

SPECIFICATION

Passenger conveyor balustrade

5 This invention relates to a balustrade for use with passenger conveyors such as escalators and electrically operated passageways and, more particularly, to a balustrade which is formed of stainless steel sheets.

10 Passenger conveyors have become widely known as fixtures which are indispensable to a building as a means for conveying persons from one point to another within the building. In recent years, a variety of demands have been put forward for industrial designs of balustrades. As is well known, the balustrade constitutes a major part of a designed body in a passenger conveyor, and it is generally recognized by the parties concerned that whether the balustrade has an attractive industrial design or not is a major selling point in respect of making a discrimination among room designs.

As described in U.S. Patents Nos. 3,321,059 and 3,353,650, the passenger conveyor includes an endless series of steps adapted to convey passengers thereon, and the balustrade having stationary members and moving parts such as handrails. As described above, each balustrade includes, as main components thereof, a main deck member upon which a handrail is mounted, a lower deck member and a glass pannel, all of which constitute an object of industrial design. It is conventional to form the main and lower deck members by extruded material of aluminum alloy, of which surfaces have been subjected to alumite treatment.

35 Aluminum alloy material has been widely used for the main and lower deck members of a balustrade since it is advantageous in its formability into substantially complex shapes. However, the use of this material has a disadvantage in that the manufacturing cost thereof continues to be increased due to high electric power consumption and the raw material therefor tends to be reduced. However, what is more significant than the high manufacturing cost is the fact that aluminum alloy material is relatively soft (as compared to such metallic materials as steel) so as to be readily marred. This presents a serious problem in which the respective members of balustrade present scratches and impressions on the inner sides thereof facing the steps after the members have been contacted by a large number of passengers during several years of operation. Thus such passenger conveyors present an unsightly appearance. Particularly in the case of passenger conveyors installed in underground markets, corrosion of the material of the balustrades caused by underground water adds to deterioration of the industrial design of the balustrades.

Therefore, stainless steel sheets have begun to be used in place of aluminum alloy material, which sheets are superior to the latter in price stabilization, hardness and anticorrosive resistance. However, the use of stainless steel for balustrades raises the technical problems of the material being deformed during bending and some clearances being produced. Since these problems have not been solved

satisfactorily, the practice of using a stainless steel sheet has not yet become popular.

It is an object of the present invention to provide a balustrade for passenger conveyors which is highly productive and obviates the aforementioned problem of deformation during bending.

According to the present invention there is provided a balustrade for use with a passenger conveyor having landings, an endless series of steps and a handrail for movement in synchronism with said series of steps, said balustrade comprising a first deck member formed of sheet material and having a substantially U-shaped cross-section with its opening facing inward away from the handrail; a second deck member formed of sheet material and having a substantially U-shaped cross-section with its opening facing in the opposite direction to that of said first deck member, said second deck member overlying the top surface of said first deck member for guiding said handrail; each of said first and second deck members having an arcuate shape at the landings; and arcuate deformation preventing strips provided on the first deck member adjacent the opening at the arcuate-shaped section of the first deck member for preventing deformation of the first deck member over the arcuate-shaped sections, and said top surface of the first deck member at least about the arcuate-shaped sections thereof being secured by welding to the bottom portion of the second deck member at least about the arcuate-shaped sections thereof.

Embodiments of the present invention will now be described by way of example with reference to the accompanying drawings, in which:

100 *Figure 1* is a side elevational view of a portion of a passenger conveyor adjacent an upper landing;

Figure 2 is a sectional view taken along the line II-II in *Figure 1*, showing a prior balustrade having deck members made of aluminum alloy material;

105 *Figure 3* is a sectional view similar to *Figure 2* but showing a prior balustrade having deck members made of stainless steel material;

Figure 4 to Figure 7 are views showing a deck member of stainless steel material being subject to bending, *Figure 4* being a perspective view of the member being subjected to tensile forces, *Figure 5* showing the manner in which various forces act on the member, and *Figures 6 and 7* showing the manner in which the member is deformed;

