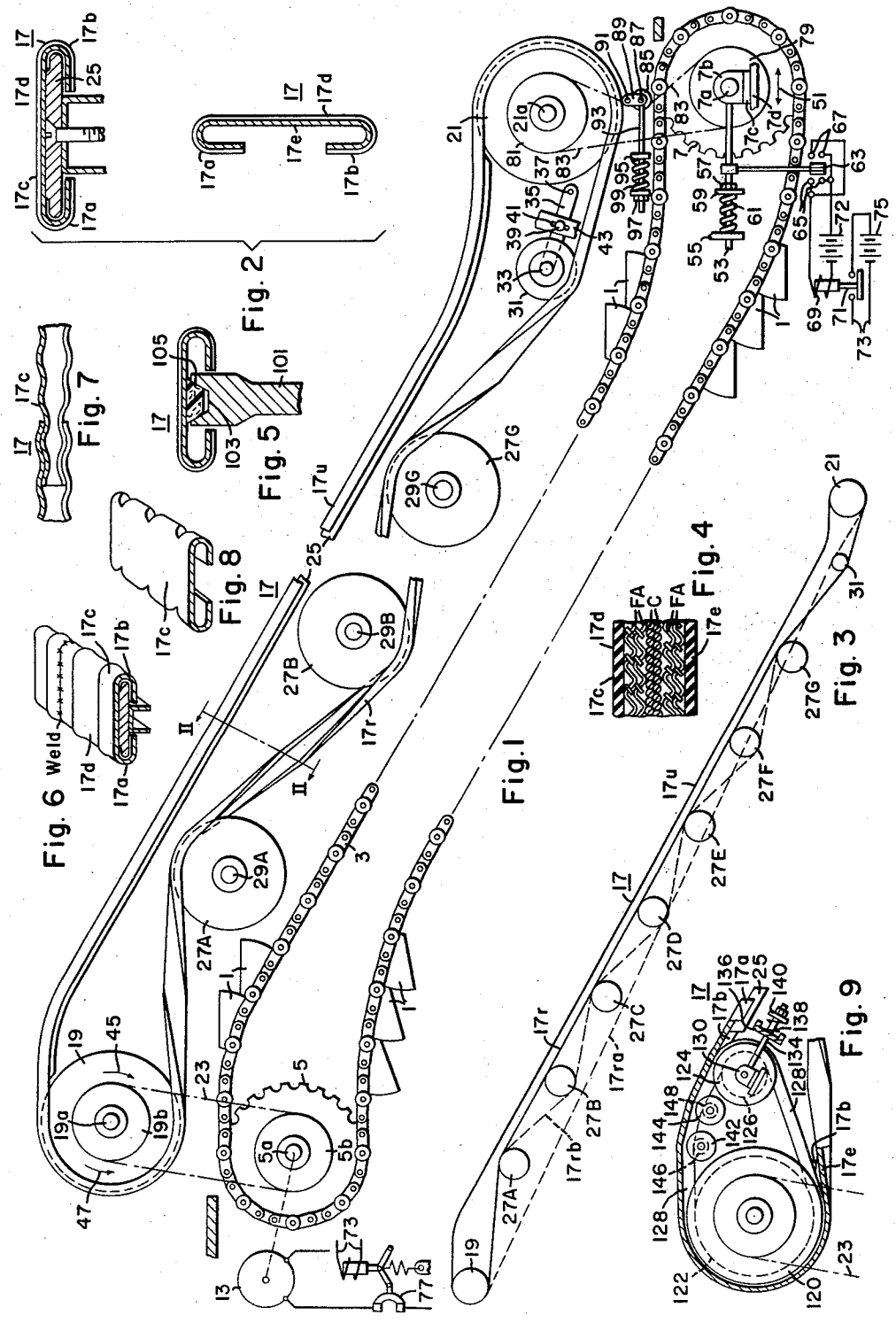
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HANDRAIL STRUCTURE FOR MOVING STAIRWAYS

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HANDRAIL STRUCTURE FOR MOVING STAIRWAYS

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This invention relates to moving stairways and it has particular relation to moving stairways having moving handrails operating in synchronism with the steps of the stairway.

In accordance with the invention, simplified guide mechanism is provided for the handrails of moving stairways. Each handrail is of continuous or endless construction and is guided about two spaced newel wheels. The upper run of the handrail between the newel wheels is employed by passengers ascending or descending on the stairway. The bottom return run is provided with a guide member preferably in the form of a wheel which is located intermediate the newel wheels and which is external to the loop formed by the handrail. The handrail on each side of the intermediate guide wheel is provided with a twist to present the same side of the handrail to the newel wheels and the guide wheel. The handrail preferably has little or no permanent set or stretch.

