

## DESCRIPTION

## CONVEYER APPARATUS

## 5      Technical Field

The present invention relates to a conveyer apparatus, for example, escalator, moving side walk, etc.

## Background Art

10      A conveyer apparatus, such as escalator and moving side walk, includes a plurality of steps provided with step rollers. These steps are integrated with an endless step chain by connecting the step rollers of the respective steps with each other through the endless step chain at regular intervals. In operation, the step chain is driven by a chain driving mechanism, so that all of the steps can move synchronously with no space  
15      between. With engagement of the step rollers with a step guide-rail installed in a structure, these plural steps are supported by a step guide-rail, thereby effecting a circulation movement of the steps between an entrance and an exit. Noted that although technical terminology of "steps" may be called "treadboards" in case of a moving side walk because of its  
20      horizontal movement, these treadboards of moving side walk are expressed by "steps" in this specification.

In the chain driving mechanism for driving a step chain, generally, the turnover end of an endless step chain is wound about a drive sprocket to be rotated by a motor. In operation, a driving force of the motor is  
25      transmitted to the step chain through the drive sprocket. Usually, such a chain driving mechanism is usually arranged in a structure called "truss" in the vicinity of an entrance or an exit for a conveyer apparatus.

Conventionally, a sufficient space for installation has been required for a truss including a chain driving mechanism. Recently, since  
30      miniaturization for truss is realized with progress in installation technique etc., they makes an attempt to make the whole conveyer apparatus thin to occupy as little space as possible. When a truss is miniaturized in the above way, it is necessary to use a small-diameter drive sprocket for a chain driving mechanism arranged in the small-sized truss. In case of  
35      adopting such a small-diameter drive sprocket, however, a large unevenness arises in the velocity of the step rollers connected with a step

chain. Then, this "velocity" unevenness reveals itself in the form of vibration of the steps, thereby causing the ride quality of the conveyer apparatus to be deteriorated.

Japanese Patent Application Laid-open No. 8-217368 disclose a  
5 technique to make movement of steps smooth by reducing unevenness in velocity of step rollers. According to this technique disclosed in Japanese Patent Application Laid-open No. 8-217368, as shown in Fig. 1, there is established a positional relationship between a step guide-rail 102 for supporting step rollers 101 connected with each other through a step  
10 chain 100, and a drive sprocket 103 where a bearing surface (running track) 102a of the step guide-rail 102 is apart from a tangential line 103a of the drive sprocket 103 by a gap ho. The step guide-rail 102 is provided, on its end close to the drive sprocket 103, with a compensating rail 104. In the compensating rail 104, its bearing surface (running track)  
15 104a supporting the step rollers 101 is level, on the side of the step guide-rail 102, with the bearing surface 102a of the step guide-rail 102 and also level, on the side of the drive sprocket 103, with its groove engaging with the step rollers 101. Further, the intermediate portion of the compensating rail 104 is shaped so as to describe a smooth curve. In  
20 movement, the step rollers 101 each moving linearly while being supported by the bearing surface 104a of the compensating rail 104 are engaged with the groove of the drive sprocket 103 via their curved movements, one after another. Subsequently, the step rollers 101 are subjected to rotational movements with the rotation of the drive sprocket  
25 103. In this way, the unevenness in velocity of the step rollers 101 is suppressed.

Although the above-mentioned prior art can suppress the "velocity" unevenness of the step rollers 101, the step guide-rail 102 is positioned higher than the drive sprocket 103, producing a drawback to the  
30 thin-formation of the whole conveyer apparatus. In detail, it is noted that the gap ho between the tangential line 103a of the drive sprocket 103 and the bearing surface 102a of the step guide-rail 102 is proportional to a link length of the step chain 100. Here, if a small-diameter sprocket is employed as the drive sprocket 103, the ratio of a link length of the step  
35 chain 100 to the drive sprocket 103 becomes a large value, thereby increasing the gap ho between the tangential line 103a of the drive

sprocket 103 and the bearing surface 102a of the step guide-rail 102. Thus, a truss is jumboized to produce an obstacle to the thin-formation of the whole conveyer apparatus.

Further, assuming to operate a conveyer apparatus of which outward route is turned around to form the homeward route, the homeward-route side of the step guide-rail 102 has to be arranged under the drive sprocket 103 at the same gap  $h_o$ , thereby causing an installation height of the conveyer apparatus to be increased with both intervals up and down ( $2 \times h_o$ ) considerably.

If the drive sprocket 103 is formed to have a pitch-circle diameter of 348.4 mm and eight teeth and the step chain 100 has a link length of 133.33 mm, according to inventors' provisional calculations, the gap  $h_o$  between the tangential line 103a of the drive sprocket 103 and the bearing surface 102a of the step guide-rail 102 is required to exceed 35.3 mm in order to eliminate the above-mentioned velocity unevenness of the step rollers 101 completely. Thus, putting both outward-route side and homeward-route side together, the height of 70.6 mm ( $2 \times h_o$ ) extra is required in addition to the size of the drive sprocket 103. As a result, the space-saving effect is spoiled in spite of reducing the pitch circle diameter of the drive sprocket 103 to 348.4 mm.

