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WIRE-SEAM-WELDING METHOD AND APPARATUS THEREFOR

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

The present invention relates to a wire-seam-welding method and an apparatus therefor.

2. Description of the Related Arts

In manufacturing the can body of a metallic container,
10 a thin plated steel sheet having a thickness of 0.5 mm or less is welded by using a conventional wire-seam-welding method in which the overlapping width of the steel sheet is made longer than the welding bead width. The conventional method was principally used for an earlier wire-seam-
15 welding method, and the inner and outer surfaces of the can body were welded by wires having an identical shape. In the conventional method, the overlapping width of the steel sheet was made longer than the welding bead width since a technique for controlling the positions of the welding beads
20 and the overlapping width of the steel sheet had not yet been sufficiently established, and the overlapping width, therefore, could not be reduced. According to the conventional method, however, non-welded edge portions in either of the peripheral regions of the thin sheet bend away
25 from the weld zone if the overlapping width is excessively

longer than the welding bead width, and it causes incomplete repair of the weld zone, or reduced corrosion resistance of the can body.

Further, since the welding conditions could not be made
5 stable, the applicable steel sheets were principally tin plates, each of which had a surface layer containing metallic tin, a low electric resistance (contact resistance), and an advantage against variation in the welding electric current. Moreover, in the case that a tin
10 free steel sheet with a high contact resistance is welded at a wire feeding speed of 5 m/min. or more, an insulating film (a metallic chromium layer and a chromium hydrate oxide layer) in the weld zone should be removed by a process such as edge cleaning before welding in order to reduce the
15 contact resistance. Furthermore, since the subject of welding is such a material which has a low contact resistance and which is advantageous against variation in the welding electric current, the welding electric current required for appropriate heat generation becomes too large if the contact
20 area between the wire and the steel sheet is large. To prevent such a problem from occurring, a wire has been used, in which the external shape at the portion which is in contact with the steel sheet is an arc in view of the width direction of the weld zone, such that the contact area
25 between the wire and the steel sheet can stably be smaller.

In contrast to the above mentioned conventional wire-seam-welding with the long-width overlap, the wire-seam-welding method for a can body, which is predominant at the present, is disclosed in Japanese
5 Examined Patent Publication No. 54-26213. In this method, the overlapping width of the steel sheet is narrowed to 1/2 or less times the welding bead width, and progress in the overlap-controlling technique has actualized such a welding method.

10 An advantage of such a wire-seam-welding method is the fact that welding can be completed including the edge portions at either of the peripheral regions of the thin sheet since the overlapping width of the steel sheet is shorter than the welding bead width, and therefore, there
15 are no problems such as incomplete repair of the weld zone or reduced corrosion resistance of the can body. Further, since the electric current is effectively concentrated onto the sheet/sheet interface, an appropriate heat generation can be achieved with a low amount of electric current even
20 if the welded material has a low contact resistance.

In the meantime, regulations concerning contamination of containers with foreign substances have become strict recently, and a cleaner welding environment is required.

As a result of this, although conventionally, tin free
25 steel sheets have been welded on condition that the portions

to be welded were cleaned just before welding, there is an increasing demand for welding without edge cleaning, and in addition, at a high speed in view of workability.

5 In the case that a tin-free steel having a high contact resistance is welded at a high speed without edge cleaning according to the above-described wire-seam-welding having short-width overlap, however, weld defects referred to as splash or hot weld are immediately generated on the
10 sheet/sheet interface. More specifically, in this welding method, the entire overlapping portion including the edge portions of the steel sheet is welded since the overlapping width of the steel sheet is short, the weld zone are mashed under a high pressure, and due to this, splash immediately
15 occur when an excessive heat is generated. As a result, the wire-seam-welding having short-width overlap is unsuitable for welding, at a high speed without edge cleaning, a material having a high contact resistance.

20 On the other hand, in the case that a tin free steel sheet is welded at a high speed without edge cleaning according to the wire-seam-welding having the long-width overlap, splash occur on the wire/sheet interface under a condition with an electric current capable of securing an
25 appropriate amount of heat generated on the sheet/sheet

interface. This problem is attributed to the fact that the current density on the wire/sheet interface becomes large and an excessive amount of heat is generated in the wire-seam-welding having the long-width overlap since the
5 current-application area on the sheet/sheet interface is larger than that on the wire/sheet interface, which is in contrast to the wire-seam-welding having the short-width overlap in which the current density on the wire/sheet interface can be reduced and heat generation can be
10 restricted since the current-application area on the sheet/sheet interface is narrower than that on the wire/sheet interface.

Further, in the wire-seam-welding method, since it is
15 difficult to improve the ability to cool the wire/sheet interface on the inner side of the can body because of limitations with regard to the structure of the welding machine, splash readily occur particularly on the inner side of the can body when high-speed welding is performed, and
20 such splash cause problems such that the inside of the can is contaminated with foreign substances, or the current range where welding is possible cannot be secured.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a wire-seam-welding method which is capable of welding a steel sheet at a high speed without causing problems such as splash.

To attain the object, the present invention provides a method for wire-seam-welding two overlapping edges of an electrolytically chromate-treated steel sheet at a wire feeding speed of at least 15 m/min. without cleaning the edges, thereby manufacturing a can body.

Said method is characterized by the following:

(1) A first wire electrode is used inside the can body and a second wire electrode is used outside the can body.

(2) The first wire electrode has a sectional area of 0.5 to 3.0 mm² perpendicular to the longitudinal direction of the can body.

(3) The first wire electrode has a linear portion in contact with said electrolytically chromate-treated steel sheet to be welded relative to the width direction of the weld zone, said linear portion having a length of 1.0 to 4.0 times the thickness of said electrolytically chromate-treated steel sheet to be welded.

(4) The second wire electrode has an arc shape portion in contact with said electrolytically chromate-treated steel sheet to be welded relative to the width direction

of the weld zone.

(5) $L \leq W < L + 1.5$ is satisfied in the relationship between the overlapping width W (mm) of said electrolytically chromate-treated steel sheet to be welded
5 and the length L (mm) of said linear portion of said first wire electrode.

It is preferable that the first wire electrode has arc portions at both ends of the linear portion in contact with said electrolytically chromate-treated steel sheet to be
10 welded relative to the width direction of the weld zone, each of said arc portions having a radius R of curvature of 0.1 mm or more. Also, it is desirable that a pressure of 30 to 150 kgf is applied between the first wire electrode and the second wire electrode and a nugget pitch is 0.6 to
15 1.8 mm in the weld zone.

Further, the present invention provides a method for wire-seam-welding two overlapping edges of a tin free steel sheet at a wire feeding speed of at least 15 m/min. without cleaning the edges, thereby manufacturing a can body. Said
20 tin free steel sheet comprises a steel sheet and a coating film, said coating film having a metallic chromium layer on the steel sheet and a chromium hydrate oxide layer on the metallic chromium layer. The total coating weight of said coating film is 30 to 250mg/m² for each surface of the
25 steel sheet in terms of metallic chromium, and the coating

weight of said chromium hydrate oxide is 0.5 to 15 mg/m² for each surface of the steel sheet in terms of metallic chromium.

Said method is characterized by the following:

5 (1) A first wire electrode is used inside the can body and a second wire electrode is used outside the can body.

(2) The first wire electrode and the second wire electrode have sectional areas of 0.5 to 3.0 mm² perpendicular to the longitudinal direction of the can body.

10 (3) The first wire electrode and the second wire electrode have linear portions in contact with said tin free steel sheet to be welded relative to the width direction of the weld zone, said linear portion having a length of 1.0 to 4.0 times the thickness of said tin free steel sheet
15 to be welded.

(4) $L \leq W < L + 1.5$ is satisfied in the relationship between the overlapping width W (mm) of said tin free steel sheet to be welded and the length L (mm) of said linear portions of said first wire electrode and said second wire
20 electrode.

It is preferable that the first wire electrode and the second wire electrode have arc portions at both ends of the linear portion in contact with said tin free steel sheet to be welded relative to the width direction of the weld
25 zone, each of said arc portions having a radius R of

curvature of 0.1 mm or more. Also, it is desirable that a pressure of 30 to 150 kgf is applied between the first wire electrode and the second wire electrode and a nugget pitch is 0.6 to 1.8 mm in the welded zone.

5 Furthermore, the present invention provides a welding machine having a welding wire forming device. The welding machine is characterized in that:

the welding wire forming device comprises a plurality pair of welding wire forming rolls which are arranged in
10 the lengthwise direction of the welding wire;

the plurality pair of welding wire forming rolls have different sectional shapes;

the pair of welding wire forming rolls comprises an upper roll and a lower roll for holding and pressing the
15 welding wire, the upper roll being movable in a vertical direction; and

the welding wire is held and pressed by any one of the plurality of the welding wire forming rolls to form a welding wire having a plurality of shapes.

20 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view of a weld zone illustrating a state of welding according to the Embodiment 1.

Fig. 2 is another sectional view of a weld zone illustrating a state of welding according to the Embodiment
25 1.

Fig. 3 is a sectional view of a weld zone illustrating a state of welding according to a conventional method.

Fig. 4(a) to 4(d) are sectional views of wires used for the inner side of the can body in the Embodiment 1.

5 Fig. 5 are sectional views of the wires used in the Embodiment 1.

Fig. 6 is a sectional view of a weld zone illustrating a state of welding according to the Embodiment 3.

Fig. 7 is another sectional view of a weld zone
10 illustrating a state of welding according to the Embodiment 3.

Fig. 8(a) to 8(d) are sectional views of wires used for the inner side of the can body in the Embodiment 3.

Fig. 9 are sectional views of the wires used in the
15 Embodiment 3.

Fig. 10 is a schematic illustration of a welding machine having a welding wire forming device according to the Embodiment 5.

Fig. 11 is a side view showing welding wire forming rolls
20 according to the Embodiment 5.

Fig. 12 is a sectional view showing welding wire forming rolls for can material A in accordance with the Embodiment 5.

Fig. 13 is a sectional view showing welding wire forming
25 rolls for can material B in accordance with the Embodiment

5.

Fig. 14 is a sectional view showing welding wire forming rolls for can material C in accordance with the embodiment 5 of the present invention.

5 Fig. 15 is a sectional view showing a welding wire for can material A.

Fig. 16 is a sectional view showing a welding wire for can material B.

10 Fig. 17 is a sectional view showing a welding wire for can material C.

DESCRIPTION OF THE EMBODIMENT

EMBODIMENT 1

15 For the present invention, an investigation was conducted on an overlapping width of the steel sheet which is optimum for inhibiting splash on the sheet/sheet interface when an electrolytically chromate-treated steel sheet is welded at a high speed without edge cleaning. As
20 a result, in relation to the wire used on the inner side of the can body, it has been concluded that the overlapping width of the steel sheet should be equal to or longer than the contact width of the wire/sheet interface along the width of the weld zone in order to inhibit splash while
25 avoiding mashing of the sheet/sheet interface. When,

however, the overlapping width of the steel sheet is longer than the contact width of the wire/sheet interface by 1.5 mm or more, repair of the weld zone becomes difficult since problems occur, such as a warp at the edge portions of the steel sheet. From this point of view, it is not suitable to make the overlapping width of the steel sheet longer by 1.5 mm or more than the contact width of the wire/sheet interface.

Here, when the overlapping width of the steel sheet is, as described above, made to be equal to or longer than the contact width of the wire/sheet interface along the width of the weld zone, reduction of the quantity of the electricity applied onto the wire/sheet interface will be difficult, and particularly, excessive heat generation at the wire/sheet interface on the inner side of the can body will be a problem.

