FLUSH-FACE ELEVATOR DOOR

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ABSTRACT

A flush-face freight elevator door is produced by welding a face plate, at least about 0.090 inches thick, to the members of a frame in the disclosed order, thereby producing a door substantially free of distortion or "oil-canning."

9 Claims, 3 Drawing Figures
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FLUSH-FACE ELEVATOR DOOR

The present invention relates to a flush-face freight elevator door, and more particularly to a flush-freight elevator door which is fabricated substantially entirely by welding and to a method of producing such a door.

Vertically slidable doors used for closing the openings of elevator shafts in buildings and warehouses, which doors are fire proof and form protection from spreading fire through elevator shafts from one floor in the building to another floor thereof, are well known and have been in extensive use for years. Horizontally divided, or single section vertically moving counterbalanced freight elevator doors have found extensive use. In many modern buildings, the freight elevators are positioned whereby they open into office space or other locations in which the elevator doors occupy a conspicuous portion of a wall. Freight elevator doors typical of the prior art have been made from metal panels which are riveted or bolted to the frame work or which contain external welds of one sort or another which present an unsightly appearance.

Elevator doors which include an angle metal frame, the panel opening of which has been closed either with corrugated metal panels, metal sheathed wooden panels, or heavy metal plates of one sort or another are well known and have been described in the prior art, such as U.S. Pat. No. 1,678,196. The use of very heavy metal plates to provide a rigid door structure is also known, but such an elevator door is extremely heavy. While the added weight of a thick metal plate can be compensated for through the use of counterbalanced doors, such doors are more expensive to produce and require heavier fittings to accomplish the counter-weighting. On the other hand, the use of light metal stock to produce the panels results in a condition known as "oil canning." "Oil canning" is manifested in relatively flexible panels, wherein sections of the panels tend to pop in and out of the vertical plane, to produce an aesthetically undesirable panel while at the same time, producing a lightweight tinny or booming sound when the door is closed or opened or when the door scrapes the hatch wall because of tight or limited operating space.

It is theorized that "oil canning" occurs when a section of a panel has an area slightly larger than the section to which the panel is affixed. When this condition occurs, the panel warps within sectioned areas of the overall vertical door plane, creating a non-planar inward divergence in some areas and, conversely, a non-planar outward divergence in other areas. The resulting inward or outward protrusions can be reversed by depressing the area toward the overall vertical door plane, but it will usually pop out on the other side of the vertical plane. This condition is similar to the condition seen in a lightweight can filled with oil. "Oil canning" is an undesirable warping, buckling or distortion which may be aggravated by existing thermal conditions.

It is the object of the present invention to produce an elevator door which has a flush face substantially free of fastener heads, exposed seams and exposed frames, which thereby facilitates painting, decorating, and otherwise covering the elevator door to match the surrounding wall and make it as unobtrusive as possible. More particularly, the present invention provides a door which is strong and rigid, which meets the ASTM fire codes, and is rated by Underwriters Laboratories, Inc., as suitable for class B openings, and which can be economically fabricated, but which presents a monolithic flush face which can be painted. More particularly, the present invention provides a relatively lightweight elevator door which is substantially free of "oil canning," but which may be economically produced by a welding process.

The invention and the method of manufacture hereinafter described in detail may be better understood by referring to the drawings in which:

FIG. 1 is an elevational view of the back, or elevator shaft side, of the elevator door of the present invention;

FIG. 2 is an expanded, fragmentary vertical section taken at line 2—2, showing the details of the of the construction of the elevator door or door section; and

FIG. 3 is a fragmentary perspective view showing the details of the corner of the rectangular frame in the elevator door face plate.