In order to tension the handrail, a tensioning member is located between the intermediate guide wheel and one of the newel wheels. By rotating the handrail to produce maximum sag adjacent the tensioning member, the tensioning member readily may be secured in proper position.

It is common practice to tension the step or conveyor chains of moving stairways by biasing one or more of the chain sprockets in a proper direction. Excessive movement of a sprocket biased for the aforesaid purpose may be employed for stopping all stairway movement. If the sprocket is employed for transmitting movement to an associated handrail, the coupling means is constructed to permit the desired movement of the sprocket.

The tensioning member has a range of adjustment sufficient to compensate for a substantial range of stretch of the handrail. In order to compensate for a greater range of stretch of the handrail, one or more guide devices or wheels may be located between the newel wheels for the purpose of guiding the return run of the handrail. By changing the threading of the handrail relative to the guide wheels, a substantial amount of stretch of the handrail may be compensated. By control of the twisting of the handrail between pairs of the guide wheels, the same side of the handrail is presented to all of the guide devices or wheels for all positions of the handrail.

Preferably, the handrail is constructed to have comparatively little stretch. If the handrail is constructed of an elastomer material, suitable re-enforcement is provided for the purpose of minimizing stretch. In accordance with the invention the handrail is constructed of a relatively inflexible material. In order to provide adequate pliability, the inflexible material is shaped or corrugated. By this expedient, materials, such as metals, which have a low stretch and an impervious surface, may be selected. At the same time, the materials may be selected to facilitate construction of the handrail.

It is, therefore, an object of the invention to provide

an improved handrail structure for moving stairways.

It is a further object of the invention to provide a moving stairway having an endless imperforate metallic handrail extending between two supporting structures.

It is also an object of the invention to provide an improved handrail for moving stairways constructed of a relatively inflexible material.

It is another object of the invention to provide a handrail of relatively inflexible material which is shaped or corrugated for the purpose of increasing its pliability in a predetermined direction.

It is a further object of the invention to provide an endless handrail for moving stairways, which is of unitary and homogeneous construction.

It is still another object of the invention to provide a handrail, as defined in any of the preceding objects, which is of U-shaped cross section.

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

Figure 1 is a view in side elevation with parts broken away and parts shown schematically of a moving stairway embodying the invention;

Fig. 2 is a sectional view taken along the lines II—II of Fig. 1;

Fig. 3 is a schematic view in side elevation showing various positions of the handrail employed in the stairway of Fig. 1;

Fig. 4 is a detailed view in cross section of a portion of a handrail suitable for the handrail of Fig. 1;

Fig. 5 is a detailed view showing a handrail guide wheel construction which may be employed for the guide wheels and newel wheels of Fig. 1;

Fig. 6 is a view in perspective showing a portion of a handrail of modified construction suitable for the handrail of Fig. 1;

Fig. 7 is a view in longitudinal cross section showing a portion of the handrail of Fig. 6;

Fig. 8 is a view in perspective showing a portion of a modified handrail suitable for the handrail of Fig. 1; and

Fig. 9 is a view in elevation with parts broken away showing a portion of a modified handrail drive which may be incorporated in the moving stairway of Figs. 1 and 3.

Referring to the drawing, Fig. 1 shows a plurality of steps **1** which are coupled to a suitable conveyor such as one or more continuous or endless chains **3** for movement about spaced upper and lower sprockets **5** and **7**. The sprockets **5** and **7** are secured respectively to shafts **5***a* and **7***a* which are mounted for rotation about their axes. In conventional practice, a suitable truss is provided for supporting the bearings of the shafts **5***a* and **7***a* together with channels for guiding the steps **1** in a desired path. Since such channels and trusses are well known in the art, it appears unnecessary to illustrate or describe them. For driving the steps **1**, the shaft **5***a* may have coupled thereto through suitable gearing the armature of an electric motor **13**.

To assist passengers traveling on the moving stairway, a continuous or endless handrail **17** is mounted for movement about two guide elements illustrated as newel wheels **19** and **21**. These newel wheels are secured to shafts **19***a* and **21***a* for rotation about the axis of the shaft. For driving the handrail, the shafts **5***a* and **19***a* respectively may carry sprockets **5***b* and **19***b* which are coupled by means of an endless chain **23**. A similar handrail may be provided on each side of the stairway.

As shown in Fig. 2, the handrail **17** has a U-shaped cross section comprising arcuate legs **17***a* and **17***b* which are connected by a relatively flat band **17***c*. As illustrated, the ends of the legs preferably are turned inward-

ly to provide a C-shaped cross section for the handrail. The handrail has an endless exterior surface 17*d* which is presented to passengers ascending or descending the stairway. The handrail has an endless interior surface 17*e* which is a guide surface.