Under such circumstances, an investigation was conducted aiming to optimize the shape of the wire for reducing the current density on the wire/sheet interface. As a result, the following was found to be effective for reducing the current density at the wire/sheet interface on the inner side of the can body: On the inner side of the can body, a wire is used in which the external shape at the site in contact with the steel sheet has a linear portion in view of the width direction of the weld zone,

namely, a wire is used in which the site in contact with the steel sheet is linear in view of the width direction of the weld zone. Meanwhile, when a wire having an external shape including a linear portion such as that described
5 above is used on the outer side of the can body, the appearance of the weld zone is deteriorated since the area discolored by welding is enlarged. Because of such a problem, a conventionally-used wire should preferably be used on the outer side of the can body, the wire's external
10 shape at the site in contact with the steel sheet being an arc (a convex arc) in view of the width direction of the weld zones. By this means, welding can be completed without affecting the appearance of the weld zone.

Further, if the above-described wire having an arch
15 shape is used for the outer side of the can body, the current density at the wire/sheet interface on the outer side of the can body will increase. As a result, in combination with the use of the above-described wire having a linear portion for the inner side of the can body, an effect of
20 improving the balance of heat generation between the inner surface and the outer surface of the can body can be obtained, although in the conventional method the center of heat generation has leaned towards the inner surface of the can body.

25 Moreover, if wires, the external shape of each of which

has a linear portion in view of the width direction of the weld zone, are used for the inner side and the outer side of the can body, the steel sheet cannot be in uniform contact with the wires unless the positions of electrodes and others
5 are strictly adjusted, and cracking may occur in the process of forming the can. In contrast, if a wire whose external shape has a linear portion in view of the width direction of the weld zone is used for the inner side of the can body while a wire with an arc portion is used for the outer side
10 of the can body, the above-described ununiform contact by the wires can be prevented.

In the case of wire-seam-welding a material having a chromium hydrate oxide layer and a high contact resistance, such as an electrolytically chromate-treated steel sheet,
15 if the length L of the above-described linear portion of the wire used for the inner side of the can body, the portion being linear in view of the width direction of the weld zone, is 1.0 or less times the thickness of the steel sheet, the width of the nuggets formed is short, and a welding strength
20 necessary for a can in practical use cannot be sufficiently achieved. Meanwhile, a length L of the above-described linear portion that is more than 4.0 times the thickness of the steel sheet is unsuitable, since the effect of enlarging the nugget width is already saturated, and in
25 addition, the applied pressure and electric current

necessary for welding wastefully increase.

Accordingly, in the welding method of the present invention, the wire on the electrode used for the inner side of the can body is specified such that its external shape
5 at the site in contact with an electrolytically chromate-treated steel sheet being a subject of welding has a linear portion in view of the width direction of the weld zone, the linear portion having a length of 1.0 to 4.0 times the thickness of the electrolytically chromate-treated
10 steel sheet which is the subject of welding. Further, the overlapping width W (mm) in the weld zone of the electrolytically chromate-treated steel sheet is specified such that it satisfies $L \leq W < L + 1.5$ in the relation with the length L of the above-described linear portion of the
15 wire on the electrode used for the inner side of the can body. Additionally, the wire on the electrode used for the outer side of the can body is specified such that its external shape at the site in contact with the electrolytically chromate-treated steel sheet to be welded
20 is an arc (convex arc) such as a circular arc, in view of the width direction of the weld zone.

Fig. 1 is a sectional view of a weld zone in an example of a state of welding according to such a method of the present invention. 1 is a wire electrode for the inner side
25 of the can body (on an upper electrode welding roller),

2 is a wire electrode for the outer side of the can body (on a lower welding electrode roller), and the external shape of the wire electrode 1 at the site which should be in contact with the steel sheet has a linear portion 3 which is linear in view of the width direction of the weld zone.

On the other hand, the external shape of the wire electrode 2 at the site which should be in contact with the steel sheet is an arc in view of the width direction of the weld zone.

Incidentally, for comparison, Fig. 3 shows a state of welding (a section of a weld zone) according to a conventional method. In Fig. 3, 5 is a wire electrode for the inner side of the can body (on an upper welding electrode roller), 6 is a wire electrode for the outer side of the can body (on a lower welding electrode roller), and the external shape of each of these wire electrodes 5 and 6 at the site which should be in contact with the steel sheet is an arc in view of the width direction of the weld zone.

Further, each of the edges of the above-described linear portion of the wire electrode for the inner side of the can body, the portion being linear in view of the width direction of the weld zone, preferably has an arc portion (convex arc portion) such as a circular arc portion.

Fig. 2 is another sectional view of a weld zone illustrating a state of welding according to the Embodiment 1 using a

wire electrode having such arc portions, and 4 indicates arc portions formed at the edges of the linear portion 3 of the wire 1. Unless the wire electrode 1 has such arc portions 4, the edge portion of a welding bead may be damaged in the case, for example, that the vertical axes of the upper and lower electrode rollers are deviated, and a crack may be generated from such a damaged portion in the step of, for example, forming flanges after welding. In particular, when the electrolytically chromate-treated steel sheet is a thin material having a thickness of 0.5 mm or less, such a crack is readily generated, and therefore, both the edges of the linear portion 3 should preferably be formed into arc portions 4. Additionally, the radius R of curvature of each arc portion should preferably be 0.1 mm or longer in order to obtain the above-described effects.

The sectional area of the wire electrode used for the inner side of the can body (the area of a section perpendicular to the longitudinal direction of the wire electrode) is 0.5 to 3.0 mm². With a sectional area of the wire electrode less than 0.5 mm², the thermal capacity is too small to sufficiently cool the wire/sheet interface.

On the other hand, with a sectional area of the wire electrode more than 3.0 mm², the cooling effect is saturated in view of heat conduction, and in addition, the cost efficiency is lowered since an expensive copper wire

material is wastefully used. Incidentally, the wire should preferably contain copper as a principal ingredient in view of heat conductivity.

Meanwhile, in the present invention, the sectional
5 shape of the wire electrode for the inner side of the can body can be arbitrarily selected so long as the above-described specifications are satisfied. For example, the sectional shapes (shapes of sections each being perpendicular to the longitudinal direction of a wire
10 electrode) shown in Fig. 4 may be adopted. Among them, (a) and (b) are modified examples of the sectional shape of the wire shown in Fig. 1 mentioned above, and (c) and (d) are modified examples of the sectional shape of the wire electrode shown in Fig. 2 mentioned above.

15 In the practice of the wire-seam-welding method of the present invention, in consideration of the fact that the welding of a tin plate and the welding of an electrolytically chromate-treated steel sheet with edge cleaning may be performed using an identical welding machine in view of
20 operability, a plurality of different wire-forming rolls should preferably be disposed just before each of both the electrode for the inner side of the can body and the electrode for the outer side of the can body in order to achieve wire exchange as the occasion demands.
25 Alternatively, a forming roll having a plurality of grooves

may preferably be disposed just before each of both the electrode for the inner side of the can body and the electrode for the outer side of the can body.

5 Example

Wire-seam-welding for can bodies was performed using the electrolytically chromate-treated steel sheets shown in Table 5 as raw materials, and a Fuji-Welder-type welding machine which achieved an overlapping width of the steel
10 sheet longer than the width of the welding wires. In this example, 4 to 100 cans were manufactured continuously at a welding speed of 10 to 30 m/min., and existence of an acceptable current range (ACR) for welding and corrosion resistance of the obtained can bodies were evaluated.
15 Incidentally, in the evaluation of the cans, the first can and the last can (the initially manufactured can and the finally manufactured can in the continuous process of manufacturing can bodies) manufactured with unstable electric currents were eliminated from the evaluation
20 subjects.

Regarding each of the wires on the electrodes, a plurality of grooves were provided in the wire-forming roll in a position just preceding the position where the wire is fed to the electrode such that a desired wire sectional
25 shape could be obtained. Fig. 5 shows the sectional shapes

of the wires used in this embodiment (each being the shape of a section perpendicular to the longitudinal direction of the wire). Among them, A is a wire having a sectional shape adopted in a conventional method, and B and C are wires
5 each having a sectional shape adopted in the method of the present invention. In Examples according to the Embodiment 1, those wires A to C were used in the combinations shown in Fig. 1 and Fig. 2.

The ACR was defined to be an electric current range
10 between the lower-limit current value below which an appropriate welding strength could not be obtained, and the upper-limit current value above which excessive heat was generated. The lower-limit current was examined by a tear test, and the upper-limit current was examined based on
15 whether splash or splash had occurred. The results were evaluated as follows.

○: There was a sufficient acceptable current range for welding.

△: There was an acceptable current range for welding,
20 though it was narrow.

×: There was no acceptable current range for welding.

Meanwhile, as to corrosion resistance, containers were manufactured from the can bodies other than the first
25 can and the last can, an aqueous content was packed in each

of the containers and stored for 3 months at room temperature, and the state of corrosion in the repaired welded-potion was evaluated as follows.

○: No corrosion.

5 ×: Corrosion was observed.

Incidentally, in the examples without acceptable current ranges for welding, corrosion resistance could not be evaluated since cans could not substantially be manufactured.

10 The results of evaluations of ACR and corrosion resistance are shown in Tables 1 to 4 together with the types of the material steel sheets and the welding conditions.

Referring to Tables 1 to 4, in each of Examples according to the Embodiment 1, there was a sufficient
15 acceptable current range for welding, and the manufactured can bodies had superior corrosion resistance.

In contrast, in each of Comparative Examples 4 and 6 to 12, where a wire (Wire A) whose external shape at the site in contact with the steel sheet was an arc in view of
20 the width direction of the weld zone was used on each of both the electrode for the inner side of the can body and the electrode for the outer side of the can body, an ACR could not be appropriately obtained since an excessive amount of heat was generated at the wire/sheet interface
25 on the inner side of the can body.

Further, in each of Comparative Examples 1 to 3, where a wire whose external shape at the site in contact with the steel sheet had a linear portion in view of the width direction of the weld zone was used as the wire electrode
5 for the inner side of the can body while a wire whose external shape at the site in contact with the steel sheet was an arc in view of the width direction of the weld zone was used as the wire electrode for the outer side of the can body, the effects of the present invention were not sufficiently
10 achieved since other specifications did not satisfy the ranges according to the Embodiment 1.

Among them, Comparative Example 2 was inferior in corrosion resistance since the relationship between the length L (mm) of the linear portion of the wire for the inner
15 side of the can body and the overlapping width W (mm) of the steel sheet was $W > L + 1.5$, separation occurred in the edge portions of the weld zone of the steel sheet, and there was a problem with sealing properties in the weld zone.

In each of Comparative Examples 1 and 3, since the
20 sectional area of the wire for the inner side of the can body was less than 0.5 mm^2 , the ability to cool the wire/sheet interface was insufficient, and splash were generated. Due to this, an appropriate ACR could not be obtained. Additionally, in Comparative Example 3, the length L of the
25 linear portion of the wire for the inner side of the can

body was less than 1.0 time the thickness of the steel sheet, a welding strength necessary for a can in practical use could not be achieved. Further, in Comparative Example 3, the relationship between the length L (mm) of the linear portion
5 of the wire for the inner side of the can body and the overlapping width W (mm) of the steel sheet was $W > L + 1.5$, which was out of the range according to the Embodiment 1.

In Comparative Example 5, a wire whose external shape at the site in contact with the steel sheet was an arc in
10 view of the width length of the weld zone was used as the wire electrode for the inner side of the can body, and a wire whose external shape at the site in contact with the steel sheet had a linear portion in view of the width direction of the weld zone was used as the wire electrode
15 for the outer side of the can body. In this comparative example, since the tendency towards an excessive amount of heat being generated on the inner side of the can body was accelerated, an appropriate ACR could not be obtained.

Incidentally, in Conventional Example, wire-seam-
20 welding was performed at a slow welding speed below 15 m/min., and this example revealed that an electrolytically chromate-treated steel sheet can be welded without edge cleaning in such a case of a slow welding speed even with a conventional technique.