In the preferred embodiment of the invention, one half of a horizontally divided pair of elevator doors is shown in FIG. 1, generally at 110. Basically the door comprises a face plate 112, more particularly described below, which is welded to a frame, the outer portion of which is a rectangle, shown generally at 114. The rectangular frame comprises two vertical members 116 and 118 and two horizontal members 120 and 122. The rectangular frame members are preferably made of angular steel wherein one flange extends substantially parallel to the wall of the elevator shaft and the other flange extends inwardly into the shaft, or away from the face of the door. Preferably the members which make up the rectangular frame are welded together at the corners E, F, G and H to form the rectangle. The rectangular frame 114 should be made of heavy gauge steel, preferably mill rolled steel sections, in order to provide substantial structural rigidity to the door.

In order to provide additional rigidity the frame structure also includes a pair or more of vertical reinforcement members 124 and 126 which are likewise preferably made from heavy gauge mill rolled steel angle sections and are disposed with one flange parallel to the wall of the elevator shaft and the other flange extending away from the face of the door. Preferably the vertical reinforcement members 124 and 126 are welded at their ends to the horizontal members 120, and 122 at A, B, C and D. The vertical reinforcement members 124 and 126 divide the face panel 112 into three or more sub-panels to produce the desired rigidity and reduce the oil canning tendency of the face panel.

While it is generally contemplated that a single pair of vertical reinforcement members, as is shown in the drawings, will provide adequate support, when the width of the elevator doors exceeds about 8 feet, two pairs of vertical reinforcement members should be used. When the width of the door exceeds about 12 feet, three pairs of vertical reinforcement members may be used. Alternatively, when it is necessary to produce doors wider than 12 feet, two smaller doors may be affixed together, side-by-side to make a wider door, or 4 doors may be affixed together 2 by 2 to form a larger door.

The remaining essential frame member comprise the horizontal stiffeners 128, 130 and 132. As is shown in FIG. 1 these members 128, 130 and 132 span the width of the elevator door at about the center, thus dividing the face panel 112 into 6 or more sub-panels. Prefera-
The horizontal stiffeners are welded at their ends to the vertical members 116, 124, 126, and 118 at I, J, K, L, M, and N. As shown in FIG. 2, the horizontal stiffeners are preferably made of formed angle metal stock, and are affixed to the face plate 112 with the apex of the angle 134 oriented away from the face plate 112 and the flanges 135 of the angle in contact with the face plate 112. Although the horizontal stiffeners may be fabricated from right angle metal with flanges of different or the same dimensions, it is preferred to use 120° angle metal with equal length flanges, as shown in FIG. 2, since the 120° angle conforms to the elevator safety code (ANSI-A 17.1d 1970).

As was mentioned above, the face plate must be essentially monolithic metal, preferably steel. It is necessary that the steel face plate be thick enough that its surface is not penetrated or damaged by a MIG spot weld. Further, it has been found that the face plate must have a thickness greater than 14 gauge (0.0747 inches) in order to avoid the “oil canning” problem. While the preferred thickness of the face plate used in the present invention is about 12 gauge or 0.1046 inches, it is contemplated that plates having a thickness of at least 13 gauge or at least about 0.090 inches will substantially avoid the “oil canning” problem. While there is no upper limit on the thickness insofar as the “oil canning” problem is concerned, as a practical matter, any metal thicker than 10 gauge or 0.1345 inches is not preferred because of increasing weight and cost with no particular benefit obtained by the added thickness.

While the present invention contemplates that face plates used on the doors will be essentially monolithic and planar, the present invention also contemplates that the face plate may have openings for vision panels and other hardware as required and as are customary in the art. However, the present invention contemplates that the face plate of the elevator door will be substantially free from fastener heads of any type, exposed seams such as exposed welding seams, and exposed frame pieces and parts.

In manufacturing the elevator doors of the present invention, it is essential that the welding be carried out in a particular order and under certain conditions in order to avoid the problem of “oil canning.” The welding must be carried out under conditions in which the welding heat is dissipated promptly, since buckling and “oil canning”) of the relatively thin face plate will occur if a substantial area of the plate becomes heated and then further welding operations take place. It is postulated that a face plate which is heated over a substantial area will expand, and if it is welded while in the expanded state, buckling or at least internal stressing will occur when the plate is cooled. In order to carry out the welding processes and allow time for the heat to dissipate, applicants have devised a process by which the welding steps are carried out in a required order. It has been found empirically that when the welding steps are carried out in the order described below, that the heat is permitted to dissipate adequately to prevent buckling of the face plate. If the required order is not followed, buckling or internal stressing occurs, which is manifested in an “oil canning” effect which is aesthetically undesirable.

