to the other screw 26, thereby imparting to said other screw rotation at an angular velocity equal to that of the screw 26 driven directly from the gear box 102. The gear 107 on the other end of the jack shaft 104 is mechanically coupled to a variable ratio gear box 109, the input to the gear box 109 being constant. The output of the gear box 109 is connected through a gear 110 and chain 111 to a drive shaft 112. The shaft 112 is coupled to a right angle worm gear box 113, thus driving a shaft 114 on which the sprocket 30 (shown in broken lines in FIG. 15) is held. Adjustment of the output of the gear box 109 by means of vernier adjustment wheel 115 allows selection of the proper rotational velocity of the sprocket 30. As can be best seen in FIGS. 5 and 6, the gear boxes and shafts of the power train 100 may conveniently be supported on the several spacers 68. The gear box 113 which directly drives the sprocket 30 is supported by upper and lower mounting brackets 116 and 117 connected to the sidewalk support structure 65 opposite the motor 101. As seen in FIG. 15, the two screws 26 rotate inwardly to prevent binding of the rollers 22 and 24 of the leaves 12 within the tracks 66 and 67.

In order to insure complete understanding of the operation of the present sidewalk, a brief summary referenced generally to the drawings and particularly to specific figures, as necessary, follows. Referring first to FIG. 2, rollers 22 and 24 of the leaves 12 are seen to be movable in the outer and inner tracks 66 and 67, said leaves being joined in a continuous loop by the chain 28. Immediately below the entry platform 13, the powered sprocket 30 moves the leaves 12 into positions for engagement with the screws 26. The screws 26 have a pitched thread 73 at the ends thereof equal to the pitch of the chain 28. The screws 26, through the successive connections between the leaves 12, pull each leaf 12 away from the sprocket 30. At the point of release from the sprocket 30, the inner track 67 slopes abruptly downwardly to move each leaf 12 to the level of the screws 26 for engagement therewith. The outer track 66 also slopes very slightly to co-ordinate with the slope of the inner track 67.

After entry of the leaves 12 onto the screws 26 and immediately prior to movement of said leaves from beneath the platform 13 (as can be also seen in FIG. 5), said leaves are slowed and caused to group together by the narrow pitch of the screws 26. Thus the leaves 12 are first exposed to a user in a substantially vertical

position and at a constant low speed. FIGS. 4 and 8 clearly illustrate this position and the portions of the leaves which comprise the surface of the sidewalk 10. The leaves are caused to accelerate by the regularly increasing pitch of the screws 26. Simultaneously, the outer track 66 slopes gradually downwardly toward the inner track 67, thus causing the leaves to tilt rearwardly from the vertical, thereby gradually exposing the combs 46 on said leaves and continuously presenting a safe travel surface to a user. At a predetermined sidewalk surface velocity and tilt angle of the leaves 12, the screws 26 maintain a constant pitch and the outer track 66 resumes a horizontal position, thereby remaining a fixed distance from the inner track 67. Thus, the leaves 12 travel at a constant relatively high speed along the middle portion of the sidewalk, i.e., the travel portion 16.

The leaves 12 are decelerated in a fashion essentially the reverse of the operations which accelerated them. Briefly, the pitch of the screws 26 gradually reduce and the outer track 66 slopes gradually upwardly from the inner track 67. The leaves 12 tilt back toward the vertical, thus reducing the exposed surface area of each leaf. At the exit platform 15, the surface of the sidewalk 10 is again traveling at a constant speed sufficiently reduced to allow safe exit therefrom. Under the platform 15, the pitch of the screws 26 increases to match the length of the link chain 28, thus bringing the leaves 12 to full separation whereby said leaves are pulled around the passive sprocket 32 and returned along the lower portion of the loop by force exerted by the powered sprocket 30. The position of the leaves 12 during this return phase is clearly shown in FIGS. 13 and 14.

The invention may be embodied in apparatus other than that specifically shown and described herein. In particular, the leaves 12 may be driven by means other than the variable pitch screws 26. Mechanical devices, such as expansion links, could be employed to provide acceleration, deceleration, and constant speed operation of the leaves. Basic to the invention is the function of each of the leaves 12. However, as noted previously, each leaf may be configured other than as shown to provide various low speed to high speed ratios, etc. Of particular note is the use of the screws 26 to drive the leaves along only the acceleration and deceleration portions of the sidewalk. In such a sidewalk system, the chain 28 could be made shorter in order to be fully extended at the point where the leaves 12 reach the constant high speed travel portion 16 of the sidewalk. Thus, the leaves would disengage the screws 26 and be pulled along the constant speed portion 16. Deceleration would occur by re-engagement of the leaves 12 with a separate set of deceleration screws at the opposite end of the sidewalk. In this fashion, a longer sidewalk could be constructed without the expense and operational problems associated with an extremely lengthy screw 26. Supplementary drive sources would certainly be required if such an arrangement were designed to travel any great distance. The sidewalk 10 may also be structured to remove the slight unobjectionable slope of the surface during the acceleration and deceleration phases by reversing the functions of the tracks 66 and 67 and by causing the screws 26 to maintain contact with the cam followers 60 during