Table 1

No.	Steel Sheet Used ^{*1}	Type of Wire for Outer Side of Can Body ^{*2}	Type of Wire for Inner Side of Can Body ^{*2}	Width of Wire (mm)	Wire for Inner Side of Can Body			Wire Speed (m/min.)	Thickness of Steel Sheet (mm)	Overlapping Width of Steel Sheet W (mm)	Properties	
					Wire Contact Width of Wire (mm) ^{*3}	Wire Edge R (mm) ^{*4}	Sectional Area of Wire (mm ²)				ACR	corrosion resistance
Example 1	A	A	B	1.0	1.0	-	1.6	20	0.32	1.8	○	○
Example 2	A	A	B	1.0	1.0	-	1.6	15	0.32	1.1	○	○
Example 3	A	A	B	1.0	1.0	-	1.6	26	0.32	2.4	○	○
Example 4	A	A	B	0.5	0.5	-	0.6	15	0.32	1.5	○	○
Example 5	A	A	B	1.8	1.8	-	2.9	20	0.49	3.0	○	○
Example 6	A	A	B	1.0	1.0	-	1.6	20	0.25	1.8	○	○
Example 7	A	A	B	1.0	1.0	-	1.6	20	0.40	1.8	○	○
Example 8	A	A	B	1.0	1.0	-	1.6	30	0.49	1.8	○	○
Example 9	A	A	B	1.0	1.0	-	1.6	32	0.32	1.8	○	○
Example 10	A	A	C	0.8	0.8	0.1	1.6	20	0.22	1.8	○	○

*1 The electrolytically chromate-treated steel sheets A to H described in Table 5.

*2 Wires A to C having sectional shapes shown in Fig. 5.

*3 The width of the site where the wire is in contact with the steel sheet (In the case that the wire's external shape in the site contacted with the steel sheet has a linear portion in view of the width direction of the weld zone, it equals the length L of the linear portion.)

*4 The radius R of curvature of the arc portions formed in both end portions of the linear portion in the site contacted with the steel sheet, the linear portion being linear in view of the width direction of the weld zone.

※ The underlined signs and numeral values are out of the scope of the Embodiment 1.

Table 2

No.	Steel Sheet Used ^{*1}	Type of Wire for Outer Side of Can Body ^{*2}	Type of Wire for Inner Side of Can Body ^{*2}	Width of Wire (mm)	Wire for Inner Side of Can Body			Wire Speed (m/min.)	Thickness of Steel Sheet (mm)	Overlapping Width of Steel Sheet W (mm)	Properties	
					Contact Wire Width of Wire (mm) ^{*3}	Wire Edge R (mm) ^{*4}	Sectional Area of Wire (mm ²)				ACR	corrosion resistance
Example 11	A	A	C	1.1	0.8	0.2	1.6	20	0.32	1.8	○	○
Example 12	A	A	C	1.1	0.9	0.1	1.6	20	0.32	1.8	○	○
Example 13	A	A	C	0.8	0.7	0.1	1.6	15	0.32	1.5	○	○
Example 14	B	A	B	1.0	1.0	-	1.6	26	0.32	1.8	○	○
Example 15	C	A	B	1.0	1.0	-	1.6	20	0.32	1.8	○	○
Example 16	D	A	B	1.0	1.0	-	1.6	26	0.32	1.8	○	○
Example 17	E	A	B	1.0	1.0	-	1.6	26	0.32	1.8	○	○
Example 18	F	A	B	1.0	1.0	-	1.6	26	0.32	1.8	○	○
Example 19	G	A	B	1.0	1.0	-	1.6	26	0.32	1.8	○	○
Example 20	H	A	B	1.0	1.0	-	1.6	20	0.32	1.8	○	○

*1 The electrolytically chromate-treated steel sheets A to H described in Table 5.

*2 Wires A to C having sectional shapes shown in Fig. 5.

*3 The width of the site where the wire is in contact with the steel sheet (In the case that the wire's external shape in the site contacted with the steel sheet has a linear portion in view of the width direction of the weld zone, it equals the length L of the linear portion.)

*4 The radius R of curvature of the arc portions formed in both end portions of the linear portion in the site contacted with the steel sheet, the linear portion being linear in view of the width direction of the weld zone.

※ The underlined signs and numeral values are out of the scope of the Embodiment 1.

Table 3

No.	Steel Sheet Used *1	Type of Wire for Outer Side of Can Body *2	Type of Wire for Inner Side of Can Body *2	Width of Wire (mm)	Wire for Inner Side of Can Body			Wire Speed (m/min.)	Thickness of Steel Sheet (mm)	Overlapping Width of Steel Sheet W (mm)	Properties	
					Contact Width of Wire (mm) *3	Wire Edge R (mm) *4	Sectional Area of Wire (mm ²)				ACR	corrosion resistance
Comparative Example 1	A	A	B	0.4	0.4	-	<u>0.4</u>	20	0.32	1.8	×	-
Comparative Example 2	A	A	B	1.9	<u>1.9</u>	-	3.0	20	0.32	<u>3.6</u>	○	×
Comparative Example 3	A	A	B	0.2	<u>0.2</u>	-	<u>0.2</u>	20	0.32	<u>1.8</u>	×	-
Comparative Example 4	A	A	<u>A</u>	1.0	1.0	-	1.6	20	0.32	1.8	×	-
Comparative Example 5	A	<u>B</u>	<u>A</u>	1.0	1.0	-	1.6	20	0.32	1.8	×	-
Conventional Example	A	A	<u>A</u>	1.0	1.0	-	1.6	10	0.32	1.8	○	○
Comparative Example 6	B	A	<u>A</u>	1.0	1.0	-	1.6	26	0.32	1.8	△	×
Comparative Example 7	C	A	<u>A</u>	1.0	1.0	-	1.6	20	0.32	1.8	×	-

*1 The electrolytically chromate-treated steel sheets A to H described in Table 5.

*2 Wires A to C having sectional shapes shown in Fig. 5.

*3 The width of the site where the wire is in contact with the steel sheet (In the case that the wire's external shape in the site contacted with the steel sheet has a linear portion in view of the width direction of the weld zone, it equals the length L of the linear portion.)

*4 The radius R of curvature of the arc portions formed in both end portions of the linear portion in the site contacted with the steel sheet, the linear portion being linear in view of the width direction of the weld zone.

※ The underlined signs and numeral values are out of the scope of the Embodiment 1.

Table 4

No.	Steel Sheet Used *1	Type of Wire for Outer Side of Can Body *2	Type of Wire for Inner Side of Can Body *2	Width of Wire (mm)	Wire for Inner Side of Can Body			Wire Speed (m/min.)	Thickness of Steel Sheet (mm)	Overlapping Width of Steel Sheet W (mm)	Properties	
					Wire Contact Width of Wire (mm) *3	Wire Edge R (mm) *4	Sectional Area of Wire (mm ²)				ACR	corrosion resistance
Comparative Example 8	D	A	<u>A</u>	1.0	1.0	.	1.6	26	0.32	1.8	×	.
Comparative Example 9	E	A	<u>A</u>	1.0	1.0	.	1.6	26	0.32	1.8	△	×
Comparative Example 10	F	A	<u>A</u>	1.0	1.0	.	1.6	26	0.32	1.8	△	×
Comparative Example 11	G	A	<u>A</u>	1.0	1.0	.	1.6	26	0.32	1.8	△	×
Comparative Example 12	H	A	<u>A</u>	1.0	1.0	.	1.6	20	0.32	1.8	×	.

*1 The electrolytically chromate-treated steel sheets A to H described in Table 5.

*2 Wires A to C having sectional shapes shown in Fig. 5.

*3 The width of the site where the wire is in contact with the steel sheet (In the case that the wire's external shape in the site contacted with the steel sheet has a linear portion in view of the width direction of the weld zone, it equals the length L of the linear portion.)

*4 The radius R of curvature of the arc portions formed in both end portions of the linear portion in the site contacted with the steel sheet, the linear portion being linear in view of the width direction of the weld zone.

※ The underlined signs and numeral values are out of the scope of the Embodiment 1.

Table 5

No.	Coating Weight of Metallic Chromium (mg/m ²)	Coating Weight of Chromium Hydrate Oxide (mg/m ²) *1	Coating Weight of Metallic Tin (g/m ²)	Coating Weight of Tin Alloy (g/m ²)	Coating Weight of Nickel (mg/m ²)	Structure of Coating Film
A	100	5	-	-	-	Steel Sheet/Metallic Cr/Cr Hydrate Oxide
B	90	15	0.2	0.1	-	Steel Sheet/Sn Alloy/Ununiform Metallic Sn/ Metallic Cr/Cr Hydrate Oxide
C	120	10	0.2	-	-	Steel Sheet/Metallic Cr/Ununiform Metallic Sn/Metallic Cr/Cr Hydrate Oxide
D	100	10	0.2	-	-	Steel Sheet/Metallic Cr/Ununiform Metallic Sn/Cr Hydrate Oxide
E	10	10	0.5	0.6	15	Steel Sheet/Sn-Ni Alloy/Ununiform Metallic Sn/Metallic Cr/Cr Hydrate Oxide
F	10	10	0.5	0.6	-	Steel Sheet/Sn Alloy/Ununiform Metallic Sn/ Metallic Cr/Cr Hydrate Oxide
G	10	10	0.7	0.6	-	Steel Sheet/Sn Alloy/Uniform Metallic Sn/ Metallic Cr/Cr Hydrate Oxide
H	10	10	-	0.4	-	Steel Sheet/Sn Alloy/Metallic Cr/Cr Hydrate Oxide

*1 Coating weight in terms of metallic chromium.

EMBODIMENT 2

Embodiment 2 satisfies the following requirements:

(a) A first wire electrode is used inside the can body and a second wire electrode is used outside the can body.

5 The first wire electrode has a sectional area of 0.5 to 3.0 mm² perpendicular to the longitudinal direction of the can body.

(b) The first wire electrode has a linear portion in contact with said electrolytically chromate-treated steel
10 sheet to be welded relative to the width direction of the weld zone, said linear portion having a length of 1.0 to 4.0 times the thickness of said electrolytically chromate-treated steel sheet to be welded.

(c) The second wire electrode has an arc shape portion
15 in contact with said electrolytically chromate-treated steel sheet to be welded relative to the width direction of the weld zone.

(d) $L \leq W < L + 1.5$ is satisfied in the relationship between the overlapping width W (mm) of said
20 electrolytically chromate-treated steel sheet to be welded and the length L (mm) of said linear portion of said first wire.

(e) A pressure of 30 to 150 kgf is applied between the first wire electrode and the second wire electrode and a
25 nugget pitch is 0.6 to 1.8 mm in the welded zone.

The nugget pitch is an important factor which influences the airtightness of the container. In a material having a low contact resistance and a satisfactory pressure adhesion, such as an edge-cleaned material derived from an electrolytically chromate-treated steel sheet, since the current application can be started even if the applied pressure is low, the area where heat is generated by the current application is wide, and the range of the applicable nugget pitch for welding can be made large, for example, 2 mm or more. Further, since cleaning is performed just before welding, the distribution of contact resistance on the surface of the steel sheet is stable, and ununiform heat generation rarely occur even if the nugget pitch is reduced.

In contrast, in the case of welding a material having a high contact resistance, such as a material having a chromium hydrate oxide layer, without edge cleaning, since the current application can be started only when the applied pressure is high, the area where heat is generated by the current application is narrow, and an appropriate airtightness cannot be obtained with a nugget pitch longer than 1.8 mm since unheated portions remain. Further, in welding without edge cleaning, since insulating foreign substances and others inevitably exist on the surface of

the steel sheet, the flow of electric currents between nuggets tends to be ununiform with a nugget pitch less than 0.6 mm, and appropriate welding conditions cannot be obtained even if the shapes of the wires are optimized.

5 In a material having a high contact resistance and a material having inferiority in the press adhesion properties, decomposition of the coating film and pressure adhesion are accelerated by increasing the pressure loaded onto the upper and lower electrodes, and the current pathway
10 can be stably secured and the welding strength can be improved. Even if the shapes of the wires are optimized, in the case that the pressure loaded between the upper and lower electrodes is less than 30 kgf, the pressure adhesion is insufficient even in a generally-used material which
15 contains a chromium hydrate oxide layer having a coating weight of approximately 5 to 10 mg/m² in terms of metallic chromium, and therefore, an ACR cannot be appropriately obtained and a sufficient welding strength cannot also be obtained. Meanwhile, when the pressure loaded onto the
20 upper and lower electrodes exceeds 150 kgf, the steel sheet cannot be caught smoothly between the electrodes, and an excessive amount of heat is generated at the leading edge and the terminal edge of the welding portion in response to variation in the welding speed.

