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(54) METHOD OF CONNECTING A SHEET METAL END CLOSURE TO A SHEET METAL CONTAINER

(71) We, KONINKLIJKE EMBALLAGE INDUSTRIE VAN LEER N.V., a Dutch limited liability company, of Amsterdamseweg, Postbus 25, Amstelveen, Holland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of connecting a sheet metal end closure to a sheet metal container by rolling together flange portions of said end closure and said container to form a seam connection. The invention also relates to a rolled seam connection formed by said method.

Seam connections of the above kind made by the method described are known, for example from prior patent specification No. 1,153,872.

According to the known method the end closure and the container are each provided with an outwardly directed radial flange, extending at right angles to the axis of the container, with the flange of the closure projecting outwardly beyond the flange of the container and the flange of the closure being provided with a slightly downturned peripheral edge. The closure is then positioned on the container with the flanges superimposed and the seam connection is then formed by profiled seaming rollers and a sealing compound is introduced into the seam during the seaming operation.

When the rolling operation is completed the flanges of the closure and container grip around each other, but there is still some clearance between the rolled flanges. To remove said clearance and to obtain a seam which is tight, the rolled flanges are finally crushed or flattened thereby forming a tightly-rolled or folded seam. With a simple double seam as generally known, at least one of the flanges is folded twice over 180°.

With the seam according to Figure 6 of the

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aforsaid patent specification at least one of the flanges is folded three times over 180°. The greater the number of folds the more difficult it is to correctly arrange the flanges relative to each other within the seam. Said flanges should overlap each other as much as possible. In practice it is difficult to arrange said flanges correctly with respect to each other since there always are differences in quality and thickness of sheet material which also define the length of the sheets to be seamed and it is impossible always to change said length and the seaming rollers.

A main object of the present invention is to provide a seam connection which is free from the above-stated objections.

According to the invention this is achieved by a method which includes the steps of folding the outer edge of the flange of the end closure inwardly to form a substantially U-shaped channel having its open side facing inwardly, providing the container body with a flange which, in axial cross-section of the container body, curves outwardly over substantially its full width, the flange having an outer diameter smaller than the inner diameter of the inwardly folded portion of the flange of the end closure, then placing the end closure on the flanged end of the container body and finally rolling the flanges of the end closure and container body together to form a true spiral seam by means of a seaming roller having a groove whose height and depth dimensions correspond to those of the rolled seam.

According to a preferred embodiment of the invention the flanges of the end closure and the container are rolled through more than 360° and 270° respectively and a sealing compound is introduced into said U-shaped channel before the rolling step.

With the method according to the invention the flanges are closely rolled around each other such that at the end of the rolling operation a seam is obtained which is sub-

stantially solid, in other words, without any clearance, and which is a true spiral, that is, cannot and need not be crushed or flattened.

The earlier mentioned tolerances are no longer of any importance since the quantity of material to be rolled is equal to the quantity in the closely rolled finished seam. Due to the fact that said seam is a true spiral shape, its height and width are substantially equal to each other. If the seam is used for connecting wall and bottom of a container such as a drum, this means that at least in radial direction a larger moment of inertia of the seam according to the invention as compared with the known seam starting from the same quantity of material and accordingly a larger strength in that direction where this is desired most.

A further advantage is that the risk of so-called overseaming, which means that during flattening of the seam by known seaming apparatus the material is pressed inwardly over a counter pressure member or seaming chuck of such apparatus, does not exist due to the fact that the flattening operation is completely eliminated. In the manufacturing of drums this means one operation less. A further advantage of the spiral shape seam is that the number of windings can be adapted to the strength of the seam required for a given performance.

Of further importance is the fact that with inner pressure within the seam, for example when the drum drops, the known seam has the tendency to open by partly unrolling resulting in leakage. This part-unrolling is due to the fact that the more or less rectangular cross-section of the flattened seam has a different bending resistance in different directions so that deformation by impacts results in buckling or unrolling. The closely rolled true spiral seam according to the invention has virtually equal bending resistance in all directions and so does not buckle by bending and so does not unroll.

The flattening or crushing of the known seam has the result that the material, in particular at the location of the relatively sharp folds, is hardened more. Under load the seam can burst at this location. This does not happen with the seam according to the invention. This seam forms in effect a circular massive belt around the container.