Before the welding sequence is started, it is preferred that the members of the rectangular frame (116, 118, 120, and 122) and the vertical reinforcing members (124 and 126) be fitted and securely clamped to the face plate 112. Basically the welding sequence, which is shown in FIG. 1 in some detail, commences by MIG spot welding the vertical members 116, 124, 126 and 118 to the face plate 112, starting at one end and working across the door. The center portion of horizontal members 120 and 122, (the portion between the pair of vertical reinforcing members 124 and 126) are next MIG spot welded to the face plate. The vertical reinforcing members 124 and 126 are then MIG arc welded to the horizontal members 120 and 122 at the ends of the vertical reinforcing members at A, B, C, and D. Next, one end portion of both of the horizontal members 120 and 122 of the rectangle are MIG spot welded to the face plate 112 and are MIG arc welded to the vertical member adjacent thereto, i.e., 116 at E and F to form the corners of the rectangular frame. Then, the other end portion of both horizontal members 120 and 122 are MIG spot welded to the face plate 112, followed by MIG arc welding the corners, i.e., welding the horizontal members 120 and 122 to the vertical member 118 at G and H. Finally, the horizontal stiffeners 128, 130 and 132 are MIG arc welded to the vertical members 116, 124, 126, and 118, starting with the center horizontal stiffener 130 at I and J, then the horizontal stiffener at one end, i.e., 128 at M and N and the horizontal stiffener at the other end, i.e., 132 at K and L. The horizontal stiffeners are then MIG spot welded, as is shown in FIG. 2, at 152 and 154 whereby the flanges 135 are MIG tack welded to the face plate. The MIG tack welds for the horizontal stiffener are shown by the numbered X’s 45 through 62 on FIG. 1. Preferably, the balance of the MIG spot welds shown on FIG. 1 by a series of X’s on vertical members 124 and 126 and those shown as unnumbered X’s around the rectangle are also added. The MIG spot welds shown by the X’s, while not essential, are desirable to reduce the noise, which can be characterized as a tinnny sound, created between the face plate and the frame members. A vertical section of the MIG tack welds is shown in FIG. 2 at 150, 152, 154 and 156.

In the preferred embodiment, the spot welds are produced in the order shown in FIG. 1 as numbers 1 through 44 inclusive, with the MIG arc welds carried out as described above. Thus in the preferred process, the welding sequence is:

a. MIG spot weld the vertical members (spots 1 through 28)

b. MIG spot weld the center portion of the horizontal members (spots 29 through 32)

c. MIG arc weld center panel corners (arc welds A, B, C and D)

d. MIG spot weld one end portion of the horizontal members (spots 33 through 38)

e. MIG arc weld rectangle corners (arc welds E and F)

f. MIG spot weld other end portion of the horizontals (spots 39 through 44)

g. MIG arc weld rectangle corners (arc welds G and H)

h. MIG arc weld ends of center horizontal stiffener (arc weld I and J)
i. MIG spot weld center horizontal stiffener (tacks 45 through 50)

j. MIG are weld ends of one horizontal stiffener (arc welds K and L)
k. MIG spot weld end horizontal stiffener (tacks 51 through 56)
l. MIG arc weld ends of other horizontal stiffener (arc welds M and N)
m. MIG spot weld other end horizontal stiffener (tacks 57 through 60)
n. MIG spot weld remaining locations marked X, in any sequence

It will be obvious to those skilled in the art that a greater or fewer number of spot welds may be used and that the optimum number of welds used is determined by the size of the door and the penetration of the weld into the face plate. The present invention is not limited to the precise number of welds shown and described in the preferred embodiment, but the general sequence of welding operations described above must be used to obviate the “oil canning” problem.