#### Summary of Invention

Under the conventional circumference as mentioned above, it is therefore an object to provide a conveyer apparatus which allows comfortable ride quality to be ensured by suppressing the unevenness in velocity of step rollers effectively and which can realize the thin-formation of the whole conveyer apparatus.

In one aspect, the present invention provides a conveyer apparatus comprising: a step guide-rail; a plurality of steps having respective step rollers movable along the step guide-rail; a step chain connecting the step rollers of the steps; a rotating unit generating a driving force to move the steps; a drive sprocket rotated by the rotating unit to transmit the driving force to the step chain; and a chevron-shaped deflecting part formed in a first part of the step guide-rail so as to project to the steps, the first part of the step guide-rail being positioned between a reference position that is one of a plurality of reference positions established along the step guide-rail and that is the nearest to the drive sprocket, and a driving start point established on the drive sprocket,

the driving start point being apart from the nearest reference position in a direction of the drive sprocket by a link length of the step chain, providing that a velocity " $V_t$ " represents a circle speed of the drive sprocket and a velocity " $V_o$ " represents an average velocity of the step rollers moving in connection with the step chain, wherein the reference positions are established as respective positions where a moving speed of each of the step rollers becomes the velocity " $V_o$ " as a result of decelerating from the velocity " $V_t$ ".

In the operation of an embodiment of the above-constructed conveyer apparatus, when the rotating unit drives, the drive sprocket is rotated to transmit a driving force of the rotating unit to the step chain. With the drive of the step chain, the respective step rollers of the steps connected with each other through the step chain cyclically move along the step guide-rail to transport passengers on the steps.

In example embodiments, focusing attention on three neighboring step rollers of the step rollers in succession through the step chain, when the headmost step roller reaches the drive sprocket and passes through a predetermined position (reference position), the moving speed of the headmost step roller gets slower than the average velocity of the step rollers. Then, when the second step roller reaches the chevron-shaped deflecting part at part (i.e. the first part) of the step guide-rail between the nearest reference position to the drive sprocket and the driving start point on the drive sprocket (the driving start point: a starting point from which each step roller is fed at the velocity  $V_t$  by the drive sprocket and which is apart from the nearest reference position by the link length of the step chain), the level of the second step roller changes corresponding to the profile of the chevron-shaped deflecting part. When the level of the second step roller is changed in the above way, the third step roller approaches the headmost step roller by the above change in level of the second step roller because of a constant pitch (i.e. link length) between the adjoining step rollers. In other words, this change in level of the second step roller causes the third step roller to be accelerated. As a result, the above "velocity" decrement that has been produced by of the headmost step roller is canceled out by the above "velocity" increment of the third step roller, so that the moving speed of the third step roller is maintained at the above average velocity of the step rollers.

When the headmost step roller is advanced furthermore, the moving speed of the headmost step roller becomes larger than the average speed. When the second step

roller passes through the deflecting part 43 of the step guide-rail, the level of the second step roller returns, so that the third step roller recedes from the headmost step roller and is decelerated. Consequently, the above "velocity" increment of the headmost step roller is canceled out by the above "velocity" decrement of the third step roller, so that the moving speed of the third step roller is maintained at the average velocity.

In this way, since the chevron-shaped deflecting part of the step guide-rail between the nearest reference position to the drive sprocket and the driving start point on the drive sprocket serves to absorb such a velocity unevenness about the preceding step roller so that the velocity unevenness is not transmitted to the following step roller, it is possible to maintain the moving speed of the step rollers at the average velocity generally and also possible to suppress vibration of the steps due to the above velocity unevenness, thereby accomplishing the comfortable ride quality of the conveyer apparatus. In addition, since there is no need of making the chevron-shaped deflecting part so large, the so-formed chevron-shaped deflecting part will be advantageous for the whole conveyer apparatus to be constructed thin.

#### Brief Description of Drawings

Fig. 1 is an enlarged view of an essential part of a chain driving mechanism of the conventional conveyer apparatus;

Fig. 2 is an overall structural view of a conveyer apparatus in accordance with one example of the present invention;

Fig. 3 is a view explaining the relationship between moving velocity of one step roller and its various positions in the conveyer apparatus of the present invention, in which diagram (a) is a view showing a change in moving velocity of the step roller corresponding to the positions of the step roller, diagram (b) is a view showing various positions of the step

roller where its moving velocity becomes equal to a pitch-circle speed  $V_t$  of a drive sprocket, diagram (c) is a view showing various positions of the step roller where its moving velocity becomes equal to an average speed  $V_o$ , and diagram (d) is a view showing preferable positions of a curved  
5 part;

Fig. 4 is a schematic view explaining an optimum shape of the curved part in the conveyer apparatus of the invention;

Fig. 5 is an overall structural view of a conveyer apparatus in accordance with another example of the present invention; and

10 Fig. 6 is a schematic view showing an essential part of an escalator on the application of the present invention.

#### Best Mode for Carrying Out the Invention

Embodiments of the present invention will be described with reference  
15 to the drawings.