115 *Figure 8* is a side elevational view showing the both deck members joined together;

Figure 9 is a sectional view taken along the line IX-IX in *Figure 8*;

120 *Figure 10* is a sectional view similar to *Figure 3*, but showing a balustrade having deck members made of stainless steel according to one embodiment of the invention;

Figure 11 is a detailed view showing the essential part of the balustrade shown in *Figure 10*;

125 *Figure 12* is an enlarged view showing the essential part of the balustrade shown in *Figure 10*; and

Figures 13 and 14 show another embodiment of the invention; *Figure 13* being a sectional view showing the essential part of a first deck member, and *Figure 14* being a sectional view showing a

portion at which the both deck members are joined together.

As shown in Figure 1, a passenger conveyor comprises an endless series of steps 1 for conveying passengers thereon, and balustrades each including stationary members and a handrail 2. The stationary members comprise mainly a main deck member 3 for supporting the handrail 2, a lower deck member 4 and a balustrade glass panel 5, all of which are objects of industrial design. A material for balustrades is, first of all, required to have a good bending workability since the contour of balustrade consists of concave or U-shaped curve, T-shaped terminal curve and unique, streamlined arcs.

Referring now to figure 2, the prior main deck member 3 made of aluminum alloy material has a glass panel 5 fitted thereinto at the lower portion thereof and has a guide 6 secured thereto at the upper end portion thereof by means of bolts 7, which guide 6 serves to guide the handrail 2 therealong.

The configuration in section of the main deck member 3 is conventionally determined such that portions thereof are thickened at areas where wrinkles tend to be produced (as at 3a in figure 2), are thinned at areas where wrinkles are hard to be produced (as at 3b in figure 2), and are formed with a decorative line (3c). In the prior art, attempts have been made to meet the requirements of compensating for the lack of workability of material and increasing the attractiveness of decorative design as aforementioned.

In figure 3, there is shown a main deck member formed of stainless steel sheet which has come to attract attention in recent years. A thin sheet of 1 to 3 millimeters in thickness t is subjected to bending by means of a press brake to provide a main deck member having a desired cross-sectional shape. Therefore, it is conventional neither to provide any variation in thickness of the material nor to provide a decorative line. As it is, the main deck member 3 is produced by separately forming a first, substantially U-shaped deck portion 8a and a second, substantially U-shaped deck portion 8b, and then securing them together by means of bolts 9 when assembled.

Although the first and second deck portions 8a and 8b lack variety in industrial design (such as decorative line) and it is troublesome to join the two deck portions together by means of bolts, there has been an increasing demand for deck members made of stainless steel sheet because they are resistant to scratches, are highly durable, and present deep gloss thereon which is favoured by many people.

The manner in which a balustrade deck member made of stainless steel sheet is subjected to bending will now be described by referring to the deck portion 8a by way of example.

As shown in figures 4 to 7, opposite ends a and b of the deck portion 8a are subjected to tension in the directions of arrows A and B with the flange portions thereof facing inwardly, so that an outer peripheral surface g_1 may have a radius of curvature R_1 and an inner peripheral surface g_2 may have a radius of curvature R_2 . Thus reaction forces against the tensile forces in the directions of arrows A and B are distributed over substantially the entire areas of the

inner peripheral portion of the deck portion 8a as designated by an arrow C, and the outer peripheral surface portion g_1 is elongated as indicated by an arrow D. As a result, the portion of the member disposed inwardly of a neutral axis L, as shown in Figure 6, begins to contract as indicated by the arrows F in Figure 5. Such phenomenon is physically natural, but causes disadvantages as presently to be described when this type of thin stainless steel sheet is bent.