The upper run 17 of the handrail is guided between the newel wheels 19 and 21 by means of a conventional T-shaped stationary guide member 25 for presentation to passengers of the stairway. The guide member 25 is located between the legs 17*a* and 17*b* (Fig. 2) to engage the guide surface 17*e* and extends substantially over the distance between the newel wheels. The lower or return run 17*r* of the handrail is guided between the newel wheels 19 and 21 in a novel manner by means of one or more intermediate guide wheels 27A to 27G which are mounted for rotation about shafts 29A to 29G, respectively. These shafts 29A to 29G may be secured in any suitable manner to the truss (not shown) commonly employed for such a moving stairway.

In order to understand the problems presented in guiding handrails, reference again may be made to Fig. 2. It will be recalled that the exterior surface 17*d* of the handrail is presented to stairway passengers. In order to prevent the formation of cracks, pits or scuffed areas in the surface, it is desirable that the surface be clear of guide members throughout its entire path of travel. Furthermore, it may be observed that when the handrail is flexed, the exposed edges of the legs 17*a* and 17*b* are subjected to substantial forces. These edges crack or fail more readily when subjected to tension forces than when subjected to compression forces. For this reason, it is desirable to avoid the application of substantial forces, particularly tension forces, to the edges during moving of the handrail.

Referring again to Fig. 1, it may be noted that the handrail between the newel wheel 19 and the guide wheel 27A is twisted about its path of travel through a substantial angle to present the guide surface 17*e* to both of the wheels. In a similar manner, the handrail between the guide wheel 27G and the newel wheel 21 is twisted through a substantial angle about its path of travel for the purpose of presenting the same guide surface 17*e* to the guide wheel 27G and the newel wheel 21.

In order to provide proper tension in the handrail, a tensioning wheel 31 is positioned to engage the guide surface 17*e* of the handrail. It will be observed that the tensioning wheel 31 is located intermediate the guide wheel 27G and one of the newel wheels 21, but is relatively close to the wheel 21. The wheel 31 is mounted for rotation about a shaft 33 which is secured to a link 35. The link, in turn, is pivoted for movement about a pin 37 which is secured to a stationary part of the truss (not shown). The tensioning wheel 31 may be biased in any suitable manner. For example, the desired biasing may be obtained by providing sufficient weight in the wheel.

Although the tensioning wheel 31 may be left free to pivot about the pin 37, preferably it is secured in an adjusted position. To this end, the link 35 may be provided with a threaded opening for reception of a cap screw 39. This cap screw projects through a slot 41 in a stationary arm 43 which may be secured to the stairway truss. Consequently, the tensioning wheel may be adjusted into proper position, and then by manipulation of the cap screw 39, the tensioning wheel 31 may be secured in an adjusted position.

Conveniently, the tensioning wheel 31 may be adjusted by rotation of the newel wheel 19 in the proper direction. It will be observed that when the newel wheel 19 is rotated by means of the chain 23 in a clockwise direction represented by the arrow 45, minimum sag of the handrail is produced adjacent the tensioning wheel 31. However, when the newel wheel 19 is rotated by the chain 23 in a counterclockwise direction as represented by an arrow 47, maximum sag of the handrail adjacent the tensioning wheel 31 is produced. If the tensioning wheel 31 is provided with a sufficient weight acting in a direction tending to increase the sag of the adjacent portion of the handrail, it automatically will take the proper position for tensioning the handrail. While the newel wheel 19 is still rotating in a counterclockwise direction, the cap screw 39 may be manipulated to secure the tensioning wheel 31 in the desired adjusted position.

It is believed that the invention can be understood most readily by a consideration of Fig. 3. It will be assumed initially that the handrail 17 is applied around the newel wheels 19 and 21 with the upper run 17*u* in operating position and with the lower run extending along the dotted line 17*ra* directly between the newel wheels 19 and 21. In this position, the legs 17*a* and 17*b* at any cross-section taken along the handrail extend toward the interior of the continuous loop formed by the handrail. It will be assumed further that the guide wheel 27D is the only guide wheel located between the newel wheels 19 and 21.

By inspection of Fig. 3, it will be noted that the lower run of the handrail under the assumed conditions engages the lower portion of the periphery of the guide wheel 27D. Consequently, the guide wheel assists in guiding the handrail. The guide surface of the handrail engages all of the wheels 19, 27D and 21.