25 For the above-described reasons, the present

invention specifies that the nugget pitch be 0.6 to 1.8 mm, and that the pressure applied between the electrodes for the inner side of the can body and for the outer side of the can body be 30 to 150 kgf.

5 In the practice of the wire-seam-welding method of the present invention, in consideration of the fact that the welding of a tin plate and the welding of an electrolytically chromate-treated steel sheet with edge cleaning may be performed using an identical welding machine in view of
10 operability, a plurality of different wire-forming rolls should preferably be disposed just before each of both the electrode for the inner side of the can body and the electrode for the outer side of the can body in order to achieve wire exchange as the occasion demands.
15 Alternatively, a forming roll having a plurality of grooves may preferably be disposed just before each of both the electrode for the inner side of the can body and the electrode for the outer side of the can body.

20 Example

Wire-seam-welding for can bodies was performed using the electrolytically chromate-treated steel sheets shown in Table 14 as raw materials, and a Fuji-Welder-type welding machine which achieved an overlapping width of the steel
25 sheet longer than the width of the welding wires. In this

example, 4 to 100 cans were manufactured continuously at a welding speed of 10 to 30 m/min., and existence of an acceptable current range for welding (ACR), corrosion resistance of the obtained can bodies and the appearances
5 of the weld zones were evaluated. Incidentally, in the evaluation of the cans, the first can and the last can (the initially manufactured can and the finally manufactured can in the continuous process of manufacturing can bodies) manufactured with unstable electric currents were
10 eliminated from the evaluation subjects.

Regarding each of the wires on the electrodes, a plurality of grooves were provided in the wire-forming roll in a position just preceding the position where the wire is fed to the electrode such that a desired wire sectional
15 shape could be obtained. Fig. 5 shows the sectional shapes of the wires used in this embodiment (each being the shape of a section perpendicular to the longitudinal direction of the wire). Among them, A is a wire having a sectional shape adopted in a conventional method, and B and C are wires
20 each having a sectional shape adopted in the method of the present invention. In Examples according to the Embodiment 2, those wires A to C were used in the combinations shown in Fig. 1 and Fig. 2.

The ACR was defined to be an electric current range
25 between the lower-limit current value below which an

appropriate welding strength could not be obtained, and the upper-limit current value above which excessive heat was generated. The lower-limit current was examined by a tear test, and the upper-limit current was examined based on whether splash or splash had occurred. The results were evaluated as follows.

○: There was a sufficient acceptable current range for welding.

△: There was an acceptable current range for welding, though it was narrow.

×: There was no acceptable current range for welding.

Meanwhile, as to corrosion resistance, containers were manufactured from the can bodies other than the first can and the last can, an aqueous content was packed in each of the containers and stored for 3 months at room temperature, and the state of corrosion in the repaired welded-potion was evaluated as follows.

○: No corrosion.

×: Corrosion was observed.

Incidentally, in the examples without acceptable current ranges for welding, corrosion resistance could not be evaluated since cans could not substantially be manufactured.

Further, as for the appearance of the weld zone, the weld zone was visibly observed, and evaluated as follows.

○: There was no heterogeneous discoloration in the weld zone.

5 ×: There was heterogeneous discoloration in the weld zone.

The results of evaluations of ACR and corrosion resistance are shown in Tables 6 to 13 together with the types of the material steel sheets and the welding
10 conditions.

Referring to Tables 6 to 13, in each of Examples according to the present invention, there was a sufficient acceptable current range for welding, and the manufactured can bodies had superior corrosion resistance.

15 In contrast, in each of Comparative Examples 10 to 16, where a wire (Wire A) whose external shape at the site in contact with the steel sheet was an arc in view of the width direction of the weld zone was used on each of both the electrode for the inner side of the can body and the
20 electrode for the outer side of the can body, an ACR could not be appropriately obtained since an excessive amount of heat was generated at the wire/sheet interface on the inner side of the can body.

Further, in each of Comparative Examples 1 to 8, where
25 a wire whose external shape at the site in contact with the

steel sheet had a linear portion in view of the width direction of the weld zone was used as the wire on the electrode for the inner side of the can body while a wire whose external shape at the site in contact with the steel sheet was an arc in view of the width direction of the weld zone was used as the wire on the electrode for the outer side of the can body, the effects of the present invention were not sufficiently achieved since other specifications did not satisfy the ranges according to the present invention.

Among them, Comparative Example 2 was inferior in corrosion resistance since the relationship between the length L (mm) of the linear portion of the wire for the inner side of the can body and the overlapping width W (mm) of the steel sheet was $W > L + 1.5$, separation occurred in the edge portions of the weld zone of the steel sheet, and there was a problem with sealing properties in the weld zone.

In each of Comparative Examples 1 and 3, since the sectional area of the wire for the inner side of the can body was less than 0.5 mm^2 , the ability to cool the wire/sheet interface was insufficient, and splash were generated. Due to this, an appropriate ACR could not be obtained. Additionally, in Comparative Example 3, the length L of the linear portion of the wire for the inner side of the can body was less than 1.0 time the thickness of the steel sheet,

a welding strength necessary for a can in practical use could not be achieved. Further, in Comparative Example 3, the relationship between the length L (mm) of the linear portion of the wire for the inner side of the can body and the overlapping width W (mm) of the steel sheet was $W > L + 1.5$, which was out of the range according to the present invention.

In Comparative Example 4, since the pressure applied between both the electrodes was less than 30 kgf, an ACR could not be appropriately obtained due to the insufficient pressure application, and the welding strength was also insufficient.

In each of Comparative Examples 7 and 8, since the pressure applied between both the electrodes exceeded 150 kgf, an excessive amount of heat was generated at the leading edge and the terminal edge of the weld zone based on variation in the welding speed accompanying the incomplete capture of the steel sheet between both the electrodes, and as a result, the appearance of the weld zone was inferior.

In Comparative Example 5, since the nugget pitch exceeded 1.8 mm, non-weld zones remained between nugget pitches, and as a result, an appropriate welding strength could not be obtained. Further, regarding the appearance, heterogeneous discoloration was generated.

In Comparative Example 6, since the nugget pitch was

less than 0.6 mm, heat was ununiformly generated, and splash readily occurred. Further, regarding the appearance, heterogeneous discoloration was generated.

In Comparative Example 9, a wire whose external shape
5 at the site in contact with the steel sheet was an arc in
view of the width length of the weld zone was used as the
wire on the electrode for the inner side of the can body,
and a wire whose external shape at the site in contact with
the steel sheet had a linear portion in view of the width
10 direction of the weld zone was used as the wire on the
electrode for the outer side of the can body. In this
comparative example, since the tendency towards an
excessive amount of heat being generated on the inner side
of the can body was accelerated, an appropriate ACR could
15 not be obtained.

Incidentally, in Conventional Example, wire-seam-
welding was performed at a slow welding speed below 15 m/min.,
and this example revealed that an electrolytically
chromate-treated steel sheet can be welded without edge
20 cleaning in such a case of a slow welding speed even with
a conventional technique, although the appearance was
affected by heterogeneous discoloration.

Table 6

No.	Steel Sheet Used ^{*1}	Type of Wire for Outer Side of Can Body ^{*2}	Type of Wire for Inner Side of Can Body ^{*2}	Width of Wire (mm)	Wire for Inner Side of Can Body			Wire Speed (m/min.)	Thickness of Steel Sheet (mm)	Overlapping Width of Steel Sheet W (mm)
					Contact Width of Wire ^{*3} (mm)	Wire Edge R (mm) ^{*4}	Sectional Area of Wire (mm ²)			
Example 1	A	A	B	1.0	1.0	-	1.6	20	0.32	1.8
Example 2	A	A	B	1.0	1.0	-	1.6	15	0.32	1.1
Example 3	A	A	B	1.0	1.0	-	1.6	26	0.32	2.4
Example 4	A	A	B	0.5	1.0	-	0.6	15	0.32	1.5
Example 5	A	A	B	1.8	1.0	-	2.9	20	0.49	3.0
Example 6	A	A	B	1.0	1.0	-	1.6	20	0.25	1.8
Example 7	A	A	B	1.0	1.0	-	1.6	20	0.40	1.8
Example 8	A	A	B	1.0	1.0	-	1.6	30	0.49	1.8
Example 9	A	A	B	1.0	1.0	-	1.6	20	0.32	1.8
Example 10	A	A	B	1.0	1.0	-	1.6	15	0.32	1.1
Example 11	A	A	B	1.0	1.0	-	1.6	32	0.32	1.8

^{*1} The electrolytically chromate-treated steel sheets A to H described in Table 9.

^{*2} Wires A to C having sectional shapes shown in Fig. 5.

^{*3} The width of the site where the wire is in contact with the steel sheet (In the case that the wire's external shape in the site contacted with the steel sheet has a linear portion in view of the width direction of the weld zone, it equals the length L of the linear portion.)

^{*4} The radius R of curvature of the arc portions formed in both end portions of the linear portion in the site contacted with the steel sheet, the linear portion being linear in view of the width direction of the weld zone.

※ The underlined signs and numeral values are out of the scope of the Embodiment 2.

Table 7

	Nugget Pitch (mm)	Applied Pressure (kgf)	Properties		
			ACR	Corrosion Resistance	Appearance
Example 1	1.2	80	○	○	○
Example 2	1.2	60	○	○	○
Example 3	1.2	70	○	○	○
Example 4	1.2	60	○	○	○
Example 5	1.2	60	○	○	○
Example 6	0.6	60	○	○	○
Example 7	1.2	60	○	○	○
Example 8	1.2	60	○	○	○
Example 9	1.2	60	○	○	○
Example 10	1.2	32	○	○	○
Example 11	0.9	140	○	○	○

Table 8

No.	Steel Sheet Used *1	Type of Wire for Outer Side of Can Body *2	Type of Wire for Inner Side of Can Body *2	Width of Wire (mm)	Wire for Inner Side of Can Body			Wire Speed (m/min.)	Thickness of Steel Sheet (mm)	Overlapping Width of Steel Sheet W (mm)
					Contact Width of Wire (mm) *3	Wire Edge R (mm) *4	Sectional Area of Wire (mm ²)			
Example 12	A	A	C	0.8	1.0	0.1	1.6	20	0.22	1.8
Example 13	A	A	C	1.1	1.0	0.2	1.6	20	0.32	1.8
Example 14	A	A	C	1.1	1.0	0.1	1.6	20	0.32	1.8
Example 15	A	A	C	0.8	1.0	0.1	1.0	15	0.32	1.5
Example 16	B	A	B	1.0	1.0	-	1.6	26	0.32	1.8
Example 17	C	A	B	1.0	1.0	-	1.6	20	0.32	1.8
Example 18	D	A	B	1.0	1.0	-	1.6	26	0.32	1.8
Example 19	E	A	B	1.0	1.0	-	1.6	26	0.32	1.8
Example 20	F	A	B	1.0	1.0	-	1.6	26	0.32	1.8
Example 21	G	A	B	1.0	1.0	-	1.6	26	0.32	1.8
Example 22	H	A	B	1.0	1.0	-	1.6	20	0.32	1.8

*1 The electrolytically chromate-treated steel sheets A to H described in Table 9.

*2 Wires A to C having sectional shapes shown in Fig. 5.

*3 The width of the site where the wire is in contact with the steel sheet (In the case that the wire's external shape in the site contacted with the steel sheet has a linear portion in view of the width direction of the weld zone, it equals the length L of the linear portion.)

*4 The radius R of curvature of the arc portions formed in both end portions of the linear portion in the site contacted with the steel sheet, the linear portion being linear in view of the width direction of the weld zone.

※ The underlined signs and numeral values are out of the scope of the Embodiment 2.