More specifically, the aforementioned contraction indicated by the arrows F manifests itself as large wrinkles S on the inner flange portions of the member, as shown in Figure 7. Therefore, the flange portions of the deck member 8a with a width of W therebetween are displaced laterally by a distance S_1 (Figure 6). Much work is required to correct the deformation of the deck member 8a into a regular shape. The wrinkles S are, of course, greatly related to the position of the neutral axis L from the viewpoint of strength of materials, and can not be avoided due to the shape of the deck member 8a, as shown in Figure 6, in which the neutral axis L is positioned near the outer peripheral surface g_1 (a short distance n inwardly from the outer peripheral surface g_1) and a radius of curvature R_3 at the neutral axis L is close to radius of curvature R_1 ($R_1 = R_3 > R_2$) of the outer peripheral surface g_1 . Therefore, it will be apparent that in order to eliminate wrinkles S or displacement S_1 , the neutral axis L should be positioned near the inner peripheral surface g_2 where wrinkles tend to be produced.

As alternative measures for preventing wrinkles S from being produced, that portion of the deck member which may produce wrinkles can be thickened so as to absorb wrinkles therein, as shown in Figure 2. However, such measures cannot go well in cases where stainless steel sheets of a uniform thickness are subject to bending to form deck members. Thus it has been a significant problem how to prevent wrinkles in balustrades made of stainless steel sheet.

The joint between the deck members 8a and 8b presents such inconveniences as to be described hereinbelow.

It has hitherto been common practice to secure the deck members 8a and 8b together at their arcuate portions (the underside of the second deck member 8b and the top surface of the first deck member 8a) by means of the bolts 9, as shown in figure 3. This method tends to produce an inconvenience as shown in figures 8 and 9.

More specifically, the first deck member 8a is bent to have a radius of curvature R_1 , and the second deck member 8b is also bent to have a radius of curvature R_1 at its underside. Then the two deck members 8a and 8b are closely secured together as by bolts 9. However, a difficulty has often been encountered in bringing the radius of curvature of the two deck members into agreement with each other with a result that a gap g is formed between them as shown in figures 8 and 9. The gap g is caused by technical difficulties in carrying out plastic working of sheet material as aforementioned. The major cause for this is that the U-shaped deck members 8a and 8b open

radially inwardly and outwardly respectively and the neutral axis for the deck members are unstably positioned in the above condition.

The existence of such gap g not only deteriorates uniting the two deck members 8a and 8b in one body but also presents an unsightly appearance as viewed in the direction Q , thereby reducing the estimate of the passenger conveyor as a whole in industrial design. Moreover, if the gap g is large in size to the range between 3 and 5 mm, there arise problems in safety such as catching clothes of passengers or fingers of children. Thus, when stainless steel sheet is used for balustrades for a passenger conveyor, it is essential that any gap g between the deck members 8a and 8b be eliminated.

As aforementioned, forming a balustrade by using stainless steel sheet thus poses problems in industrial design, economy and safety, and has therefore been studied by those skilled in the art for several years.

This invention is conceived in view of the above circumstances. The invention has as its object the provision of a balustrade of high productivity for use in a passenger conveyor, which is free from deformation during bending and any gaps at the joints between its components.

The object of the invention is attained by providing a balustrade in which a first deck member is formed at least at its inner peripheral open end of the arcuate-shaped section thereof with a deformation preventing plates which serve to prevent any deformation of the open end during bending, and the top surface of the arcuate-shaped section of the first deck member is joined by welding with the underside of an arcuate-shaped section of a second deck member.

Figures 10 and 11 show one embodiment of the invention. In the drawings, a handrail 2 and a glass panel 5 are similar in construction to those of the prior balustrade. According to the invention, a deck member 10 is substantially U-shaped in cross section and includes deformation preventing plates 10a, each of which extends a distance M inwardly along an inner peripheral surface g_3 (corresponding to g_2 of the prior deck member). The deformation preventing plates 10a are formed upon bending in a press brake when a stainless steel sheet is formed into a substantially U-shaped body. The distance over which each deformation preventing plate 10a extends along the surface g_3 is $1.5 (M = 1.5 \times t)$ or more, preferably three ($M = 3 \times t$) times the thickness t of the sheet. The deformation preventing plates 10a increase the flexural rigidity of the inner peripheral surface g_3 (as seen from figure 11, the cross-sectional area of the inner peripheral surface portion g_3 adds to that of the inner peripheral surface portion g_2 in figure 6), and the neutral axis I is displaced substantially toward the inner peripheral surface g_3 to be positioned a distance N from the outer peripheral surface g_1 where N is larger than n ($N > n$), and the radius of curvature is R_4 at the position of the neutral axis I . It will be apparent that wrinkles are difficult to be produced. In addition, the inner peripheral surface portion g_3 is increased in its flexural rigidity to be effective in eliminating wrinkles.

les.