these phases. This second-mentioned function could be accomplished by changing the position of the screws during these phases (i.e., by lifting them up) or by cutting high walled grooves in the screws 26 along the acceleration and deceleration portions thereof. It is believed obvious that such modification of the concepts shown and described herein are within the scope of the invention as recited in the following claims.

We claim:

1. A variable speed sidewalk comprising

a plurality of tiltable discrete transverse members, the members forming an exposed surface on which a user may stand and which surface is movable at differing speeds at various points thereon, each member having an upper surface which is variably exposed on tilting movement of the member to alter the proportional contribution of the upper surface of the member to the total exposed surface area of the sidewalk,

means for tilting the members from a substantially vertical position toward a substantially horizontal position to increase said proportional contribution of each member to the total area of the exposed surface, thereby to form an accelerating portion thereof, the means subsequently further tilting the members back toward a substantially vertical position to form a decelerating portion of the exposed surface, and

power means for driving the member at differing speeds as said members undergo tilting movement.

2. The variable speed sidewalk of claim 1, wherein the upper surface of each member has a comb thereon, the combs of the members forming a transverse surface exposable on tilting movement of said members to increase the exposed surface area provided by the members.

3. The variable speed sidewalk of claim 1, wherein the power means comprise at least one variable pitch screw, the screw having a thread so pitched that the members will be accelerated during tilting thereof away from the vertical.

4. The variable speed sidewalk of claim 1 wherein said means for tilting the members comprises inner and outer tracks and upper and lower rollers respectively engageable with the inner and outer tracks, the outer track sloping at a first point along the sidewalk toward the inner track to cause each member to tilt away from the vertical and to expose an increasing portion of the transverse surface thereof for use, thereby forming an acceleratory portion of the sidewalk, the outer track at a second point along the sidewalk sloping away from the inner track to cause each member to tilt back toward the vertical, thereby decreasing the contribution of each member to the exposed surface of the sidewalk and thus forming a deceleratory portion of the sidewalk.

5. The variable speed sidewalk of claim 4 wherein said track means are formed in a continuous loop.

6. A continuous belt having portions of its surface movable at differing speeds, the belt comprising a plurality of discrete, tiltable transverse members, each member being of arcuate contour and having a transversely extending comb on its upper surface, the comb having a flat transverse surface which is exposed on tilting movement of the

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member to alter the proportional contribution of the member to the surface area of the belt, the members further being mutually separable at both predetermined temporal and physical intervals, means for tilting the members away from the vertical during relative movement therebetween at a predetermined position of the belt to form an accelerating portion, and power means for driving the belt.

7. The continuous belt of claim 6, including additionally means connected between the members and said power means for driving said members at different speeds at predetermined positions of said belt.

8. The continuous belt of claim 6, wherein successive members are closely spaced at loci on the surface of the belt traveling at a constant relatively low speed, said members tilting away from the vertical during acceleration thereof by the power means to expose increasing portions of the upper surfaces of said members, the teeth of each member of the belt following the arcuate contour of the upper surface of the next rearward member and interdigitatably meshing with the teeth of the comb of said next rearward member to expose the transverse surface formed by said teeth and said comb.

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9. The continuous belt of claim 6, wherein the members discontinue tilting movement on full exposure of the transverse surface formed by the combs and the teeth of the members, being driven in the full exposure position at a constant relatively high speed by the power means.

10. The continuous belt of claim 9, wherein the members are tilted toward the vertical following travel at the constant relatively high speed to decrease the proportional surface area provided by each member and simultaneously decelerated by the power means.

11. The belt of claim 10, including additionally a continuous chain, said members being connected to said chain at spaced points therealong.

12. The continuous belt of claim 5 wherein each member has a trailing edge which includes a transversely extending series of teeth, the teeth interdigitating between the elements of the comb on the upper surface of the rearwardly adjacent member, said teeth following the curvature of the upper surface of said rearwardly adjacent member on tilting movement of the members.

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