Table 9

No.	Nugget Pitch (mm)	Applied Pressure (kgf)	Properties		
			ACR	Corrosion Resistance	Appearance
Example 12	0.6	60	○	○	○
Example 13	1.2	60	○	○	○
Example 14	1.2	60	○	○	○
Example 15	1.5	60	○	○	○
Example 16	1.2	80	○	○	○
Example 17	1.2	80	○	○	○
Example 18	1.2	80	○	○	○
Example 19	1.2	80	○	○	○
Example 20	1.2	80	○	○	○
Example 21	1.2	80	○	○	○
Example 22	1.2	80	○	○	○

Table 10

No.	Steel Sheet Used *1	Type of Wire for Outer Side of Can Body *2	Type of Wire for Inner Side of Can Body *2	Width of Wire (mm)	Wire for Inner Side of Can Body			Wire Speed (m/min.)	Thickness of Steel Sheet (mm)	Overlapping Width of Steel Sheet W (mm)
					Wire Contact Width of Wire *3	Wire Edge R (mm) *4	Sectional Area of Wire (mm ²)			
Comparative Example 1	A	A	B	0.4	0.4	-	0.4	20	0.32	1.8
Comparative Example 2	A	A	B	1.9	1.9	-	3.0	20	0.32	3.6
Comparative Example 3	A	A	B	0.2	0.2	-	0.2	20	0.32	1.8
Comparative Example 4	A	A	B	1.9	3.0	-	3.0	20	0.32	3.6
Comparative Example 5	A	A	B	1.0	1.0	-	1.6	20	0.32	1.8
Comparative Example 6	A	A	B	1.0	1.0	-	1.6	30	0.32	1.8
Comparative Example 7	A	A	C	1.1	1.0	0.1	1.6	20	0.32	1.8
Comparative Example 8	A	A	B	1.1	1.0	-	1.6	20	0.32	1.8

*1 The electrolytically chromate-treated steel sheets A to H described in Table 9.

*2 Wires A to C having sectional shapes shown in Fig. 5.

*3 The width of the site where the wire is in contact with the steel sheet (In the case that the wire's external shape in the site contacted with the steel sheet has a linear portion in view of the width direction of the weld zone, it equals the length L of the linear portion.)

*4 The radius R of curvature of the arc portions formed in both end portions of the linear portion in the site contacted with the steel sheet, the linear portion being linear in view of the width direction of the weld zone.

※ The underlined signs and numeral values are out of the scope of the Embodiment 2.

Table 11

No.	Nugget Pitch (mm)	Applied Pressure (kgf)	Properties		
			ACR	Corrosion Resistance	Appearance
Comparative Example 1	1.2	60	×	-	×
Comparative Example 2	1.2	60	○	×	○
Comparative Example 3	1.2	60	×	-	×
Comparative Example 4	1.2	<u>25</u>	×	-	○
Comparative Example 5	<u>1.9</u>	80	○	○	×
Comparative Example 6	<u>0.5</u>	80	○	○	×
Comparative Example 7	1.2	<u>155</u>	○	○	×
Comparative Example 8	1.2	<u>155</u>	○	○	×

Table 12

No.	Steel Sheet Used *1	Type of Wire for Outer Side of Can Body *2	Type of Wire for Inner Side of Can Body *2	Width of Wire (mm)	Wire for Inner Side of Can Body			Wire Speed (m/min.)	Thickness of Steel Sheet (mm)	Overlapping Width of Steel Sheet W (mm)
					Contact Width of Wire (mm) *3	Wire Edge R (mm) *4	Sectional Area of Wire (mm ²)			
Comparative Example 9	A	<u>B</u>	<u>A</u>	1.0	1.0	-	1.6	20	0.32	1.8
Comparative Example 10	B	A	<u>A</u>	1.0	1.0	-	1.6	26	0.32	1.8
Comparative Example 11	C	A	<u>A</u>	1.0	1.0	-	1.6	20	0.32	1.8
Comparative Example 12	D	A	<u>A</u>	1.0	1.0	-	1.6	26	0.32	1.8
Comparative Example 13	E	A	<u>A</u>	1.0	1.0	-	1.6	26	0.32	1.8
Comparative Example 14	F	A	<u>A</u>	1.0	1.0	-	1.6	26	0.32	1.8
Comparative Example 15	G	A	<u>A</u>	1.0	1.0	-	1.6	26	0.32	1.8
Comparative Example 16	H	A	<u>A</u>	1.0	1.0	-	1.6	20	0.32	1.8
Conventional Example 1	A	A	<u>A</u>	1.0	1.0	-	1.6	10	0.32	1.8

*1 The electrolytically chromate-treated steel sheets A to H described in Table 9.

*2 Wires A to C having sectional shapes shown in Fig. 5.

*3 The width of the site where the wire is in contact with the steel sheet (In the case that the wire's external shape in the site contacted with the steel sheet has a linear portion in view of the width direction of the weld zone, it equals the length L of the linear portion.)

*4 The radius R of curvature of the arc portions formed in both end portions of the linear portion in the site contacted with the steel sheet, the linear portion being linear in view of the width direction of the weld zone.

※ The underlined signs and numeral values are out of the scope of the Embodiment 2.

Table 13

No.	Nugget Pitch (mm)	Applied Pressure (kgf)	Properties		
			ACR	Corrosion Resistance	Appearance
Comparative Example 9			×	-	×
Comparative Example 10	1.2	80	△	×	×
Comparative Example 11	1.2	80	×	-	×
Comparative Example 12	1.2	80	×	-	×
Comparative Example 13	1.2	80	△	×	×
Comparative Example 14	1.2	80	△	×	×
Comparative Example 15	1.2	80	△	×	×
Comparative Example 16	1.2	80	×	-	×
Conventional Example	1.2	60	○	○	×

Table 14

No.	Coating Weight of Metallic Chromium (mg/m ²)	Coating Weight of Chromium Hydrate oxide (mg/m ²) *1	Coating Weight of Metallic Tin (g/m ²)	Coating Weight of Tin alloy (g/m ²)	Coating Weight of Nickel (mg/m ²)	Structure of Coating Film
A	100	5	-	-	-	Steel Sheet/Metallic Cr/Cr Hydrate Oxide
B	90	15	0.2	0.1	-	Steel Sheet/Sn Alloy/Ununiform Metallic Sn/ Metallic Cr/Cr Hydrate Oxide
C	120	10	0.2	-	-	Steel Sheet/Metallic Cr/Ununiform Metallic Sn/Metallic Cr/Cr Hydrate Oxide
D	100	10	0.2	-	-	Steel Sheet/Metallic Cr/Ununiform Metallic Sn/Cr Hydrate Oxide
E	10	10	0.5	0.6	15	Steel Sheet/Sn-Ni Alloy/Ununiform Metallic Sn/Metallic Cr/Cr Hydrate Oxide
F	10	10	0.5	0.6	-	Steel Sheet/Sn Alloy/Ununiform Metallic Sn/ Metallic Cr/Cr Hydrate Oxide
G	10	10	0.7	0.6	-	Steel Sheet/Sn Alloy/Uniform Metallic Sn/ Metallic Cr/Cr Hydrate Oxide
H	10	10	-	0.4	-	Steel Sheet/Sn Alloy/Metallic Cr/Cr Hydrate Oxide

*1 Coating Weight in terms of metallic chromium.

EMBODIMENT 3

An investigation was conducted on an overlapping width
5 of the steel sheet which is optimum for inhibiting splash
on the sheet/sheet interface when a tin free steel sheet
is welded at a high speed without edge cleaning. As a result,
it has been concluded that the overlapping width of the steel
sheet should be equal to or longer than the contact width
10 of the wire/sheet interface along the width of the weld zone
in order to inhibit splash while avoiding mashing of the
sheet/sheet interface. When, however, the overlapping
width of the steel sheet is longer than the contact width
of the wire/sheet interface by 1.5 mm or more, repair of
15 the weld zone becomes difficult since problems occur, such
as a warp at the edge portions of the steel sheet. From
this point of view, it is not suitable to make the
overlapping width of the steel sheet longer by 1.5 mm or
more than the contact width of the wire/sheet interface.

20 Here, when the overlapping width of the steel sheet
is, as described above, made to be equal to or longer than
the contact width of the wire/sheet interface along the
width of the weld zone, reduction of the quantity of the
electricity applied onto the wire/sheet interface will be
25 difficult, and excessive heat generation at the wire/sheet

interface will be a problem.

Under such circumstances, an investigation was conducted aiming to reduce the current density at the wire/sheet interface. As a result, the following was found
5 to be effective for reducing the current density at the wire/sheet interface: A wire is used in which the external shape at the site in contact with the steel sheet has a linear portion in view of the width direction of the weld zone, namely, a wire is used in which the site in contact with
10 the steel sheet is linear in view of the width direction of the weld zone.

If a wire in which the site in contact with the steel sheet is linear as described above is used for welding a tin plate or an edge-cleaned tin free steel sheet having
15 a low contact resistance, an extremely large electric current is required since the current pathway becomes wide.

As a result, problems occur, such as the necessity for a power source exceeding the capacity of the welding machine, and appearance deterioration due to unnecessary enlargement
20 of the portion burned by welding. In contrast, in the case of welding a material having a high contact resistance, such as a non-polished tin free steel sheet, owing to the surface resistance of the sheet, excessive extension of the current pathway on the sheet/sheet interface does not occur even
25 if a wire in which the site in contact with the steel sheet

is linear as described above is used. Further, since the wire is made to be in planar contact with the steel sheet and the pressure is thereby uniformly applied, the area for current application is more enlarged as compared with an arc-shaped wire, and generation of splash on the wire/sheet interface is inhibited.

In the case of wire-seam-welding a material having a high contact resistance, such as a tin free steel sheet, the width of the nuggets formed is shorter than in the cases of a material having a low contact resistance, such as a tin plate. Because of this, if the length L of the above-described linear portion of the wire, the portion being linear in view of the width direction of the weld zone, is 1.0 or less times the thickness of the steel sheet, the width of the nuggets formed is short, and a welding strength necessary for a can in practical use cannot be sufficiently achieved. If the length L of the linear portion is long, the width of the nuggets becomes long, and a satisfactory welding strength can be stably obtained even when the conditions for welding are varied. In particular, since the widths for current application are short in materials having high contact resistances, it is significant to make the width of the nugget long. Meanwhile, a length L of the above-described linear portion that is more than 4.0 times the thickness of the steel sheet is unsuitable, since the

effect of enlarging the nugget width is already saturated, and in addition, the applied pressure and electric current necessary for welding wastefully increase.

Accordingly, in the welding method of the Embodiment 3, each of the wires on the electrodes used for the inner side of the can body and for the outer side of the can body is specified such that its external shape at the site in contact with a tin free steel sheet to be welded has a linear portion in view of the width direction of the weld zone, the linear portion having a length of 1.0 to 4.0 times the thickness of the tin free steel sheet to be welded. Further, the overlapping width W (mm) in the weld zone of the tin free steel sheet as the subject of welding is specified such that it satisfies $L \leq W < L + 1.5$ in the relation with the length L of the above-described linear portion of the wire.

Fig. 6 is a sectional view of a weld zone showing a state of welding according to Embodiment 3. 1 is a wire electrode for the inner side of the can body (upper welding electrode roller), 2 is a wire electrode for the outer side of the can body (lower electrode roll), and the external shape of each of the aforementioned wire electrodes 1 and 2 at the site which should be in contact with the steel sheet has a linear portion 3 which is linear in view of the width direction of the weld zone.

Incidentally, for comparison, Fig. 3 shows a state of welding (a section of a weld zone) according to a conventional method. In Fig. 3, 5 is a wire electrode for the inner side of the can body (on an upper welding electrode roller), 6 is a wire electrode for the outer side of the can body (on a lower electrode roller), and the external shape of each of these wires 5 and 6 at the site which should be in contact with the steel sheet is an arc in view of the width direction of the weld zone.