Initially, or after the handrail has been in operation for a time, it may be found that the handrail has stretched sufficiently to require a tensioning adjustment. Such tensioning may be effected by movement of the lower run of the handrail from the position illustrated by the dotted line 17*ra* to a position wherein the handrail engages the upper part of the periphery of the guide wheel 27D. Since the handrail now is guided through a longer path, it is clear that the handrail is tensioned by such movement thereof.

If the handrail is moved to its new position directly, the exterior surface of the handrail would engage the guide wheel 27D. To avoid such engagement, the lower run of the handrail is twisted about its line of travel as it is moved from the lower to the upper portions of the guide wheel 27D to present the guide surface of the handrail to the upper portion of the guide wheel.

It will be understood that the tensioning wheel 31 also may be employed for controlling the tensioning of the handrail.

A single guide wheel, such as the guide wheel 27D, may suffice for a stairway having a length of the order of 20 feet or less. However, as the length of the stairway increases, it is desirable to increase the number of guide wheels employed between the newel wheels 19 and 21. For example, a maximum spacing of the order of 10 feet may be maintained between successive guide wheels.

In the specific embodiment of Fig. 3, seven guide wheels 27A to 27G are employed. The wheels 19, 27A to 27G, 31 and 21, preferably are located in a common plane, and the wheels 27A to 27G preferably are displaced from each other along substantially a straight line.

When the handrail 17 is applied to the wheels of Fig. 3, it may be initially located as illustrated by the full lines in Fig. 3. In such location, the lower run 17*r* of the handrail engages the upper portions of the guide wheels 27A to 27G.

If no other provision were made, the exterior surface of the handrail would engage the guide wheels 27A to 27G, and such engagement is objectionable. For this reason, the handrail is twisted about its line of travel between the wheels 19 and 27A through an angle of 180° to present the guide surface of the handrail to the wheels 19 and 27A. Such twisting is clearly illustrated in Fig. 1.

In a somewhat analogous manner, the handrail is twisted about its line of travel through an angle of 180°

between the guide wheel 27G and the tensioning wheel 31 for the purpose of presenting the guide surface of the handrail to the wheels 27G, 31 and 21. No twisting of the handrail is employed at this stage between the guide wheels 27A and 27G.

The guide surface of the handrail now engages all of the wheels associated therewith. The tensioning wheel 31 may be adjusted in the manner previously described, and the handrail may be operated in normal service.

During the operation of the stairway, the handrail 17 may stretch. For this reason, the tensioning wheel 31 is adjusted at intervals to compensate for the stretch of the handrail.

When the stretch of the handrail reaches a predetermined value, the tensioning wheel 31 is released and the lower run of the handrail is moved to engage the lower portion of the guide wheel 27B. To this end, the handrail is grasped adjacent its point of engagement with the guide wheel 27B and is lowered to the position shown by the dash line 17*rb* to engage the lower portion of the guide wheel 27B.

If no other change were made, the exterior surface of the handrail would engage the guide wheel 27B. However, as the handrail is lowered, it is twisted about its line of travel through an angle of 180° to present the guide surface of the handrail to the lower portion of the guide wheel 27B. The twisting of the handrail is clearly illustrated in Fig. 1.

The tensioning wheel 31 again is adjusted in the manner previously discussed, and the stairway is placed in operation. At intervals, the tensioning wheel 31 is adjusted to compensate for stretch of the handrail. If the stretch reaches a predetermined value, the tensioning wheel 31 is released, and the handrail is moved about the guide wheel 27D to the position shown by the dash line. During such movement of the handrail, the handrail is twisted through an angle of 180° about its line of travel to present the guide surface to the guide wheel 27D.

The tension wheel again is adjusted and the stairway is placed in operation. Further stretch of the handrail is compensated by the tensioning wheel 31 until it reaches a predetermined value. At this stage, the tensioning wheel 31 is released and the lower run of the handrail 17 is moved about the wheel 27F to the position illustrated by the dash line. During the lowering operation of the handrail, the handrail is twisted to present the guide surface thereof to the guide wheel 27F.

The tensioning wheel 31 is adjusted in the manner previously discussed, and the stairway again is placed in operation.

By the foregoing procedure, a large range of adjustment of the stairway is provided. Furthermore, it will be noted that the guide wheels urge the lower run of the handrail towards the upper run 17*u* to provide an extremely compact construction. As a matter of fact, when the handrail is in the position illustrated by full lines in Fig. 3, the upper and return runs of the handrail may be adjacent and parallel to each other.

At the same time, a minimum width is required for the handrail and its guide mechanism. Since two handrails are ordinarily applied for each moving stairway, the decreased width of the handrails provides an extremely compact stairway.