A method for eliminating the gap g accompanied with the prior art balustrade will now be described by referring to figures 10 and 12. The method according to the embodiment has a feature in that a second deck member 11 similar in construction to the conventional deck member 8b is joined by electric welding with the top surface of a first deck member 10.

Although there are various welding processes to perform the above joining operation, spot welding process presently to be described is considered to be most appropriate. As is well known, according to spot welding process, two components to be welded are locally fused (at a point z in figures 10 and 12) by passing an electric current therethrough. As shown in figure 12, the two deck members 10 and 11 are interposed under pressure between two electrodes A and B (positive and negative) which contact with substantially center portions of the top and bottom walls thereof. A current is passed through the two electrodes to fuse the deck members and produce a weld.

Thus the first deck member 10 and the second deck member 11 are joined to each other by spot welding process at several points (at several scores of points, if necessary) therealong, and these two deck members are rigidly secured together to intercept one's eye Q , thereby presenting an appearance as if they were integrally formed.

It is apparent from the following description that the deformation preventing plates 10a increase the effect achieved by spot welding process.

More specifically, as seen from the drawing, the first deck member 10 is increased in its rigidity by the deformation prevention plates 10a and is greater in rigidity than the second deck member 11 from the viewpoint of construction. If the first deck member 10 is precisely bent to have a radius of curvature R_1 , the underside (which should have a radius of curvature R_1) of the second deck member 11 can be spot welded to the top surface of the first deck member 10 to take the contour thereof with relative ease, that is to be wound around the deck member 10 of higher rigidity. Thus the two deck members can be joined with substantially little clearance therebetween.

Meanwhile thermal deformation due to the welds by this welding process are developed on the bottom surface of the second deck member 11 which faces outwardly towards the handrail and on a restricted area (an area within the width of the deck member 11) of the deck member 10 which underlies the deck member 11. Thus the portions of the deck members under the influence of thermal deformation are not exposed in outward appearance to preclude the possibility of deteriorating industrial design of the balustrade.

By using the welding process, it is possible to eliminate any gaps which are believed to be harmful in terms of industrial design and safety. Moreover, bolts 9 and holes therefor are useless to provide a high economical advantage.

It is to be understood that the deformation preventing plates 10a of the first deck member 10 are

not limited in its shape shown. For example, the plate may assume the shape as at 10b in figure 13, in which the plate is turned down to be brought into contact with the flange portions of the deck member.

- 5 The deformation preventing plates 10a may be of any shape so long as they project toward the inner periphery of the deck member 10.

In the embodiment shown and described hereinabove, the welds are arranged only in the central

- 10 portion of the second deck member 11. Alternatively, two or more arrays of welds z may be arranged on the associated surfaces of the deck members to be joined, as shown in figure 14. Also, any welding process other than spot welding process shown and
15 described may be used so long as welds are locally arranged in the members to be welded.

From the foregoing description, it will be appreciated that the present invention provides deck members made of stainless steel sheet which facilitate

- 20 bending work, are free of any clearance therebetween, and are highly improved in productivity and safety. Moreover, the invention presents advantages in that problems associated with scratches and corrosion which are encountered in balustrades
25 made of aluminum can be solved to render a passenger conveyor durable.