Attempts have been made to manufacture a round, i.e., non-flattened seam. To this end, however, the flanges were first welded together and subsequently bent into an open roll.

In the manufacturing of a seam connection it is well known to use seaming rollers. The afore-mentioned prior specification describes a method of manufacturing a triple seam in which one flange is folded back upon the other by means of a first seaming roller, after which both flanges are rolled

into a still open spiral shape by another seaming roller, the open spiral seam subsequently being flattened by means of a third roller to form the well known triple seam containing seven layers. Said seven layers can be considered to be seven cylinders fitting into each other.

In the said prior specification a sealing compound is injected into the seam during said rolling operations.

Said known method requires that after assembling the pre-shaped parts, three different seaming rollers have to engage the flanges to produce the closed seam. This also applies when instead of a triple seam the more usual double seam is made. The seam obtained, whether double or triple, has the disadvantage that the cylindrical portions of the seam have different bending moments with respect to the different axes of bending. When during transportation deformation occurs, twisting results with the aforementioned opening of the seam.

Moreover, the cylindrical portions of the seam, causing the undesirable uneven bending resistance, require additional material over a spiral-rolled seam, so that for the same number of layers a spirally-rolled seam uses less material than the seam according to the aforementioned prior patent specification.

Further, it is almost impossible to obtain an air-tight connection and very often not possible to obtain a liquid-tight connection with double seams and triple seams. The sealing compound which is injected into the seam during the seaming operation is spread at random between the layers of the seam during the seaming operation and accordingly does not form a coherent layer; furthermore, such layer loses volume by drying so that small openings are formed. If the sealing compound is applied prior to the seaming operation to avoid said disadvantage, the flanges which during the seaming operations shift over each other will cut the sealing compound, displace it by shifting it, and will divide it into separate pieces.

The inwardly facing substantially U-shaped channel portion of the end closure can be filled with sealing compound before the rolling step and said portion forms the core about which the flanges of the end closure and container are rolled and thus forms the core of the finally rolled seam with the outer edge of the container flange projecting into the U-shaped channel and accordingly into sealing compound previously filled into said U-shaped channel portion. Furthermore, the U-shaped channel portion ensures that the sealing compound will remain in the core of the seam and will not shift or be scraped away.

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seaming operation. Thus when a liquid is used, said liquid first has to be dried to obtain an uninterrupted well-adhering film. It is also possible to apply a loose ring of synthetic resin or rubber which fits into the U-shaped channel in the end closure flange. The use of polyurethane or a rubber-based compound sprayed into the U-shaped channel and allowed to set is, however, preferred.

The actual rolling together of the flanges of the end closure and container by the method according to the invention can be carried out by means of one single seaming roller so that the number of operations is reduced, compared with the known seaming-rolling operations, and the end result is that there is formed a completely closed solid spiral seam having bending moments which are equal, or substantially equal, in axial and radial directions relative to the container axis.

By providing the flange portion of the container with an outwardly curved marginal flange and giving said flange an outer diameter smaller than that of the inwardly folded portion of the flange of the end closure in accordance with the invention enables the two flanges to be wound into a closed spiral seam without undesirable deformations or upsetting occurring.

With the known method described in the aforesaid prior patent specification, the cylindrical portions of the end closure and the container body engage each other during the seaming operation and accordingly the flanges must shift with respect to each other, whilst according to the method of the present invention the flanges cannot shift with respect to each other so that the relative movement during the seaming operation has to take place backwards which means in the direction of the cylindrical portions.

The invention will now be further described with reference to the accompanying drawings, in which:—

Figure 1 shows a known seam in cross-section after the seaming operation and before the flattening operation;

Figure 2 is a cross-section through the seam of Figure 1 in its finished flattened form;

Figure 3 is a cross-section through a seam according to the invention;

Figure 4 is a cross-section of a different embodiment of the seam according to the invention;

Figure 5 shows at *a*, *b*, *c* and *d* schematically the steps in the manufacture of a triple seam according to the method known from British specification No. 1,153,872;

Figure 6 shows the initial form of the end closure according to the present invention;

Figure 7 shows the end closure after bending the outer edge over 180°; and

Figure 8 shows diagrammatically the arrangement of the end closure and the container before the commencement of the seaming operation.

Figure 1 shows how, after the known rolling operation, the flanges of the end closure and container engage each other with large clearance. To close the seam to obtain the form shown in Figure 2 a flattening operation by means of rollers has to take place. The seam then assumes a height which is larger than its thickness.