Successive twists of the handrail may be in the same or in opposite directions. For example, as viewed from the bottom of the stairway, the twist of the return run when moving it from a position below to a position above all of the wheels 27A to 27G may be in a clockwise direction. When so twisted, the portion of the return run between the wheels 19 and 27A and the portion of the return run between the wheels 27G and 31 would have the appearance illustrated in Fig. 1. The twists of the lower run of the handrail in transferring the handrail from the upper to the lower edges of the wheels 27B, 27D and 27F all may be in the clockwise direction. However, a slight balancing of the twists may be effected by twisting portions of the handrail in the opposite direction. For example, the portions of the handrail adjacent the wheels 27B and 27F may be twisted in a counterclockwise direction, as viewed from the lower end of the stairway when the handrail is moved from the positions illustrated in full lines to the positions illustrated in dash lines. The remaining twists of the handrail may be in the clockwise direction.

Additional adjustment of the handrail for tensioning purposes may be effected by mounting any of the guide wheels for adjustment in the manner discussed for the tensioning wheel 31. However, the tensioning wheel 31 generally provides an adequate range of adjustment in this manner.

To minimize the degree of bending of the handrail, the wheels employed preferably should have a substantial diameter. Thus, wheels having a diameter of the order of 20 inches or larger may be employed, and in a preferred embodiment the guide wheels and newel wheels may have diameters of the order of 30 inches or larger.

In order to facilitate installation and adjustment of the handrail, all of the guide wheels for the handrail may be mounted on stub shafts which are secured at only one end to the truss or supporting structure of the stairway. Thus, the ends of the shafts adjacent the space traversed by the stairway passengers may be free or unsecured to permit ready application of the handrail to the wheels or to permit ready movement of the handrail from a first to a second side of a wheel.

It will be observed that between pairs of the wheels, the outer edges of the handrail may be slightly elongated relative to the center line of the handrail. However, since these distances are usually relatively long, the resulting stresses due to the twisting action are small.

In order to tension the chain 3, the sprocket 7 is mounted for movement in a direction transverse to its axis as represented by arrows 51. To this end, the bearing 7*b* for the shaft 7*a* may be secured to a block 7*c* which is mounted for reciprocation in the direction of the arrows 51 on a suitable stationary supporting member 7*d* in a manner well understood in the art. The bearing 7*b* has secured thereto a rod 53 which projects through an opening in a stationary plate 55. The rod 53 has a threaded intermediate portion on which a nut 57 and a washer 59 are positioned. The nut 57 is rotated to compress a spring 61 between the plate 55 and the washer 59. Consequently, the spring urges the sprocket 7 towards the right as viewed in Fig. 1 to tension the associated chain 3. Although only one chain and one pair of sprockets 5 and 7 are illustrated in Fig. 1, it will be observed that in conventional practice two sprockets 7 would be mounted on the shaft 7*a* and two sprockets 5 would be mounted on the shaft 5*a* for reception of two spaced chains. The shaft 7*a* ordinarily would be provided with two bearings 7*b* each of which would be biased in a similar manner by means of a spring similar to the spring 61.

Excessive movement of the sprocket 7 may be employed for controlling the energization of the motor 13 and for operating mechanism to stop the stairway as desired. For example, in Fig. 1 the rod 53 has secured thereto a movable electrical contact 63 which is positioned intermediate two pairs of fixed electrical contacts 65 and 67. In response to excessive movement of the sprocket 7, which may occur for example if one of the chains 3 breaks, one of the pairs of stationary contacts 65 or 67 is bridged by the movable contact 63 to connect the coil 69 of a relay 71 across a suitable source of energy which is represented in Fig. 1 by a battery 72. Energization of the coil 69 results in the closure of the contacts of the relay 71 to complete a circuit 73 which includes a suitable source of energization such as that represented by a battery 75. Completion of the circuit 73

may be employed for setting a stairway brake and for deenergizing the stairway motor or for many other purposes. In Fig. 1, the circuit **73** is shown as including the trip coil of a circuit interrupter **77** which controls the supply of electrical energy to the motor **13**. Consequently, operation of the relay **71** results in deenergization of the motor **13**.