Fig. 2 shows the whole structure of a conveyer apparatus to which the present invention is applied, schematically. A conveyer apparatus 31 of Fig. 2, which is in the form of a moving side walk that is established substantially horizontally to a road surface to convey passengers, includes  
20 a structure 32 called "truss" to support its own weight and the weight of passengers. The structure 32 is accommodated in a pit formed below the road surface.

In the structure 32, a step guide-rail 33 is arranged so as to extend from an entrance 31a to an exit 31b of the conveyer apparatus 31. The  
25 step guide-rail 33 is provided to guide the movements of a plurality of steps 34 for conveying passengers. Thus, the plural steps 34 are provided with step rollers 35 respectively. With the movements of the step rollers 35 along the step guide-rail 33, the respective steps 34 move between the entrance 31a and the exit 31b cyclically.

30 The step guide-rail 33 includes a rail body 33a provided on the outward-route side of the apparatus to have a supporting surface and a presser rail 33b provided on the homeward-route side of the apparatus. On the outward-route side of the apparatus, since the step rollers 35 are supported on the supporting surface of the rail body 33a, the steps 34  
35 translate from the entrance 31a toward the exit 31b in the direction of arrow A of Fig. 1 while making their step surfaces level with the road

surface and also exposing the step surfaces to the outside of the structure 32. In the vicinities of the entrance 31a and the exit 31b on the outward-route side, comb plates 36 are provided, at respective leading ends thereof, with combs. In movement, the steps 36 move under the  
5 comb plates 36.

On the homeward-route side of the apparatus, the steps 34 successively return from the exit 31b to the entrance 31a while the step rollers 35 are engaged between the rail body 33a and the presser rail 33b. On the side of the rail body 33a near the entrance 31a, the step guide-rail  
10 33 further includes a movable rail 33c that is movable in a direction apart from the rail body 33a.

The plural steps 34 are integrated with an endless step chain 37 since the step rollers 35 of the steps 34 are connected with each other through the step chain 37 at predetermined intervals. Since the step chain 37 is  
15 driven by a chain driving mechanism while the step rollers 35 of the steps 34 come in contact with the step guide-rail 33, the steps 34 are adapted so as to move between the entrance 31a and the exit 31b with no space between the steps 34 while being guided by the step guide-rail 33.

In the chain driving mechanism, a drive motor 38 rotates a drive  
20 sprocket 39 about which the turnover part of the step chain 37 is wound. Thus, a driving force of the drive motor 38 is transmitted to the step chain 37 through the drive sprocket 39.

The drive motor 38 as a driving source is disposed inside the structure 32 and associated with the drive sprocket 39 through the drive chain 40.  
25 The drive sprocket 30 is positioned on the side of the conveyer apparatus 31 near the exit 31b and rotatably arranged in the structure 32. Due to a driving force of the drive motor 38, the drive sprocket 38 rotates to transmit the driving force of the motor 38 to the step chain 37. While making each of the step rollers 35, which are connected with each other  
30 through the step chain 37, mesh between adjoining teeth, the drive sprocket 39 is rotated at a predetermined circle speed (pitch-circle velocity) by the driving force of the drive motor 38, thereby feeding the step chain 37 and also the step rollers 35. The conveyer apparatus 31 on the application of the present invention employs, as the drive sprocket 39,  
35 a small-diameter sprocket having a small number of teeth, for example, about sixteen teeth. With the adoption of such a small-sized sprocket as

the drive sprocket 39, it is possible to realize the miniaturization of the structure 32 and thin the whole conveyer apparatus 31, thereby providing a conveyer apparatus that occupies as little installation space as possible.

While, on the other side of the conveyer apparatus 31 near the  
5 entrance 31a, there is arranged a driven sprocket 41 which is rotated with the rotation of the drive sprocket 39 to feed the step chain 37 in cooperation with the drive sprocket 39. The driven sprocket 41 is shaped with a diameter substantially equal to the diameter of the drive sprocket 39 and also rotatably arranged in the structure 32. The step chain 37 is  
10 wound around the driven sprocket 41 and the drive sprocket 39.

The driven sprocket 41 is urged to a direction apart from the drive sprocket 39 by a spring member 42 of a chain tensioner mechanism, thereby applying an appropriate tension to the step chain 37. If the step chain 37 is expanded, the driven sprocket 41 is shifted to a direction apart  
15 from the drive sprocket 39 within a predetermined extent due to the urging force of the spring member 42 of the chain tensioner mechanism, thereby taking up the slack about the step chain 37. Note, when the driven sprocket 41 moves, the above-mentioned movable rail 33c of the step guide-rail 33 is moved to a direction apart from the drive sprocket 39 due  
20 to the urging force of the spring member 42 of the chain tensioner mechanism, in association with the driven sprocket 41.