CLAIMS

- 30 1. A balustrade for use with a passenger conveyor having landings, an endless series of steps and a handrail for movement in synchronism with said series of steps, said balustrade comprising a first deck member formed of sheet material and
35 having a substantially U-shaped cross-section with its opening facing inward away from the handrail; a second deck member formed of sheet material and having a substantially U-shaped cross-section with its opening facing in the opposite direction to that of
40 said first deck member, said second deck member overlying the top surface of said first deck member for guiding said handrail; each of said first and second deck members having an arcuate shape at the landings; and arcuate deformation preventing
45 strips provided on the first deck member adjacent the opening at the arcuate-shaped section of the first deck member for preventing deformation of the first deck member over the arcuate-shaped sections, and said top surface of the first deck member at least
50 about the arcuate-shaped sections thereof being secured by welding to the bottom portion of the second deck member at least about the arcuate-shaped sections thereof.

2. A balustrade as claimed in claim 1 wherein
55 said top surface of the first deck member is secured to the bottom portion of the second deck member by performing spot welding process at areas within the lateral width of the second deck member.

3. A balustrade as claimed in claim 1 wherein
60 said each of deformation preventing strips is formed such that it extends from the first deck member over a distance of over 1.5 times the thickness of the material of the first deck member.

4. A balustrade as claimed in claim 1 wherein
65 said first and second deck members are formed of

stainless steel material.

5. A balustrade substantially as hereinbefore described with reference to and as illustrated in Figure 10 to 12 or Figures 13 and 14 of the
70 accompanying drawings.

Printed for Her Majesty's Stationery Office, by Croydon Printing Company Limited, Croydon, Surrey, 1982.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

19



4

GB 2 000 095 B

4

not limited in its shape shown. For example, the plate may assume the shape as at 10b in figure 13, in which the plate is turned down to be brought into contact with the flange portions of the deck member.

- 5 The deformation preventing plates 10a may be of any shape so long as they project toward the inner periphery of the deck member 10.

In the embodiment shown and described hereinabove, the welds are arranged only in the central

- 10 portion of the second deck member 11. Alternatively, two or more arrays of welds z may be arranged on the associated surfaces of the deck members to be joined, as shown in figure 14. Also, any welding process other than spot welding process shown and
15 described may be used so long as welds are locally arranged in the members to be welded.

From the foregoing description, it will be appreciated that the present invention provides deck members made of stainless steel sheet which facilitate

- 20 bending work, are free of any clearance therebetween, and are highly improved in productivity and safety. Moreover, the invention presents advantages in that problems associated with scratches and corrosion which are encountered in balustrades
25 made of aluminum can be solved to render a passenger conveyor durable.

CLAIMS

- 30 1. A balustrade for use with a passenger conveyor having landings, an endless series of steps and a handrail for movement in synchronism with said series of steps, said balustrade comprising a first deck member formed of sheet material and
35 having a substantially U-shaped cross-section with its opening facing inward away from the handrail; a second deck member formed of sheet material and having a substantially U-shaped cross-section with its opening facing in the opposite direction to that of
40 said first deck member, said second deck member overlying the top surface of said first deck member for guiding said handrail; each of said first and second deck members having an arcuate shape at the landings; and arcuate deformation preventing
45 strips provided on the first deck member adjacent the opening at the arcuate-shaped section of the first deck member for preventing deformation of the first deck member over the arcuate-shaped sections, and said top surface of the first deck member at least
50 about the arcuate-shaped sections thereof being secured by welding to the bottom portion of the second deck member at least about the arcuate-shaped sections thereof.

2. A balustrade as claimed in claim 1 wherein
55 said top surface of the first deck member is secured to the bottom portion of the second deck member by performing spot welding process at areas within the lateral width of the second deck member.

3. A balustrade as claimed in claim 1 wherein
60 said each of deformation preventing strips is formed such that it extends from the first deck member over a distance of over 1.5 times the thickness of the material of the first deck member.

4. A balustrade as claimed in claim 1 wherein
65 said first and second deck members are formed of

stainless steel material.

5. A balustrade substantially as hereinbefore described with reference to and as illustrated in Figure 10 to 12 or Figures 13 and 14 of the
70 accompanying drawings.

Printed for Her Majesty's Stationary Office, by Croydon Printing Company Limited, Croydon, Surrey, 1982.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.