Further, each of the edges of the above-described linear portion of the wire, the portion being linear in view of the width direction of the weld zone, preferably has an arc portion (convex arc portion) such as a circular arc portion. Fig. 7 is a sectional view of a weld zone in an example of a state of welding according to the Embodiment 3 using wires having such arc portions, and 4 indicates arc portions formed at the edges of the linear portion 3 of each of the wire electrodes 1 and 2. Unless the wire electrode 1 has such arc portions 4, the edge portion of a welding bead may be damaged in the case, for example, that the vertical axes of the upper and lower electrode rollers are deviated, and a crack may be generated from such a damaged portion in the step of, for example, forming flanges after welding. In particular, when the tin free steel sheet is a thin material having a thickness of 0.5 mm or less, such

a crack is readily generated, and therefore, both the edges of the linear portion 3 should preferably be formed into arc portions 4. Additionally, the radius R of curvature of each arc portion should preferably be 0.1 mm or longer
5 in order to obtain the above-described effects.

A tin free steel sheet has a coating film on its steel sheet surface, the coating film principally consisting of a metallic chromium layer and a chromium hydrate oxide layer
10 thereon, and the high-speed non-edge cleaning weldability of such a tin free steel sheet as a material principally depends on the coating weight of the chromium hydrate oxide and the total chromium coating weight in the surface layers.

In welding, the process in which the steel sheet is caught
15 between the electrodes, the insulating coating film as the surface layers are decomposed, and the current application is started requires a time period depending on the amount of the insulating coating film. Further, since chromium is a refractory metal, its amount slightly influences the
20 weldability. From this point of view, in high-speed welding at 15 m/min. or higher, there is an upper limit with respect to the amount of the adhering coating film, up to which welding is possible.

More specifically, high-speed non-edge cleaning
25 welding requires that the total coating weight of the

coating film in terms of metallic chromium (total chromium amount) be 250 mg/m^2 or less for each surface of the steel sheet, and the coating weight of the chromium hydrate oxide layer in terms of metallic chromium be 15 mg/m^2 or less for each surface of the steel sheet. When the amounts exceed the upper limits, there is no acceptable current range for welding regardless of the conditions for welding.

Further, the corrosion resistance of the repaired weld zone cannot be secured if the total coating weight of the coating film in terms of metallic chromium (total chromium amount) is less than 30 mg/m^2 for each surface of the steel sheet, or the coating weight of the chromium hydrate oxide layer in terms of metallic chromium is less than 0.5 mg/m^2 for each surface of the steel sheet.

Accordingly, the tin free steel sheet used in the present invention is specified such that the total coating weight of the coating film in terms of metallic chromium (total chromium amount) is 30 to 250 mg/m^2 for each surface of the steel sheet, and the coating weight of the chromium hydrate oxide layer in terms of metallic chromium is 0.5 to 15 mg/m^2 for each surface of the steel sheet.

The sectional area of each of the wires used for the inner side of the can body and for the outer side of the can body (the area of a section perpendicular to the longitudinal direction of the wire) is 0.5 to 3.0 mm^2 . With

a sectional area of each wire less than 0.5 mm^2 , the thermal capacity is too small to sufficiently cool the wire/sheet interface. On the other hand, with a sectional area of each wire more than 3.0 mm^2 , the cooling effect is saturated in view of heat conduction, and in addition, the cost efficiency is lowered since an expensive copper wire material is wastefully used. Incidentally, the wires should preferably contain copper as a principal ingredient in view of heat conductivity.

10

Meanwhile, in the Embodiment 3, the sectional shape of each of the wires used on the electrodes for the inner side of the can body and for the outer side of the can body can be arbitrarily selected so long as the above-described specifications are satisfied. For example, the sectional shapes (shapes of sections each being perpendicular to the longitudinal direction of a wire) shown in Fig. 8 may be adopted. Among them, (a) and (b) are modified examples of the sectional shape of the wire shown in Fig. 6 mentioned above, and (c) and (d) are modified examples of the sectional shape of the wire shown in Fig. 7 mentioned above.

In the case of welding a material having a low contact resistance, such as a tin plate or an edge-cleaned tin free steel sheet, under the welding conditions of the Embodiment 3, the appearance may be damaged since the nugget width may

25

be too long, or the load to the power source of the welding machine may be excessively large and welding may rarely be completed since an extremely large amount of electric current is required. Accordingly, in the practice of the
5 wire-seam-welding method of the Embodiment 3 while using a preexisting welding machine, in consideration of the fact that the welding of tin plate and the welding of an edge-cleaned material derived from a tin free steel sheet may be performed using an identical welding machine in view
10 of operability, a plurality of different wire-forming rolls should preferably be disposed just before each of both the electrode for the inner side of the can body and the electrode for the outer side of the can body in order to achieve wire exchange as the occasion demands.
15 Alternatively, a forming roll having a plurality of grooves may preferably be disposed just before each of both the electrode for the inner side of the can body and the electrode for the outer side of the can body.

20 Example

Wire-seam-welding for can bodies was performed using non-edge-cleaned tin free steel sheets and a tin plate, and a Fuji-Welder-type welding machine which achieved an overlapping width of the steel sheet longer than the width
25 of the welding wires. In this example, 4 to 100 cans were

manufactured continuously at a welding speed of 10 to 30 m/min., and existence of an acceptable current range for welding (ACR) and corrosion resistance of the obtained can bodies were evaluated. Incidentally, in the evaluation of the cans, the first can and the last can (the initially manufactured can and the finally manufactured can in the continuous process of manufacturing can bodies) manufactured with unstable electric currents were eliminated from the evaluation subjects.

Regarding each of the wire electrodes, a plurality of grooves were provided in the wire-forming roll in a position just preceding the position where the wire is fed to the electrode such that a desired wire sectional shape could be obtained. Fig. 9 shows the sectional shapes of the wires used in this embodiment (each being the shape of a section perpendicular to the longitudinal direction of the wire).

Among them, A is a wire having a sectional shape adopted in a conventional method, and B and C are wires each having a sectional shape adopted in the method of the Embodiment 3. In Examples according to the Embodiment 3, those wires A to C were used in the combinations shown in Fig. 6 and Fig. 7.

The ACR was defined to be an electric current range between the lower-limit current value below which an appropriate welding strength could not be obtained, and the

upper-limit current value above which heat was excessively generated. The lower-limit current was examined by a tear test, and the upper-limit current was examined based on whether splash or splash had occurred. The results were
5 evaluated as follows.

○: There was a sufficient acceptable current range for welding.

△: There was an acceptable current range for welding, though it was narrow.

10 ×: There was no acceptable current range for welding.

Meanwhile, as to corrosion resistance, containers were manufactured from the can bodies other than the first
15 can and the last can, an aqueous content was packed in each of the containers and stored for 3 months at room temperature, and the state of corrosion in the repaired welded-potion was evaluated as follows.

○: No corrosion.

20 ×: Corrosion was observed.

Incidentally, in the examples without acceptable current ranges for welding, corrosion resistance could not be evaluated since cans could not substantially be manufactured.

25 The results of evaluations of ACR and corrosion

resistance are shown in Tables 1 to 6 together with the types of the material steel sheets and the welding conditions.

Referring to Tables 15 to 20, in each of Examples
5 according to the Embodiment 3, there was a sufficient acceptable current range for welding, and the manufactured can bodies had superior corrosion resistance.

In contrast, in each of Comparative Examples 4 and 5,
where a wire (Wire A) whose external shape at the site in
10 contact with the steel sheet was an arc in view of the width direction of the weld zone was used on each of both the electrode for the inner side of the can body and the electrode for the outer side of the can body, an ACR could not be appropriately obtained since an excessive amount of
15 heat was generated at the wire/sheet interface.

Further, in each of Comparative Examples 1 to 3 and 6 to 10, where a wire whose external shape at the site in contact with the steel sheet had a linear portion in view of the width direction of the weld zone was used as each
20 of the wires on the electrodes for the inner side of the can body and for the outer side of the can body, the effects of the present invention were not sufficiently achieved since other specifications did not satisfy the ranges according to the present invention.

25 Among them, Comparative Example 2 was inferior in

corrosion resistance since the relationship between the length L (mm) of the linear portion of each wire and the overlapping width W (mm) of the steel sheet was $W > L + 1.5$, separation occurred in the edge portions of the weld zone of the steel sheet, and there was a problem with sealing properties in the weld zone.

In each of Comparative Examples 1 and 3, since the sectional area of each wire was less than 0.5 mm^2 , the ability to cool the wire/sheet interfaces was insufficient, and splash were generated. Due to this, an appropriate ACR could not be obtained. Additionally, in Comparative Example 3, the length L of the linear portion of each wire was less than 1.0 time the thickness of the steel sheet, a welding strength necessary for a can in practical use could not be achieved. Further, in Comparative Example 3, the relationship between the length L (mm) of the linear portion of each wire and the overlapping width W (mm) of the steel sheet was $W > L + 1.5$, which was out of the range according to the present invention.

20

In each of Comparative Examples 6 and 7, both the amount of chromium hydrate oxide and the amount of metallic chromium (total chromium amount) in the tin free steel sheet exceeded the upper limits specified in the present invention, and therefore, an appropriate ACR could not be obtained.

25

Meanwhile, in each of Comparative Examples 8 and 10, since neither the amount of chromium hydrate oxide and the amount of metallic chromium (total chromium amount) in the tin free steel sheet reached the lower limits specified in the present invention, corrosion resistance was inferior.

Further, in Comparative Example 9, although a tin plate was welded under the welding conditions specified in the present invention, an appropriate ACR could not be obtained in contrast to Examples according to the present invention in which non-polished tin free steel sheets were the subjects.

Incidentally, in Conventional Example, wire-seam-welding was performed at a slow welding speed below 15 m/min., and this example revealed that a tin free steel sheet can be welded without edge cleaning in such a case of a slow welding speed even with a conventional technique.

Table 15

No.	Steel Sheet Used	Coating Weight of Metallic Chromium (mg/m ²) *1	Coating Weight of Chromium Hydrate Oxide (mg/m ²) *2	Coating Weight of Tin (g/m ²)
Example 1	Non-Cleaned TFS	100	5	0
Example 2	Non-Cleaned TFS	100	5	0
Example 3	Non-Cleaned TFS	100	5	0
Example 4	Non-Cleaned TFS	100	5	0
Example 5	Non-Cleaned TFS	100	5	0
Example 6	Non-Cleaned TFS	100	5	0
Example 7	Non-Cleaned TFS	100	5	0
Example 8	Non-Cleaned TFS	100	5	0
Example 9	Non-Cleaned TFS	100	5	0
Example 10	Non-Cleaned TFS	100	5	0

*1 Coating Weight of total chromium in the coating film.

*2 Coating Weight in terms of metallic chromium.

Table 16

No.	Type of Wire for Outer Side of Can Body *1	Type of Wire for Inner Side of Can Body *1	Width of Wire (mm)	Contact Width of Wire (mm) *2	Wire Edge R (m) *3	Sectional Area of Wire (mm ²)	Wire Speed (m/min.)	Thickness of Steel Sheet (mm)	Overlapping Width of Steel Sheet (mm)	ACR	Corrosion Resistance
Example 2	B	B	1.0	1.0	-	1.6	15	0.32	1.1	○	○
Example 3	B	B	1.0	1.0	-	1.6	26	0.32	2.4	○	○
Example 4	B	B	0.5	0.5	-	0.6	15	0.32	1.5	○	○
Example 5	B	B	1.8	1.8	-	2.9	20	0.49	3.0	○	○
Example 6	B	B	1.0	1.0	-	1.6	20	0.25	1.8	○	○
Example 7	B	B	1.0	1.0	-	1.6	20	0.40	1.8	○	○
Example 8	B	B	1.0	1.0	-	1.6	30	0.49	1.8	○	○
Example 9	B	B	1.0	1.0	-	1.6	20	0.22	0.6	○	○
Example 10	B	B	1.0	1.0	-	1.6	20	0.32	1.8	○	○

*1 Wires A to C having sectional shapes shown in Fig. 9.