Meanwhile, it is noted that each step roller 35 moving along the step guide-rail 33 is subjected to unevenness in its moving velocity when the linear movement along the step guide-rail 33 is changed to the curved  
25 movement along the drive sprocket 39, due to the engagement with the drive sprocket 39. The smaller the diameter of the drive sprocket 39 is established, the more remarkably the "velocity unevenness" of the step rollers 35 becomes. In such a case, the steps 34 are oscillated to produce a main cause to deteriorate the ride quality.

Therefore, in the conveyer apparatus 31 on the application of the  
30 present invention, the step guide-rail 33 is provided, at a leading end thereof, in detail, at the introductory part of the rail body 33a (outward-route side) for the drive sprocket 39, with a chevron-shaped deflecting part 43. Here, the introductory part for the drive sprocket 39  
35 means a region (position) to deliver the step roller 35 from the step guide-rail 33 to the drive sprocket 39.

The conveyer apparatus 31 further includes chevron-shaped deflecting parts 43 arranged at the leading end (homeward-route side) of the step guide-rail 33 near the drive sprocket 39 and at the leading ends (both outward-route side and homeward-route side) of the movable rail 33c near the driven sprocket 41, for absorbing the velocity unevenness of the step rollers 35. Consequently, the step rollers 35 pass through the chevron-shaped deflecting parts 43 while following the tracks corresponding to the contours of the deflecting parts 43. Noted that, recesses 44 are formed at respective positions opposing these deflecting parts 43 so that the step rollers 35 can move along the deflecting parts 43 appropriately.

At a position opposing the front part of the deflecting part 43 (i.e. section of the part 43 closer to the entrance 31a) in the vicinity of the drive sprocket 39 (on the outward-route side), a presser member 45 is arranged in order to prevent the trailing step roller 35 from being lifted since the preceding step roller 35 passes through the deflecting part 43. Being arranged below the comb plate 36, the presser member 45 comes into contact with the top end of one step roller 35 traveling near the drive sprocket 39, thereby preventing the lifting of the step roller 35. Additionally, at a position opposing the rear part of the deflecting part 43 (i.e. section of the part 43 closer to the exit 31b) in the vicinity of the driven sprocket 41 (on the outward-route side), there is arranged another presser member 45 that comes into contact with the top end of one step roller 35 thereby preventing the lifting of this step roller 35.

It is noted that if only providing at least one deflecting part 43 in the rail body 33a at its introductory part (on the outward-route side) for the drive sprocket 39 of the rail body 33a, then the "velocity unevenness" of the step rollers 35 is effectively absorbed to make the movements of the rollers 35 smooth, whereby the vibration about the steps 34 can be suppressed effectively. Nevertheless, since the deflecting part 34 is further arranged at the leading end (on the homeward-route side) of the step guide-rail 33 on the side of the drive sprocket 39, it would become possible to suppress the vibration of the steps 34 effectively with the smooth movements of the step rollers 35 even if the operation of the conveyer apparatus 31 is reversed.

Although there is a tendency that the rotating speed of the driven

sprocket 41 is easy to become unstable due to the velocity unevenness of the step rollers 35, the provision of the deflecting parts 43 at the leading ends (both outward-route side and homeward-route side) of the movable rail 33c near the driven sprocket 41 allows the velocity unevenness of the  
5 step rollers 35 on the side of the driven sprocket 41 to be suppressed effectively, so that the rotating speed of the driven sprocket 41 can be stabilized to suppress the vibration of the steps 34 effectively. Further, even if the operation of the conveyer apparatus 31 is reversed, the similar effects mentioned above would be expected by the provision of the  
10 deflecting parts 43 on the side of the driven sprocket 41.

The deflecting part 43 for absorbing the velocity unevenness of the step rollers 35 will be described in detail with reference to Figs. 3 and 4.