If the stairway is long, it may be desirable to drive the handrail through the newel wheel **21** as well as the newel wheel **19**. In such cases, the shafts *7a* and *21a* may have secured thereto sprockets **79** and **81** which are coupled by means of an endless chain **83**. If the chain **83** were of conventional construction, it might tend to interfere with normal or desired movement of the sprocket **7** in the direction of the arrows **51**. In order to prevent such interference, the chain **83** is provided with substantial slack and this slack is taken up by means of an idler sprocket **85** which is mounted for rotation about a shaft **87** secured to one end of a link **89**. This link is mounted for rotation about a pin **91** which is secured to a stationary part of the stairway truss. The sprocket wheel **85** is biased towards the associated chain **83** by means of a rod **93** which has one end secured to the shaft **87**. The remaining end of the rod **93** passes through a stationary plate **95** and is threaded for reception in a threaded nut **97**. A spring **99** is compressed between the nut and the plate **95** for the purpose of urging the sprocket wheel **85** towards the left as viewed in Fig. 1. However, the spring **99** is capable of yielding to permit movement of the sprocket **7**.

With the structure herein set forth, it is desirable that the handrail have very little stretch throughout its life. It is desirable that the stretch should not exceed about 1¼% and preferably not more than 1%. For example, a stretch of 10 inches per 100 feet of handrail or less is satisfactory. To control the stretch, the handrail may have the construction illustrated in Fig. 4. It will be noted that the handrail has two layers of reenforcing cotton fabric FA adjacent the guide surface **17***e* of the handrail and two additional layers of cotton fabric FA adjacent the exterior surface **17***d* of the handrail. In addition, two rows of cord C are embedded between the pairs of layers FA of fabric. These cords run parallel to the path of travel of the handrail and are constructed of material having little or no permanent set or stretch under the conditions of use. Although the cord C may be constructed of a material such as steel wire or strand, excellent results have been obtained from cords constructed of low-stretch cotton. The fabric and cord may be embedded in a suitable elastomer, such as natural rubber. The processes for reenforcement and vulcanization of rubber to produce handrails are well known in the art.

If desired, any of the wheels for the handrail may have an inset designed to increase the traction therebetween. For example, in Fig. 5, the wheel or sheave **101** may have a continuous peripheral groove **103** for reception of a V-belt **105**. The V-belt is constructed of suitable material such as rubber having reenforcing fabric or cords embedded therein. The V-belt is snapped over the edge of the sheave into the groove and is positioned to engage the handrail **17**.

By properly shaping the handrail, it is possible to employ materials having extremely low stretch and having other desirable properties. Under such conditions, the handrail may be constructed of materials other than elastomers, such as various plastics and metals. Preferably, a readily cleaned and sterilized material is employed for the handrail. In a preferred embodiment of the handrail, stainless steel may be employed for the handrail.

Referring to Fig. 6, it will be noted that the handrail is constructed of a stainless steel ribbon which is bent to provide the U-shaped cross section including the arcuate legs **17***a* and **17***b* and the relatively flat band **17***c*. Because of the U-shaped configuration, the resulting handrail would be relatively inflexible and would have difficulty in following the various guide wheels and guide elements. To increase the pliability of the handrail, the stainless steel ribbon is shaped or corrugated as illustrated in Fig. 6. These corrugations extend around the handrail in a direction transverse to the line of travel of the handrail, and are uniformly disposed about the entire handrail. In a preferred embodiment of the invention, the corrugations are of an accordion type similar to those conventionally employed in metallic bellows.

If desired, a large number of relatively fine corrugations may be provided. These corrugations may be so fine and close together that the smallest finger of a stairway passenger cannot be forced therebetween to any appreciable extent. Alternatively, a relatively broad and shallow corrugation may be employed. The corrugations should be such that the hand of the passenger can readily be released therefrom. At the same time, the corrugations assist in preventing sliding of the hand of the passenger on the handrail. With this construction, the handrail interposes a continuous and homogeneous barrier or shield between the hands of stairway passengers and the underlying parts of the balustrade.

The ends of the ribbon employed in constructing the handrail may be joined in any suitable manner. For example, the ends may be fused together to provide a unitary handrail which is completely homogeneous throughout its extent. The line of fusion may be ground to provide an invisible joint between the ends of the ribbon. It a metal is employed, such as stainless steel, the ends of the ribbon may be joined by welding or brazing operations. The joint may be a butt joint or a lap joint. For example, in Fig. 7 the ends of the ribbons are telescoped. These ends may be riveted to each other or brazed, but if stainless steel is employed, the ends preferably are welded to each other. The ends of the ribbon may be upset or thickened prior to the welding operation.

The corrugations employed need not extend completely across the ribbon employed in fabricating the handrail. For example, in Fig. 8, the corrugations are applied only to the edges or legs of the ribbon and extend around the edges to merge into the flat band **17***c* of the handrail. Such construction minimizes the possibility of stretch of the handrail. At the same time, since the legs of the ribbon are fully corrugated, the handrail has adequate pliability.

The use of a material having a smooth impervious surface, such as that provided by stainless steel, is highly desirable. Such a surface is readily cleaned and presents a most attractive appearance.