*2 The width of the site where the wire is in contact with the steel sheet (In the case that the wire's external shape in the site contacted with the steel sheet has a linear portion in view of the width direction of the weld zone, it equals the length L of the linear portion.)

*3 The radius R of curvature of the arc portions formed in both end portions of the linear portion in the site contacted with the steel sheet, the linear portion being linear in view of the width direction of the weld zone.

※ The underlined signs and numeral values are out of the scope of the Embodiment 3.

Table 17

No.	Steel Sheet Used	Coating Weight of Metallic Chromium (mg/m ²) *1	Coating Weight of Chromium Hydrate Oxide (mg/m ²) *2	Coating Weight of Tin (g/m ²)
Example 11	Non-Cleaned TFS	100	5	0
Example 12	Non-Cleaned TFS	100	5	0
Example 13	Non-Cleaned TFS	100	5	0
Example 14	Non-Cleaned TFS	100	5	0
Example 15	Non-Cleaned TFS	100	5	0
Example 16	Non-Cleaned TFS	32	15	0
Example 17	Non-Cleaned TFS	245	1	0
Example 18	Non-Cleaned TFS	80	10	0
Example 19	Non-Cleaned TFS	80	4	0

*1 Coating Weight of total chromium in the coating film.

*2 Coating Weight of adhesion in terms of metallic chromium.

Table 18

No.	Type of Wire for Outer Side of Can Body *1	Type of Wire for Inner Side of Can Body *1	Width of Wire (mm)	Contact Width of Wire (mm) *2	Wire Edge R (m) *3	Sectional Area of Wire (mm ²)	Wire Speed (m/min.)	Thickness of Steel Sheet (mm)	Overlapping Width of Steel Sheet (mm)	ACR	Corrosion Resistance
Example 12	B	B	1.0	1.0	-	1.6	32	0.32	1.8	○	○
Example 13	C	C	1.1	0.9	0.1	1.6	20	0.32	1.8	○	○
Example 14	C	C	1.1	0.9	0.1	1.6	20	0.32	1.8	○	○
Example 15	C	C	0.8	0.7	0.1	1.2	15	0.32	1.5	○	○
Example 16	B	B	1.0	1.0	-	1.6	15	0.32	1.8	○	○
Example 17	B	B	1.0	1.0	-	1.6	15	0.32	1.8	○	○
Example 18	B	B	1.0	1.0	-	1.6	15	0.32	1.8	○	○
Example 19	B	B	1.0	1.0	-	1.6	28	0.32	1.8	○	○

*1 The electrolytically chromate-treated steel sheets A to H described in Table 19.

*2 Wires A to C having sectional shapes shown in Fig. 5.

*3 The width of the site where the wire is in contact with the steel sheet (In the case that the wire's external shape in the site contacted with the steel sheet has a linear portion in view of the width direction of the weld zone, it equals the length L of the linear portion.)

*4 The radius R of curvature of the arc portions formed in both end portions of the linear portion in the site contacted with the steel sheet, the linear portion being linear in view of the width direction of the weld zone.

※ The underlined signs and numeral values are out of the scope of the Embodiment 3.

Table 19

No.	Steel Sheet Used	Coating Weight of Metallic Chromium (mg/m ²) *1	Coating Weight of Chromium Hydrate Oxide (mg/m ²) *2	Coating Weight of Tin (g/m ²)
Comparative Example 1	Non-Cleaned TFS	100	5	0
Comparative Example 2	Non-Cleaned TFS	100	5	0
Comparative Example 3	Non-Cleaned TFS	100	5	0
Comparative Example 4	Non-Cleaned TFS	100	5	0
Comparative Example 5	Non-Cleaned TFS	100	5	0
Comparative Example 6	Non-Cleaned TFS	100	<u>17</u>	0
Comparative Example 7	Non-Cleaned TFS	<u>260</u>	12	0
Comparative Example 8	Non-Cleaned TFS	100	<u>0.2</u>	0
Comparative Example 9	Non-Cleaned TFS	0	5	2.8
Comparative Example 10	Non-Cleaned TFS	<u>27</u>	2	0
Convention- al Example	Non-Cleaned TFS	100	5	0

*1 Coating Weight of total chromium in the coating film.

*2 Coating Weight in terms of metallic chromium.

Table 20

No.	Type of Wire for Outer Side of Can Body *1	Type of Wire for Inner Side of Can Body *1	Width of Wire (mm)	Contact Width of Wire (mm) *2		Wire Edge R (m) *3	Sectional Area of Wire (mm ²)	Wire Speed (m/min.)	Thickness of Steel Sheet (mm)	Overlapping Width of Steel Sheet (mm)	ACR	Corrosion Resistance
				0.4								
Comparative Example 2	B	B	<u>1.9</u>	1.9		-	<u>0.4</u>	20	0.32	<u>3.6</u>	○	×
Comparative Example 3	B	B	0.2	<u>0.2</u>		-	<u>0.2</u>	20	0.32	<u>1.8</u>	×	-
Comparative Example 4	A	A	1.0	0.6		-	1.6	20	0.32	1.8	×	-
Comparative Example 5	A	A	1.0	0.6		-	1.6	15	0.32	1.8	×	-
Comparative Example 6	B	B	1.0	1.0		-	1.6	25	0.32	1.8	×	-
Comparative Example 7	B	B	1.0	1.0		-	1.6	25	0.32	1.8	×	-
Comparative Example 8	B	B	1.0	1.0		-	1.6	20	0.32	1.8	○	×
Comparative Example 9	B	B	1.0	1.0		-	1.6	20	0.32	1.8	×	-
Comparative Example 10	B	B	1.0	1.0		-	1.6	25	0.32	1.8	○	×
Conventional Example	A	A	1.0	0.6		-	1.6	10	0.32	1.8	○	○

*1 Wires A to C having sectional shapes shown in Fig. 9.

*2 The width of the site where the wire is in contact with the steel sheet (In the case that the wire's external shape in the site contacted with the steel sheet has a linear portion in view of the width direction of the weld zone, it equals the length L of the linear portion.)

*3 The radius R of curvature of the arc portions formed in both end portions of the linear portion in the site contacted with the steel sheet, the linear portion being linear in view of the width direction of the weld zone.

※ The underlined signs and numeral values are out of the scope of the Embodiment 3.

EMBODIMENT 4

Embodiment 4 satisfies the following requirements:

5 (a) The Embodiment 4 is a method for wire-seam-welding two overlapping edges of a tin free steel sheet at a wire feeding speed of at least 15 m/min. without cleaning the edges, thereby manufacturing a can body. Said tin free steel sheet comprises a steel sheet and a coating film, said
10 coating film having a metallic chromium layer on the steel sheet and a chromium hydrate oxide layer on the metallic chromium layer. The total coating weight of said coating film is 30 to 250 mg/m² for each surface of the steel sheet in terms of metallic chromium, and the coating weight of
15 said chromium hydrate oxide is 0.5 to 15 mg/m² for each surface of the steel sheet in terms of metallic chromium.

 (b) A first wire electrode is used inside the can body and a second wire electrode is used outside the can body. The first wire electrode and the second wire electrode have
20 sectional areas of 0.5 to 3.0 mm² perpendicular to the longitudinal direction of the can body. The first wire electrode and the second wire electrode have linear portions in contact with said tin free steel sheet to be welded relative to the width direction of the weld zone, said linear
25 portion having a length of 1.0 to 4.0 times the thickness

of said tin free steel sheet to be welded.

(c) $L \leq W < L + 1.5$ is satisfied in the relationship between the overlapping width W (mm) of said tin free steel sheet to be welded and the length L (mm) of said linear
5 portions of said first wire electrode and said second wire electrode.

(d) A pressure of 30 to 150 kgf is applied between the first wire electrode and the second wire electrode and a nugget pitch is 0.6 to 1.8 mm in the welded zone.

10

The nugget pitch is an important factor which influences the airtightness of the container. In a material having a low contact resistance and a satisfactory pressure adhesion, such as a tin plate or a edge-cleaned
15 tin free steel sheet, since the current application can be started even if the applied pressure is low, the area where heat is generated by the current application is wide, and the range of the applicable nugget pitch for welding can be made large, for example, 2 mm or more. Further, since
20 the time from when the steel sheet is caught between the electrodes up to the start of the current application is short, the nugget pitch can also be made short.

In contrast, in the case of welding a material having a high contact resistance, such as a tin free steel sheet,
25 without edge cleaning, since the current application can

be started only when the applied pressure is high, the area where heat is generated by the current application is narrow, and an appropriate airtightness cannot be obtained with a nugget pitch longer than 1.8 mm since unheated portions remain. Further, since the time from when the steel sheet is caught between the electrodes up to the start of the current application is long, the acceptable current range for welding becomes narrow with a nugget pitch less than 0.6 mm, and appropriate welding conditions cannot be obtained even if the shapes of the wires and the amount of the adhering coating film are optimized.

In a material having a high contact resistance, such as a tin free steel sheet, decomposition of the coating film and pressure adhesion are accelerated by increasing the pressure loaded onto the upper and lower electrodes, and the current pathway can be stably secured and the welding strength can be improved. Even if the shapes of the wires and the amount of the adhering coating film are optimized, since pressure adhesion is insufficient when the pressure loaded between the upper and lower electrodes is less than 30 kgf, an appropriate ACR cannot be obtained, and a sufficient welding strength cannot also be obtained. Meanwhile, when the pressure loaded onto the upper and lower electrodes exceeds 150 kgf, the steel sheet cannot be caught smoothly between the electrodes, and an excessive amount

of heat is generated at the leading edge and the terminal edge of the welding portion in response to variation in the welding speed.

For the above-described reasons, the present
5 invention specifies that the nugget pitch be 0.6 to 1.8 mm, and that the pressure applied between the electrodes for the inner side of the can body and for the outer side of the can body be 30 to 150 kgf.

In the case of welding a material having a low contact
10 resistance, such as a polished material derived from a tinplate or tin free steel sheet, under the welding conditions of the present invention, the appearance may be damaged since the nugget width may be too long, or the load to the power source of the welding machine may be excessively
15 large and welding may rarely be completed since an extremely large amount of electric current is required. Accordingly, in the practice of the wire-seam-welding method of the present invention while using a preexisting welding machine, in consideration of the fact that the welding of tin plate
20 and the welding of an edge-cleaned material derived from a tin free steel sheet may be performed using an identical welding machine in view of operability, a plurality of different wire-forming rolls should preferably be disposed just before each of both the electrode for the inner side
25 of the can body and the electrode for the outer side of the

can body in order to achieve wire exchange as the occasion demands. Alternatively, a forming roll having a plurality of grooves may preferably be disposed just before each of both the electrode for the inner side of the can body and
5 the electrode for the outer side of the can body.

Example

Wire-seam-welding for can bodies was performed using non-polished tin free steel sheets and a tin plate, and a
10 Fuji-Welder-type welding machine which achieved an overlapping width of the steel sheet longer than the width of the welding wires. In this embodiment, 4 to 100 cans were manufactured continuously at a welding speed of 10 to 30 m/min., and existence of an acceptable current range for
15 welding (ACR) and corrosion resistance of the obtained can bodies were evaluated. Incidentally, in the evaluation of the cans, the first can and the last can (the initially manufactured can and the finally manufactured can in the continuous process of manufacturing can bodies)
20 manufactured with unstable electric currents were eliminated from the evaluation subjects.

Regarding each of the wires on the electrodes, a plurality of grooves were provided in the wire-forming roll in a position just preceding the position where the wire
25 is fed to the electrode such that a desired wire sectional

shape could be obtained. Fig. 9 shows the sectional shapes of the wires used in this embodiment (each being the shape of a section perpendicular to the longitudinal direction of the wire). Among them, A is a wire having a sectional shape adopted in a conventional method, and B and C are wires each having a sectional shape adopted in the method of the present invention. In Examples according to the present invention, those wires A to C were used in the combinations shown in Fig. 6 and Fig. 7.