Again noted that each step roller 35 is subjected to a velocity unevenness shown with (a) of Fig. 3 since the step rollers 35 to be moved  
15 linearly are driven by the circular drive sprocket 39. That is, providing that " $V_t$ " represents a pitch-circle velocity (circle speed) of the drive sprocket 39, each step roller 35 has a velocity unevenness such that the moving speed is once decelerated from the velocity  $V_t$  and subsequently accelerated to the velocity  $V_t$  again. Here, when the average velocity of the step roller 35 is represented by  $V_o$ , the moving speed of each step  
20 roller 35 reaches the velocity  $V_t$  when each step roller 35 occupies respective positions shown with (b) of Fig. 3. Thereafter, when each step roller 35 occupies respective positions shown with (c) of Fig. 3 as a result of its advancing toward the drive sprocket 39 by a predetermined distance, the moving speed of each step roller 35 becomes the average velocity  $V_o$ .  
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Assuming that the above positions where the moving speed of each step roller 35 has reached the velocity  $V_o$  as a result of the roller's decelerating from the velocity  $V_t$  are referred as "reference positions" respectively, the deflecting part 43 is shaped so as to describe a  
30 chevron-shaped curve projecting the step guide-rail 33 toward the steps 34 and also arranged between the nearest one of the plural reference positions established along the step guide-rail 33 to the drive sprocket 39 and a driving start point on the drive sprocket 39, which is apart from the nearest reference position toward the drive sprocket 39 by one link length " $r$ " of  
35 the step chain 37. Here, the driving start point on the drive sprocket 39 means a starting point from which each step roller 35 is fed at the

pitch-circle velocity  $V_t$  by the drive sprocket 39. In the respective step rollers 35 connected in succession through the step chain 37, a certain step roller 35 moves along the curved contour of the deflecting part 43 while changing its own level. Consequently, since the velocity unevenness of the step rollers 35 preceding the above step roller 35 is absorbed due to the change in level of the surmounting step roller 35, the velocity unevenness is not transmitted to the following step rollers 35, whereby their moving speeds can be maintained at the average velocity  $V_o$ .

In the above way, each of the deflecting parts 43 has a function to prevent an occurrence of the velocity unevenness of the step rollers 35 following one step roller 35 passing through the deflecting part 43. According to this embodiment, since the conveyer apparatus 31 has the deflecting part 34 formed in the step guide-rail's portion between the nearest one of the plural reference positions established along the step guide-rail 33 to the drive sprocket 39 and the driving start point on the drive sprocket 39, it is possible to keep the moving speeds of the step rollers 35 generally constant over the almost whole area of the conveyer apparatus 31 from the entrance 31a to the exit 31b, whereby the vibration of the steps 34 can be suppressed effectively.

Next, an appropriate profile of the deflecting part 34 will be described with reference to Fig. 4.

Since one step roller 35, which has been transferred toward the drive sprocket 39 through the deflecting part 43, engages with the drive sprocket 39 at its drive starting point, the moving speed of the step roller 35 becomes equal to the pitch-circle velocity  $V_t$ . Here, such a step roller 35 that the moving speed of  $V_t$  can be realized due to the engagement with the drive sprocket 39 at the drive starting point will be called "sprocket roller 35a" for the sake of convenience. Additionally, the second step roller 35 from the above sprocket roller 35a toward the front part of the step guide-rail 33 (or the entrance 31a of the apparatus 31) over the deflecting part 43, travels at a constant speed (average velocity  $V_o$ ) since the step roller 35b adjacent to the sprocket roller 35c is moving along the deflecting part 43. Here, such a step roller that is the second one from the sprocket roller 35a toward the front part of the step guide-rail 33 over the deflecting part 43 and that is expected to have a constant speed will be called "constant-speed roller 35c" for the sake of convenience.

Assuming that one track, which has been followed by an intersection point P1 at one circle C1 described about the center of the sprocket roller 35a with the radius of one link length "r" of the step chain 37 and another circle C2 described about the center of the constant-speed roller 35c with the radius of one link length "r" of the step chain 37 during the displacements of these steps rollers 35a, 35b, 35c by one pitch, coincides with a roller centroid L of the figure, it is desirable to form the deflecting part 43 with a profile copying the above roller centroid L.

Owing to the above establishment in the profile of the deflecting part 43, in the course that the step roller 35b between the sprocket roller 35a and the constant-speed roller 35c passes through the deflecting part 43, the velocity unevenness about the sprocket roller 35a is absorbed by the change in level of the step roller 35b corresponding to the profile of the deflecting part 43 theoretically and completely, whereby the moving speed of the constant-speed roller 35c can be maintained at a constant speed (average velocity  $V_0$ ).

Here, providing that the deflecting part 43 is formed with a profile copying the above-mentioned roller centroid L under conditions of sixteen teeth of the drive sprocket 39 and 133 mm in the link length of the step chain 7, the deflecting part 43 results in a vertical interval of 133 mm from the top surface of the step guide-rail 33 according to inventors' provisional calculations.

In the present conveyer apparatus 31, as mentioned above, since the deflecting part 43 is formed with a profile copying the above-mentioned roller centroid L in the part of the step guide-rail 33 between the reference position nearest to the drive sprocket 39 and the driving start point on the drive sprocket 39 and the conveyer apparatus 31 is constructed so that the step rollers 35 connected in succession through the step chain 37 can pass through the deflecting part 43, it is possible to fix the moving speed of the step rollers 35 following the step roller 35 passing through the deflecting part 43 and also possible to suppress the vibration of the steps 34 effectively, thereby enabling the favorable ride quality of the conveyer apparatus 31. Additionally, since the vertical interval of the deflecting part 43 is remarkably small as mentioned above, it is possible to miniaturize the structure 32, thereby making the whole apparatus 31 thin.