Figure 3 shows one embodiment of seam according to the invention in the form of a spiral-shaped winding.

Figure 4 shows another embodiment of seam according to the invention differing from the one according to Figure 3 in that the flanges of the end closure and container are rolled over a smaller angle.

Whereas according to the embodiment of Figure 3 the flange of the end closure 1 has been rolled over more than 540° and the flange of the container 2 over more than 360°, in the embodiment of Figure 4 the flange of the end closure 1*a* has been rolled over slightly more than 450° and the flange of the container 2*a* over slightly more than 270°. Thus Figure 3 and Figure 4 respectively show an end closure 1 and 1*a* respectively and a container 2 and 2*a* respectively connected together by means of a seam 3 having the form of a true spiral-shaped winding. Since the examples shown show a spiral seam the flanges of the end closure and container during the seaming operation are deformed towards a smaller diameter which causes an increase of the metal sheet thickness. This thickness increase, however, promotes, the filling of the seam centre whereas it has no particular advantage for flattened seams according to Figure 2.

Whereas in the manufacture of the known seam a seaming roller is used having a groove whose diameter is such that an open substantially spiral-shaped winding is formed which has to be flattened, it is necessary in the manufacture of the spiral-shaped winding according to the invention to use a seaming roller having a groove whose height and depth dimensions correspond to the height and depth dimensions *h* and *d* respectively of the rolled seam (Figure 3) which results in the formation of a spiral seam which does not have to be flattened.

In the manufacture of the known seam illustrated in Figure 5, the end closure 5 is provided with a flange 6 having a downwardly bent edge 7 and the container 9 is provided with a flange 10. During a first rolling operation with a roller 11 (Figure 5*b*) the bent edge 7 is folded back upon the flange 10. By means of a further roller 12 (Figure 5*c*) the flange 6 is turned a second and a third time through a further three right

angles so that in cross-section seven layers are formed, but this does not effect closing of the seam at its centre. This is effected by means of a third roller 13 (Figure 5d) which flattens the open-centred seam to produce an almost rectangular seam, the final form obtained being similar to the one shown in Figure 2.

During said flattening operation it is in practice very difficult properly to define the degree of flattening. The tolerance in thickness and hardness of the sheet metal material and the degree of wear of the machine require adjusting the pressing force to a rather high level. This, however, means that thicker and softer sheet materials are compressed too much and over-deformation reduces the deformability of the sheet material very often to such a degree that if during transportation further deformations occur, this will lead to cracks of the sheet.

In carrying out the method according to the present invention one starts with an end closure 17 shaped as shown in Figure 6, that is, with a flange 14 which does not deviate substantially from the known starting shape shown in Figure 5a. The end closure is stamped out of a flat metal sheet and the edge 13 at the flange 14 is already somewhat bent downwardly. In this downwardly bent portion it is possible to apply a sealing material such as polyurethane or rubber-based compound indicated at 15.

The next step in the method, illustrated in Figure 7, consists in folding the edge portion 13, whether provided with the sealing material 15 or not, inwards by means of the roller 16 to form a substantially U-shaped channel having a very small radius and having its open side facing inwards as shown. If the sealing material has not been applied before said operation, it can be applied after the forming of said channel and if necessary brought into its final condition, e.g. by drying, hardening, vulcanisation, or bonding of a rubber ring or the like.

As shown in Figure 8 the container 18 is provided with an outwardly continuous curved marginal flange 19, that is in the axial cross-section of the container body the flange curves outwardly over substantially its full width, and said flange has an outer diameter smaller than the diameter of the inwardly folded portion 13 of the flange 14 of the end closure and has a large radius of curvature as shown at 20.

The end closure 14 is then placed on the flanged end of the container as shown in Figure 8 with the marginal edge of the container flange 19 facing the open side of the channel section portion 13 of the end closure this being made possible by the outer diameter of the flange 19 being smaller than the inner diameter of the channel section portion 13 of the end closure.

After the end closure and container have thus been assembled the final seaming operation is carried out by means of a seaming roller 21. This is carried out from the position shown in Figure 8 by means of one single roller 21 forming the sheet edges into a complete closed spiral in which the flanges of the end closure and the container, independent of their width, will be rolled into each other through more than 360° and 270° respectively, the centre or heart of the seam being formed by the circular cross-section of the hollow edge 13 made with the aid of the roller 16.