It will be recalled that in Fig. 5 a resilient V-belt **105** is stretched and snapped over the edge of a wheel **101** into the groove **103** which is designed for reception of such V-belt. If desired, the V-belt may be arranged to extend around a plurality of wheels. Such a modification is illustrated in Fig. 9.

Referring to Fig. 9, it will be observed that the handrail **17** extends around a wheel **120** which corresponds to the newel wheel **19** of Figs. 1 and 3 and which is similarly driven by means of the chain **23**. The only essential difference between the wheels **120** and **19** resides in the provision in the wheel **120** of a continuous peripheral V-groove **122** for reception of a V-belt. This groove is similar to the groove **103** of Fig. 4.

In Fig. 9, an additional wheel **124** is positioned within the loop formed by the handrail **17** for rotation relative to the supporting structure or truss about an axis parallel to and spaced from the axis of the newel wheel **120**. This wheel **124** also is provided with a continuous peripheral V-groove **126** similar to the V-groove **103** of Fig. 5.

A continuous V-belt **128** forms a loop extending around the wheels **120** and **124**. By inspection of Fig. 9, it

will be observed that the V-belt **128** is received within the V-groove of the wheels **120** and **124** for angular distances which may be slightly more than 180° for the wheel **120** and slightly less than 180° for the wheel **124**.

If desired, the wheels **120** and **124** may be designed for rotation about fixed axes. Since the V-belt **128** is constructed of rubber or other resilient material with or without reenforcing cords, the V-belt may be stretched sufficiently to be forced over the major peripheral dimensions of the wheels **120** and **124** for the purpose of snapping the V-belt into the grooves of the wheels to take the position illustrated in Fig. 9. In order to remove the V-belt, it may be stretched sufficiently to clear one of the associated wheels.

If desired, the wheels **120** and **124** may be biased away from each other in order to maintain the associated V-belt under continuous tension. For example, the shaft of the wheel **124** may be received within one or more bearing blocks such as a bearing block **130** which is mounted for reciprocation in a direction parallel to the upper run of the handrail on a stationary supporting member **132**. The bearing block **130** has a rod **134** extending therefrom through an opening in a stationary supporting member **136**. A helical spring **138** is compressed between the member **136** and a washer **140** which is suitably secured to the end of the rod **134**. Consequently, the spring **138** biases the wheel **124** away from the wheel **120** for the purpose of tensioning the V-belt **128**.

It is believed that the operation of the V-belt in Fig. 9 will be clear from the earlier discussion of Fig. 5. It will be recalled that Fig. 5 shows a groove having the conventional trapezoidal cross section for reception of the standard V-belt which also has a trapezoidal cross section. When the V-belt is forced into the groove, the inclined sides of the V-belt wedge themselves in the conventional manner against the inclined sides forming the groove. In Fig. 5, the usual space or clearance is shown between the lower edge of the V-belt and the bottom of the groove to facilitate such wedging action.

As shown in Fig. 5, the thickness of the wheel **101** is selected to permit location of a peripheral portion of the wheel between the legs illustrated in the cross section of the handrail **17**. The V-belt **105** projects from the wheel **101** into engagement with the guide surface **17***e* of the handrail which may be a flat inner guide surface. It will be understood that the handrail and V-belt **128** of Fig. 9 are similarly associated with each of the wheels **120** and **124**.

The conventional wedging action of the V-belt in the groove of the wheel **120** establishes a good driving coupling between the V-belt and the wheel. In addition, the material of which the V-belt is constructed establishes an excellent friction engagement between the V-belt and the handrail **17**. Consequently, motion imparted by the chain **23** to the wheel **120** is efficiently transmitted by the V-belt to the handrail.

Since the wheel **124** is positioned to guide a part of the V-belt **128** into engagement with the guide surface of the handrail **17**, it follows that such engagement further aids in transmitting motion from the V-belt **128** to the handrail **17**. Consequently, the V-belt **128** together with the wheels **120** and **124** establish good coupling between the handrail and the chain **23**.

If desired, one or more additional wheels may be located between the wheel **120** and the wheel **124**. In the specific embodiment of Fig. 9, two such additional wheels **142** and **144** are illustrated. These wheels have continous peripheral V-grooves **146** and **148**, respectively, which are similar to the V-groove **103** of Fig. 5. The wheels are mounted for rotation about axes which are parallel to and intermediate the axes of rotation of the wheels **120** and **124**. It will be noted that the wheels **142** and **144** guide the V-belt **128** in engagement with the guide surface of the handrail **17**. This further increases the coupling between the V-belt and the handrail. At the same time, the wheels **142** and **144** may be positioned to provide a desired curvature in the path of the handrail **17** with a minimum of friction.