We describe the case of maintaining the moving speed of the step

rollers 35 following the step roller 35 passing through the deflecting part 43 at a fixed speed (average velocity  $V_0$ ), hereinbefore. If a minute velocity unevenness ( $V_0 - r\omega \sin(\omega t + \phi)$ ) is allowed in the step rollers 35, it is also possible to provide the deflecting part 43 with a smaller vertical interval. Here noted that " $\omega$ " designates an angular velocity, " $t$ " denotes a time, and " $\phi$ " designates a phase difference.

That is, in this case, a step roller that the moving speed of  $V_t$  can be realized due to the engagement with the drive sprocket 39 at the drive starting point is established as a "sprocket roller" 35a, as well. Similarly, another step roller that is the second one from the sprocket roller 35a toward the front part of the step guide-rail 33 over the deflecting part 43 and that is expected to have the minute velocity unevenness ( $V_0 - r\omega \sin(\omega t + \phi)$ ) since the step roller 35b adjacent to the sprocket roller 35c travels along the deflecting part 43, is established as a "substantially constant-speed roller 35c". Then, if the track, which has been followed by the intersection point P1 at the circle C1 described about the center of the sprocket roller 35a with the radius of one link length " $r$ " of the step chain 37 and another circle C2 described about the center of the substantially constant-speed roller 35c with the radius of one link length " $r$ " of the step chain 37 during the displacements of these steps rollers 35a, 35b, 35c by one pitch, coincides with the roller centroid L, the formation of the deflecting part 43 following the roller centroid L allows the velocity unevenness of the step rollers 35 (succeeding to the step roller 34 passing through the deflecting part 43) to be suppressed within an allowable range while reducing the vertical interval of the part 43 furthermore.

In this way, when a minute velocity unevenness is allowed in the step rollers 35, it is possible to thin the whole conveyer apparatus 31 furthermore with progressed reduction in the vertical interval of the deflecting part 43.

The operation of the above-constructed conveyer apparatus 31 will be described below.

First, when the drive motor 38 as the drive source of the chain drive mechanism is driven, the drive sprocket 39 rotates, so that a driving force of the motor 38 is transmitted to the step chain 37. Then, with the drive of the step chain 37, the respective step rollers 35 of the plural steps 34 connected with each other through the step chain 37 move along the step

guide-rail 33 cyclically.

In the step rollers 35 connected with each other through the step chain 37, then, the step roller 35 approaching the drive sprocket 39 produces a velocity unevenness in the moving speed of the roller 35 in the course of engaging with the drive sprocket 39. Nevertheless, since a step roller 35 following the above step roller 35 having the velocity unevenness passes through the deflecting part 43 at the leading end of the step guide-rail 33 on the side of the drive sprocket 9, the velocity unevenness of a step roller 35 following the step roller 35 passing through the deflecting part 43 is suppressed.

Focusing attention on three neighboring rollers 35a, 35b, 35c of the step rollers 35 connected with each other through the step chain 37, we describe the operation in detail. First, when the headmost step roller 35a reaches the driving start point on the drive sprocket 39, the moving speed of the headmost step roller 35a becomes equal to the pitch-circle velocity  $V_t$  of the drive sprocket 39. Then, when the second step roller 35b reaches the deflecting part 43 at the leading end of the step guide-rail 33 on the side of the drive sprocket 39, the second step roller 35b moves while changing its level along the deflecting part 43.

When the level of the second step roller 35b changes, the constant pitch (link length) between the adjoining step rollers 35 allows the third step roller 35c to approach the headmost step roller 35a by a change in level of the second step roller 35b, so that the third step roller 35c is accelerated. Consequently, the "velocity" decrement (deceleration) of the step roller 35b is canceled out by the "velocity" increment (acceleration) of the step roller 35c, so that the moving speed of the step roller 35c is maintained at the average velocity  $V_o$ .

Here, we now discuss a case of providing no deflecting part. When the headmost step roller 35 gets on furthermore, the moving speed of the second step roller 35b ought to be reversed to become faster than the average velocity  $V_o$  conversely. Then, in case of the conveyer apparatus 21 of the present invention, since the second step roller 35b is about to surmount the deflecting part 43 arranged at the leading end of the step guide-rail 33 on the side of the drive sprocket 39, the level of the second step roller 35 returns, so that the third step roller 35c recedes from the headmost step roller 35a and is decelerated. Consequently, the velocity

increment (acceleration) of the second step roller 35b is canceled out by the velocity decrement (deceleration) of the third step roller 35c, whereby the moving speed of the third step roller 35c is maintained at the average velocity  $V_0$ .