The frame members are attached together, although not necessarily prior to attachment to the face plate, through the use of MIG arc welds A through N. The frame members are fitted in such a manner, as is shown in FIG. 3, so as to present a substantially planar surface to which the face plate 112 can be welded. The frame members are attached, as is shown in FIG. 3, through the use of MIG arc welded butt joints 140, 142, and 144. Since this portion of the door is not exposed when the elevator door is in normal use, the aesthetics of this welding process is not critical and the common form of MIG arc welding is quite satisfactory.

The face plate must be welded to the frame using metal-inert gas (MIG) spot welds. The preferred form of MIG spot welding, in which the heat used and the time of the weld are controlled, gives sufficiently accurate control to form a spot weld which will pierce through the frame and penetrate into the rear of the face plate without burning through the face plate. It is essential that the welding apparatus and conditions be adjusted to avoid burning through the face plate, since a burn will produce a marred surface which is undesired, and which defeats the objectives of the present invention. The depth of the spot welds ideally are shown in FIG. 2 at spot weld 146 and 148. Desirably the frames 120 and 122 are penetrated and the weld melts approximately the full thickness of face plate 112.

While it is not preferred, the frame joints may be welded using welding techniques other than MIG arc welding, such as continuous short arc welds. Also it is possible to use untimed tack welds rather than MIG spot welds at the points indicated by the X's on the drawing. The MIG welding technique is preferred because of its easy control, reproducibility, and high quality.

It has been found that the shielding gas used in the MIG welding is important since it controls penetration to some extent. Preferably, an inert gas comprising approximately 75 percent argon and 25 percent carbon dioxide is preferred. Other inert gases may be used.

Preferably, the welding process is carried out by placing the monolithic face plate on a heat sink means, such as a copper topped table, preferably fitted with clamps. It has been found that copper, which is an excellent conductor of heat, tends to carry the heat away from the face plate. This prevents any large section of the face plate from becoming heated and expanding and also aids in obviating burn throughs. Additionally, it has been found that the MIG welds do not stick to cop-

per, so that an occasionally burn through will not weld the door to the table, or the jig.

While it is possible to use heat sink metals other than copper, such as aluminum, and to use additional cooling means such as water or carbon dioxide, it has been found that a copper topped jig table, in which the copper thickness is approximately ¼ inch is perfectly adequate.

Further, in carrying out the MIG spot welding process, it is essential that the frame be held tightly against the face plate during the welding operation. This will permit the frame to firmly bond to the face plate and to obviate the possibility of “oil canning,” booming, and burn through.

Additionally, it is usually desirable to use MIG spot welds, as are shown in FIG. 1 by a series of X's, to further affix the plate 112 to the framework 114. MIG spot welds are also shown in FIG. 2 at 150, 152, 154, and 156.

The process of the present invention can be used to fabricate elevator doors of any conventional metal. While the usual door is produced from hot rolled steel, stainless steel can similarly be used. It is contemplated that the present invention would be useful in producing an aluminum door. Although an aluminum door would not pass a fire test, it is desirable where spark prevention or certain corrosion resistant surfaces are necessary.

As will be known to those skilled in the art, freight elevator doors, and particularly horizontally divided freight elevator doors must meet standards of strength and durability not required of ordinary doors. In such doors it is conventional to provide the top edge of the lower door with a trucking still which must accommodate substantial loads being trucked across the top of the door on to the elevator platform. These loads are actually supported from the opposite ends or the sides of the elevator door and it is essential that the load be accommodated without any distortion, either temporary or permanent of the door per se. The strength standards required of the doors is determined by the elevator capacity and type loading as is shown in ANSI-A17.1.

The forms of the invention herein shown and described are to be considered only as illustrative. It will be apparent to those skilled in the art that numerous modifications may be made therein without departure from the spirit of the invention or the scope of the appended claims.