If desired, the wheel **124** may have a diameter sufficient to guide the lower run of the V-belt **128** in engagement with the lower run of the handrail **17**. In the embodiment of Fig. 9, the wheel **124** has a smaller diameter and is positioned to guide the V-belt **128** into engagement only with the upper run of the handrail.

It will be understood that the V-belt assembly of Fig. 9 may be located at the upper end of the stairway of Figs. 1 and 3 to the left of the wheel **27A**. The T-shaped stationary guide member **25** may be proportioned to guide the upper run of the handrail to a position adjacent the wheel **124**. If desired, a similar V-belt assembly may be located at the lower end of the stairway of Figs. 1 and 3. For example, a single V-belt may extend around the wheels **21** and **31** in a manner similar to the association of the V-belt **128** with the wheels **120** and **124** of Fig. 9.

Certain subject matter herein set forth is disclosed in my copending patent application Serial No. 14,660, filed March 13, 1948, now Patent 2,669,339, of which this is a continuation-in-part, and in my copending patent application, Serial No. 359,939, filed June 5, 1953, of which this is a division.

Although the invention has been described with reference to certain specific embodiments thereof, numerous modifications falling within the spirit and scope of the invention are possible.

I claim as my invention:

1. In a moving stairway, a supporting structure, a pair of spaced guide elements mounted on the supporting structure, a continuous flexible handrail in the form of an elongated loop guided by said guide elements relative to the supporting structure along a path of travel defined by said handrail, and a guide device positioned between said guide elements, said guide device being positioned to guide one run of the handrail between the guide elements, said handrail having edges extending angularly from a central part to define a U-shaped cross-section and being substantially imperforate between the edges of the handrail, said edges having a plurality of corrugations extending transversely relative to the length of the member for increasing the pliability of the member, said corrugations being spaced along said loop.

2. In a moving stairway, a supporting structure, a pair of spaced guide elements mounted on the supporting structure, and a continuous flexible handrail in the form of an elongated loop guided by said guide elements relative to the supporting structure along a path of travel defined by said handrail, said handrail comprising an endless metal ribbon having its edges bent from a central part into legs providing a U-shaped cross section, said ribbon having corrugations extending at least in said legs transversely relative to the length of the ribbon, said corrugations being distributed uniformly along the length of the ribbon to increase the pliability of the ribbon in a direction transverse to the central part, said legs being directed inwardly relative to said loop, said loop extending around a substantial part of each of said guide elements and said guide elements having portions disposed between said legs in engagement with the inner surface of said central part, the outer surfaces of said central part and said legs being exposed to stairway passengers while in said path of travel.

3. A handrail for moving stairways comprising an elongated member having a central part and edges extending angularly from the central part to define a U-shaped cross-section substantially imperforate between the edges of the handrail, said edges having a plurality of corrugations extending transversely relative to the length of the member for increasing the pliability of

the member, said corrugations being spaced along said member.

4. A handrail for moving stairways comprising an endless unitary metal member substantially imperforate between the edges of the handrail and having a U-shaped cross section, said metal member being pliable in a direction parallel to the U-shaped cross section and substantially inextensible in a direction transverse to said cross section, said metal member having a central part constituting an endless metal ribbon and a separate metal edge extending angularly from each side of the central part to provide said U-shaped cross-section.

5. A handrail for moving stairways comprising an endless unitary metal member substantially imperforate between the edges of the handrail, said metal member having a central part constituting an endless metal ribbon and a separate endless metal leg extending angularly from each edge of the central part to provide a U-shaped cross-section for the metal member, said legs having a plurality of uniformly distributed corrugations, each of said corrugations extending transversely relative to the length of the member for increasing the pliability of the member in a direction transverse to the length and width of the member.

6. A handrail for moving stairways comprising a ribbon member having its edges bent from a central part into legs providing a U-shaped cross section, said ribbon member having a plurality of corrugations, each of said corrugations extending at least in said legs transversely relative to the length of the ribbon, said corrugations being distributed uniformly along the length of the ribbon to increase the pliability of the ribbon in a direction transverse to the central part, the outer surface of the ribbon member being exposed for a substantial portion of the length of such ribbon member.

7. A handrail for moving stairways comprising an endless metal ribbon member having its edges bent from a central part into legs providing a U-shaped cross section, said ribbon member having a plurality of corrugations, each of said corrugations extending at least in said legs transversely relative to the length of the ribbon, said corrugations being distributed uniformly along the length of the ribbon to increase the pliability of the ribbon in a direction transverse to the central part.

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