5 It is noted that, at this time, a designated tension is applied on the step chain 37 by the above-mentioned chain tensioner mechanism. However, since the third step roller 35c is prevented from lifting by the presser member 45, the change in level of the second step roller 35b along the deflecting part 43 allows the third step roller 35c to be accelerated or  
10 decelerated appropriately, whereby the moving speed of the third step roller 35c can be maintained at the average velocity  $V_0$  certainly.

As mentioned before, in the arrangement where the deflecting part 43 is provided at the leading end of the step guide-rail 33 (on the homeward-route side) on the side of the drive sprocket 39 in addition to  
15 the deflecting part 43 in the step guide-rail 33 on the outward-route side, even if the conveyer apparatus 31 is operated in reverse, it is possible to suppress the velocity unevenness of the step rollers 35 effectively. Further, in the arrangement where the deflecting parts 43 are provided at the leading ends of the step guide-rail 33 (on both outward-route side and  
20 homeward-route side) on the side of the entrance 31a of the conveyer apparatus 31 and also the side of the driven sprocket 41, it is possible to suppress the velocity unevenness of the step rollers 35 on the side of the driven sprocket 41 effectively.

According to the conveyer apparatus 31 of the present invention, since  
25 the velocity unevenness of the step rollers 35 caused by the engagement of each step roller 35 with the drive sprocket 39 is absorbed by the deflecting part(s) 43 of the step guide-rail 33 so that the step rollers 35 move at a constant speed, the vibration of the steps 34 is effectively suppressed to enable ensuring of comfortable ride quality.

30 Additionally, as each deflecting part 43 does not require so much vertical interval to the step guide-rail 33, the structure 32 can be miniaturized to realize the thin structure of the whole conveyer apparatus 31. Especially, when the step roller 35 on the downstream side of the deflecting part 43 is allowed with a minute velocity unevenness, it is  
35 possible to reduce the vertical interval of the deflecting part 43 furthermore, whereby the whole conveyer apparatus 31 can be provided

with a further thinned structure.

It will be understood by those skilled in the art that the foregoing description of the conveyer apparatus 31 is related to one application of the present invention and therefore, various changes and modifications  
5 may be made without departing from the spirit of the present invention. For example, as shown in Fig. 5, the driven sprocket 41 of the embodiment may be replaced with a substantial U-shaped movable rail 51. Then, the step chain 37 is wound over the drive sprocket 39 and the movable rail 51. As a conveyer apparatus 50 of Fig. 5 has the same  
10 structure as that of the above-mentioned conveyer apparatus 31 but the above feature, elements similar to those of the conveyer apparatus 31 are indicated with the same reference numerals respectively and their overlapping descriptions are eliminated.

The movable rail 51 is provided, at its portion engaging with the step  
15 chain 37, with a circular part of a diameter substantially equal to the diameter of the drive sprocket 39. The movable rail 51 is adapted so as to guide the movements of the step rollers 35 while making the outer circumference of the rail 51 contact with the step rollers 35. Similarly to the driven sprocket 41 of the above-mentioned conveyer apparatus 31, the  
20 movable rail 51 is urged in a direction apart from the drive sprocket 39 by the spring member 41 of the chain tensioner mechanism, thereby applying an appropriate tension on the step chain 37.

As for the movable rail 51, it is noted that the velocity unevenness of the step rollers 35 may cause the rail 51 to be vibrated in both directions  
25 approaching to and separating from the drive sprocket 39. Therefore, it is desirable to provide the deflecting parts 43 on both outward-route side and homeward-route side of the movable rail 51. Then, the velocity unevenness of the step rollers 35 on the side of the movable rail 51 is suppressed effectively, whereby it is possible to suppress the vibration of  
30 the movable rail 51 in addition to the vibration of the steps 34 effectively, making the ride quality of the conveyer apparatus 50 remarkably excellent. Further, owing to the provision of the deflecting parts 43 on both sides (outward-route and homeward-route sides) of the movable rail 51, it is possible to cope with the reverse operation of the conveyer apparatus 50.

35 Although the present invention is illustrated in the form of a moving side walk in substantial parallel with a road surface to transport passengers,

the present invention is also applicable to an escalator extending over the inside of a building up and down to transport passengers.

In the escalator, it is general that a plurality of pitches of the step chain 37 correspond to one step and, in many cases, a plurality of step rollers 35 are arranged for each step. Thus, there is a tendency for an escalator to increase the number of teeth of the drive sprocket 39 in comparison with a moving side walk, as shown in Fig. 6. In the application of the invention to such an escalator where the deflecting part 43 is formed in an introductory part of the step guide-rail 33 to the drive sprocket 39, as similar to the above-mentioned application to a moving side walk, it is possible to suppress the vibration of the steps 34 effectively, whereby the comfortable ride quality can be ensured. Additionally, in this case, there arises no problem that the engagement of the step rollers 35 with drive sprocket 39 is deteriorated since the step roller 35 is raised by the deflecting part 43.