The radius of the groove in the roller 21 is defined by the sheet thickness and the number of windings to be made. If the spiral winding is 2.5 times 180° the outer side of the seam is substantially circular. If the winding is continued to e.g. three times 180°, then the upper half of the seam may have a slightly different radius of curvature from that of the lower half. The result of the last possibility has been shown in Figure 3. Figure 4 shows a seam with a spiral shape of 2.5 times 180° and an outer shape which is substantially circular.

WHAT WE CLAIM IS:—

1. A method of connecting a sheet metal end closure to a cylindrical sheet metal container by providing said end closure and the body of said container each with an outwardly directed flange and rolling the flanges of the end closure and the container body together to form a rolled seam, the method comprising the steps of folding the outer edge of the flange of the end closure inwardly to form a substantially U-shaped channel having its open side facing inwardly, providing the container body with a flange which, in axial cross-section of the body, curves outwardly over substantially its full width, the flange having an outer diameter smaller than the inner diameter of the inwardly folded portion of the flange of the end closure, then placing the end closure on the flanged end of the container body and finally rolling the flanges of the end closure and container body together to form a true spiral seam by means of a seaming roller having a groove whose height and depth dimensions correspond to those of the rolled seam.

2. A method of connecting a sheet metal end closure to a cylindrical sheet metal container by providing said end closure and the body of said container each with an outwardly directed flange and rolling the flanges of the end closure and the container body together to form a rolled seam, the method comprising the steps of folding the outer edge of the flange of the end closure inwardly to form a substantially U-shaped channel having its open side facing inwardly, providing the container body with a flange

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The radius of the groove in the roller 21 is defined by the sheet thickness and the number of windings to be made. If the spiral winding is 2.5 times 180° the outer side of the seam is substantially circular. If the winding is continued to e.g. three times 180°, then the upper half of the seam may have a slightly different radius of curvature from that of the lower half. The result of the last possibility has been shown in Figure 3. Figure 4 shows a seam with a spiral shape of 2.5 times 180° and an outer shape which is substantially circular.

WHAT WE CLAIM IS:—

1. A method of connecting a sheet metal end closure to a cylindrical sheet metal container by providing said end closure and the body of said container each with an outwardly directed flange and rolling the flanges of the end closure and the container body together to form a rolled seam, the method comprising the steps of folding the outer edge of the flange of the end closure inwardly to form a substantially U-shaped channel having its open side facing inwardly, providing the container body with a flange which, in axial cross-section of the body, curves outwardly over substantially its full width, the flange having an outer diameter smaller than the inner diameter of the inwardly folded portion of the flange of the end closure, then placing the end closure on the flanged end of the container body and finally rolling the flanges of the end closure and container body together to form a true spiral seam by means of a seaming roller having a groove whose height and depth dimensions correspond to those of the rolled seam.

2. A method of connecting a sheet metal end closure to a cylindrical sheet metal container by providing said end closure and the body of said container each with an outwardly directed flange and rolling the flanges of the end closure and the container body together to form a rolled seam, the method comprising the steps of folding the outer edge of the flange of the end closure inwardly to form a substantially U-shaped channel having its open side facing inwardly, providing the container body with a flange



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which, in axial cross-section of the body, curves outwardly over substantially its full width, the flange having an outer diameter smaller than the inner diameter of the inwardly folded portion of the flange of the end closure, then placing the end closure on the flanged end of the container body and finally rolling the flanges of the end closure and container body together by means of a seaming roller having a groove whose height and depth dimensions correspond to those of the rolled seam to form a true spiral seam, the flanges of the end closure and of the container being rolled through more than 15 360° and 270° respectively and a sealing compound being introduced into said U-shaped channel before the rolling step.

3. A method according to claim 2, wherein the sealing compound is brought into its 20 final condition before the end closure and

container are assembled.

4. A method according to claim 2 or 3, wherein the sealing compound consists of polyurethane.

5. A method according to any one of 25 claims 2 to 3, wherein the sealing compound consists of a rubber ring.

6. A method of connecting a sheet metal end closure to a cylindrical sheet metal container, substantially as herein described with 30 reference to Figures 3, 4 and 6 to 8 of the accompanying drawings.

7. A sheet metal container having an end closure connected thereto by the method claimed in claim 1 or 2 and any one of 35 claims 3 to 6.

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