We claim:

1. A method of making a flush-face freight elevator door which is essentially free of “oil canning” comprises welding a frame to a flat metal face plate, said face plate having a thickness between about 0.090 and about 0.1345 inches, said frame comprising a rectangle formed of metal angle, one flange of which extends substantially parallel with the wall of an elevator shaft and the other flange of which extends inwardly into the shaft, a pair of vertical reinforce members within said rectangle, being affixed at the ends of said horizontal members of said rectangle, and horizontal stiffener members affixed between all four vertical members, said welding being carried out in the following order:

   a. spot weld one vertical member of said rectangle to said face plate;
b. spot weld the vertical reinforcer member adjacent to said welded vertical member to said face plate;

c. spot weld the second vertical reinforcer member to said face plate;

d. spot weld the second vertical member of said rectangle to said face plate;

e. spot weld the center portions of both of the horizontal members of said rectangle to said face plate;

f. arc weld ends of both vertical reinforcer members to said horizontal members of said rectangle;

g. spot weld one end portion of both horizontal members of said rectangle to said face plate, and arc weld ends of said horizontal members to the adjacent vertical members of said rectangle at corners;

h. spot weld the other end portion of both horizontal members of said rectangle to said face plate, and arc weld ends of said horizontal members to the adjacent vertical member of said rectangle at corners;

i. arc weld center horizontal stiffener to vertical reinforcer members, and spot weld said horizontal stiffener to said face plate;

j. arc weld one end horizontal stiffener between the corresponding vertical reinforcer member and the adjacent vertical member of said rectangle and spot weld said horizontal stiffener to said face plate; and

k. arc weld the other end horizontal stiffener between the other vertical reinforcer member and the adjacent vertical member of said rectangle and tack weld said horizontal stiffener to said face plate.

2. A method as described in claim 1, wherein all spot welds are made using metal-inert gas welds.

3. A method as described in claim 2, wherein the welds are made using an inert gas comprising argon.

4. A method as described in claim 3 wherein the inert gas is about 75% argon and about 25% carbon dioxide.

5. A method as described in claim 1, wherein said face plate is in contact with a heat sink during the welding operation.

6. A method as described in claim 5, wherein said heat sink is a copper topped table.

7. A method of making a flush-face freight elevator door which is essentially free of “oil canning” comprises welding a frame to a flat metal face plate, said face plate having a thickness between about 0.090 and 0.1345 inches, said frame comprising a rectangle formed of metal angle, one flange of which extends substantially parallel with the wall of an elevator shaft and the other flange of which extends inwardly into the shaft, a plurality of pairs of vertical reinforcer members within said rectangle, being affixed at the ends to said horizontal members of said rectangle, and horizontal stiffener members affixed between all vertical members, said welding being carried out in the following order:

a. spot weld one vertical member of said rectangle to said face plate;

b. spot weld the first vertical reinforcer member of all pairs to said face plate, starting with the vertical reinforcers closest to the vertical member of said rectangle welded in step a;

c. spot weld the second vertical reinforcer member of each pair to said face plate starting with the vertical member closest to the center of said door;

d. spot weld the second vertical member of said rectangle to said face plate;

e. spot weld the center portions of both of the horizontal members of said rectangle to said face plate;

f. arc weld ends of the central pair of vertical reinforcer members to said horizontal members of said rectangle;

g. spot weld intermediate portions of both horizontal members of said rectangle to said face plate, and arc weld ends of said horizontal members to the adjacent pairs of reinforcer members;

h. spot weld the end portions of both horizontal members of said rectangle to said face plate, and arc weld ends of said horizontal members to the adjacent vertical members of said rectangle at corners;

i. arc weld center horizontal stiffeners between all vertical reinforcer members, and spot weld said horizontal stiffeners to said face plate, starting with the central horizontal stiffener; and

j. arc weld the end horizontal stiffeners between the corresponding vertical reinforcer members and the adjacent vertical members of said rectangle and spot weld said horizontal stiffeners to said face plate.

8. A method as described in claim 7, wherein all spot welds are made using metal-inert gas welds.

9. A method as described in claim 8, wherein the welds are made using an inert gas comprising argon.

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