#### Industrial Applicability

According to the present invention, since the chevron-shaped deflecting part of the step guide-rail between the nearest reference position to the drive sprocket and the driving start point on the drive sprocket serves to absorb the velocity unevenness about one step roller so that the velocity unevenness is not transmitted to another step roller on the downstream side of the former step roller, it is possible to maintain the moving speed of the step rollers at the average velocity generally and also possible to suppress vibration of the steps due to the above velocity unevenness, thereby accomplishing the comfortable ride quality of the conveyer apparatus.

In addition, owing to the provision of the deflecting part having a small vertical interval (height) at the step guide-rail, it is possible to realize the thin-formation of the whole conveyer apparatus while ensuring the comfortable ride quality.

## CLAIMS

1. A conveyer apparatus comprising:
  - a step guide-rail;
  - 5 a plurality of steps having respective step rollers movable along the step guide-rail;
  - a step chain connecting the step rollers of the steps;
  - a rotating unit generating a driving force to move the steps;
  - a drive sprocket rotating by the rotating unit to transmit the driving
  - 10 force to the step chain; and
  - a chevron-shaped deflecting part formed in a first part of the step guide-rail so as to project to the steps, the first part of the step guide-rail being positioned between a reference position that is one of a plurality of reference positions established along the step guide-rail and that is the
  - 15 nearest to the drive sprocket, and a driving start point established on the drive sprocket, the driving start point being apart from the nearest reference position in a direction of the drive sprocket by a link length of the step chain,
  - providing that a velocity " $V_t$ " represents a circle speed of the drive
  - 20 sprocket and a velocity " $V_o$ " represents an average velocity of the step rollers moving in connection with the step chain, wherein
  - the reference positions are established as respective positions where a moving speed of each of the step rollers becomes the velocity " $V_o$ " as a result of decelerating from the velocity " $V_t$ ".
  - 25
2. A conveyer apparatus as claimed in Claim 1, further comprising a presser member for contact with the step rollers, wherein the presser member is arranged so as to oppose a second part of the step guide-rail on the outward-route side of the conveyer apparatus, the second part of the
- 30 step guide-rail being positioned on the upstream side of the first part of the step guide-rail in the moving direction of the step rollers.
3. A conveyer apparatus as claimed in Claim 1 or 2, providing that:
  - one step roller engaging with the drive sprocket at the drive
  - 35 starting point is referred as a sprocket roller;
  - another step roller that is the second one from the sprocket roller

over the deflecting part on the upstream side of the step guide-rail and that is expected to have a constant speed is referred as a constant-speed roller; and

5 a track that is followed by an intersection point at a first circle described about the center of the sprocket roller with a radius of the link length of the step chain and a second circle described about the center of the constant-speed roller with a radius of the link length of the step chain during the displacements of the sprocket roller and the constant-speed roller by the predetermined pitch, is referred as an introductory-roller centroid, wherein

10 the deflecting part is formed with a profile copying the introductory-roller centroid.

4. A conveyer apparatus as claimed in Claim 1 or 2, providing that:  
15 one step roller engaging with the drive sprocket at the drive starting point is referred as a sprocket roller;

another step roller that is the second one from the sprocket roller over the deflecting part on the upstream side of the step guide-rail and that is allowed to have a minute unevenness in moving velocity is referred as a  
20 substantial constant-speed roller; and

a track that is followed by an intersection point at a first circle described about the center of the sprocket roller with a radius of the link length of the step chain and a second circle described about the center of the substantial constant-speed roller with a radius of the link length of the  
25 step chain during the displacements of the sprocket roller and the substantial constant-speed roller by the predetermined pitch, is referred as an introductory-roller centroid, wherein

the deflecting part is formed with a profile copying the introductory-roller centroid.

30

5. A conveyer apparatus as claimed in Claim 1 or 2, wherein the deflecting part is provided, on the homeward-route side of the step guide-rail, at its leading end closer to the drive sprocket.

35 6. A conveyer apparatus as claimed in Claim 1 or 2, further comprising:

a driven sprocket shaped to have a diameter substantially equal to the diameter of the drive sprocket;

5 a chain tensioner mechanism that urges the driven sprocket in a direction apart from the driven sprocket thereby applying a predetermined tension to the step chain; and

a movable rail that can move in a direction apart from the drive sprocket, in association with the driven sprocket, by an urging force of the chain tensioner mechanism, wherein the deflecting part is provided at a leading end of the movable rail closer to the driven sprocket.

10

7. A conveyer apparatus as claimed in Claim 1 or 2, further comprising:

15 a movable rail having a circular part of a diameter substantially equal to the diameter of the drive sprocket, the movable rail being movable in a direction apart from the drive sprocket; and

a chain tensioner mechanism that urges the movable rail in a direction apart from the drive sprocket thereby applying a predetermined tension to the step chain,

20 wherein the deflecting part is provided at a leading end of the movable rail on the opposite side of the driven sprocket.