10 The ACR was defined to be an electric current range between the lower-limit current value below which an appropriate welding strength could not be obtained, and the upper-limit current value above which heat was excessively generated. The lower-limit current was examined by a tear
15 test, and the upper-limit current was examined based on whether splash or splash had occurred. The results were evaluated as follows.

○: There was a sufficient acceptable current range for welding.

20 △: There was an acceptable current range for welding, though it was narrow.

×: There was no acceptable current range for welding.

Meanwhile, as to corrosion resistance, containers
25 were manufactured from the can bodies other than the first

can and the last can, an aqueous content was packed in each of the containers and stored for 3 months at room temperature, and the state of corrosion in the repaired welded-potion was evaluated as follows.

5 ○: No corrosion.

 ×: Corrosion was observed.

 Incidentally, in the examples without acceptable current ranges for welding, corrosion resistance could not be evaluated since cans could not substantially be
10 manufactured.

 Further, as for the appearance of the weld zone, the weld zone was visibly observed, and evaluated as follows.

 ○: There was no heterogeneous discoloration in the weld zone.

15 ×: There was heterogeneous discoloration in the weld zone.

 The results of evaluations of ACR and corrosion resistance are shown in Tables 21 to 28 together with the
20 types of the material steel sheets and the welding conditions.

 Referring to Tables 21 to 28, in each of Examples according to the present invention, there was a sufficient acceptable current range for welding, and the manufactured
25 can bodies had superior corrosion resistance.

In contrast, in each of Comparative Examples 9 and 10, where a wire (Wire A) whose external shape at the site in contact with the steel sheet was an arc in view of the width direction of the weld zone was used on each of both the electrode for the inner side of the can body and the electrode for the outer side of the can body, an ACR could not be appropriately obtained since an excessive amount of heat was generated at the wire/sheet interface.

Further, in each of Comparative Examples 1 to 8 and Comparative Examples 11 to 15, where a wire whose external shape at the site in contact with the steel sheet had a linear portion in view of the width direction of the weld zone was used as each of the wire electrodes for the inner side of the can body and for the outer side of the can body, the effects of the Embodiment 4 were not sufficiently achieved since other specifications did not satisfy the ranges according to the Embodiment 4.

Among them, Comparative Example 2 was inferior in corrosion resistance since the relationship between the length L (mm) of the linear portion of each wire and the overlapping width W (mm) of the steel sheet was $W > L + 1.5$, separation occurred in the edge portions of the weld zone of the steel sheet, and there was a problem with sealing properties in the weld zone.

In each of Comparative Examples 1 and 3, since the

sectional area of each wire was less than 0.5 mm^2 , the ability to cool the wire/sheet interfaces was insufficient, and splash were generated. Due to this, an appropriate ACR could not be obtained. Additionally, in Comparative Example 3, the length L of the linear portion of each wire was less than 1.0 time the thickness of the steel sheet, a welding strength necessary for a can in practical use could not be achieved. Further, in Comparative Example 3, the relationship between the length L (mm) of the linear portion of each wire and the overlapping width W (mm) of the steel sheet was $W > L + 1.5$, which was out of the range according to the Embodiment 4.

In Comparative Example 4, since the pressure applied between both the electrodes was less than 30 kgf, an ACR could not be appropriately obtained due to the insufficient pressure application, and the welding strength was also insufficient.

In each of Comparative Examples 7 and 8, since the pressure applied between both the electrodes exceeded 150 kgf, an excessive amount of heat was generated at the leading edge and the terminal edge of the weld zone based on variation in the welding speed accompanying the incomplete capture of the steel sheet between both the electrodes, and as a result, the appearance of the weld zone was inferior.

In Comparative Example 5, since the nugget pitch

exceeded 1.8 mm, non-weld zones remained between nugget pitches, and as a result, an appropriate welding strength could not be obtained. Further, regarding the appearance, heterogeneous discoloration was generated.

5 In Comparative Example 6, since the nugget pitch was less than 0.6 mm, heat was ununiformly generated, and splash readily occurred. Further, regarding the appearance, heterogeneous discoloration was generated.

10 In each of Comparative Examples 11 and 12, both the amount of chromium hydrate oxide and the amount of metallic chromium (total chromium amount) in the tin free steel sheet exceeded the upper limits specified in the present invention, and therefore, an appropriate ACR could not be obtained.

15 Meanwhile, in each of Comparative Examples 13 and 15, since neither the amount of chromium hydrate oxide and the amount of metallic chromium (total chromium amount) in the tin free steel sheet reached the lower limits specified in the present invention, corrosion resistance was inferior.

20 Further, in Comparative Example 14, although a tin plate was welded under the welding conditions specified in the Embodiment 4, an appropriate ACR could not be obtained in contrast to Examples according to the Embodiment 4 in which non-edge-cleaned tin free steel sheets were the subjects.

25 Incidentally, in Conventional Example, wire-seam-

welding was performed at a slow welding speed below 15 m/min.,
and this example revealed that a tin free steel sheet can
be welded without edge cleaning in such a case of a slow
welding speed even with a conventional technique, although
5 the appearance was affected by heterogeneous discoloration.

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Table 21

No.	Steel Sheet Used	Coating Weight of Metallic Chromium (mg/m^2) *1	Coating Weight of Chromium Hydrate Oxide (mg/m^2) *2	Coating Weight of Tin (g/m^2)	Type of Wire for Outer Side of Can Body *3	Type of Wire for Inner Side of Can Body *3	Width of Wire (mm)
Example 1	Non-Cleaned TFS	100	5	0	B	B	1.0
Example 2	Non-Cleaned TFS	100	5	0	B	B	1.0
Example 3	Non-Cleaned TFS	100	5	0	B	B	1.0
Example 4	Non-Cleaned TFS	100	5	0	B	B	0.5
Example 5	Non-Cleaned TFS	100	5	0	B	B	1.8
Example 6	Non-Cleaned TFS	100	5	0	B	B	1.0
Example 7	Non-Cleaned TFS	100	5	0	B	B	1.0
Example 8	Non-Cleaned TFS	100	5	0	B	B	1.0
Example 9	Non-Cleaned TFS	100	5	0	B	B	1.0
Example 10	Non-Cleaned TFS	100	5	0	B	B	1.0

*1 Coating Weight of total chromium in the coating film.

*2 Coating Weight in terms of metallic chromium.

Table 22

No.	Contact Width of Wire (mm) *1	Wire Edge R (m) *2	Sectional Area of Wire (mm ²)	Wire Speed (m/min.)	Thickness of Steel Sheet (mm)	Overlapping Width of Steel Sheet (mm)	Nugget Pitch (mm)	Applied Pressure (kgf)	ACR	Corrosion resistance	Appearance
	1.0	-	1.6			1.8	1.2	80	○	○	○
Example 2	1.0	-	1.6	15	0.32	1.1	1.2	60	○	○	○
Example 3	1.0	-	1.6	26	0.32	2.4	1.2	70	○	○	○
Example 4	0.5	-	0.6	15	0.32	1.5	1.2	60	○	○	○
Example 5	1.8	-	2.9	20	0.49	3.0	1.2	60	○	○	○
Example 6	1.0	-	1.6	20	0.25	1.8	1.2	60	○	○	○
Example 7	1.0	-	1.6	20	0.40	1.8	1.2	60	○	○	○
Example 8	1.0	-	1.6	30	0.49	1.8	1.2	60	○	○	○
Example 9	1.0	-	1.6	20	0.22	0.6	1.2	60	○	○	○
Example 10	1.0	-	1.6	20	0.32	1.8	1.2	60	○	○	○

- *1 The width of the site where the wire is in contact with the steel sheet (In the case that the wire's external shape in the site contacted with the steel sheet has a linear portion in view of the width direction of the weld zone, it equals the length L of the linear portion.)
- *2 The radius R of curvature of the arc portions formed in both end portions of the linear portion in the site contacted with the steel sheet, the linear portion being linear in view of the width direction of the weld zone.
- ※ The underlined signs and numeral values are out of the scope of the Embodiment 4.

Table 23

No.	Steel Sheet Used	Coating Weight of Metallic Chromium (mg/m^2) *1	Coating Weight of Chromium Hydrate Oxide (mg/m^2) *2	Coating Weight of Tin (g/m^2)	Type of Wire for Outer Side of Can Body *3	Type of Wire for Inner Side of Can Body *3	Width of Wire (mm)
Example 11	Non-Cleaned TFS	100	5	0	B	B	1.0
Example 12	Non-Cleaned TFS	100	5	0	B	B	1.0
Example 13	Non-Cleaned TFS	100	5	0	C	C	1.1
Example 14	Non-Cleaned TFS	100	5	0	C	C	1.1
Example 15	Non-Cleaned TFS	100	5	0	C	C	0.8
Example 16	Non-Cleaned TFS	32	15	0	B	B	1.0
Example 17	Non-Cleaned TFS	245	1	0	B	B	1.0
Example 18	Non-Cleaned TFS	80	10	0	B	B	1.0
Example 19	Non-Cleaned TFS	80	4	0	B	B	1.0

*1 Coating Weight of total chromium in the coating film.

*2 Coating Weight in terms of metallic chromium.

Table 24

No.	Contact Width of Wire (mm) *1	Wire Edge R (m) *2	Sectional Area of Wire (mm ²)	Wire Speed (m/min.)	Thickness of Steel Sheet (mm)	Overlapping Width of Steel Sheet (mm)	Nugget Pitch (mm)	Applied Pressure (kgf)	ACR	Corrosion resistance	Appearance
	1.0	-	1.6			1.8	1.2	32	○	○	○
Example 12	1.0	-	1.6	32	0.32	1.8	0.9	140	○	○	○
Example 13	0.9	0.1	1.6	20	0.32	1.8	1.2	60	○	○	○
Example 14	0.9	0.1	1.6	20	0.32	1.8	1.2	60	○	○	○
Example 15	0.7	0.1	1.2	15	0.32	1.5	1.5	60	○	○	○
Example 16	1.0	-	1.6	15	0.32	1.8	1.2	80	○	○	○
Example 17	1.0	-	1.6	15	0.32	1.8	1.2	80	○	○	○
Example 18	1.0	-	1.6	15	0.32	1.8	1.2	80	○	○	○
Example 19	1.0	-	1.6	28	0.32	1.8	1.2	80	○	○	○

*1 The width of the site where the wire is in contact with the steel sheet (In the case that the wire's external shape in the site contacted with the steel sheet has a linear portion in view of the width direction of the weld zone, it equals the length L of the linear portion.)

*2 The radius R of curvature of the arc portions formed in both end portions of the linear portion in the site contacted with the steel sheet, the linear portion being linear in view of the width direction of the weld zone.

※ The underlined signs and numeral values are out of the scope of the Embodiment 4.

Table 25

No.	Steel Sheet Used	Coating Weight of Metallic Chromium (mg/m ²) *1	Coating Weight of Chromium Hydrate Oxide (mg/m ²) *2	Coating Weight of Tin (g/m ²)	Type of Wire for Outer Side of Can Body *3	Type of Wire for Inner Side of Can Body *3	Width of Wire (mm)
Comparative Example 1	Non-Cleaned TFS	100	5	0	B	B	0.4
Comparative Example 2	Non-Cleaned TFS	100	5	0	B	B	1.9
Comparative Example 3	Non-Cleaned TFS	100	5	0	B	B	0.2
Comparative Example 4	Non-Cleaned TFS	100	5	0	B	B	1.9
Comparative Example 5	Non-Cleaned TFS	100	5	0	B	B	1.0
Comparative Example 6	Non-Cleaned TFS	100	5	0	B	B	1.0
Comparative Example 7	Non-Cleaned TFS	100	5	0	C	C	1.1
Comparative Example 8	Non-Cleaned TFS	100	5	0	C	C	1.1

*1 Coating Weight of total chromium in the coating film.

*2 Coating Weight in terms of metallic chromium.

Table 26

No.	Contact Width of Wire (mm) *1	Wire Edge R (m) *2	Sectional Area of Wire (mm ²)	Wire Speed (m/min.)	Thickness of Steel Sheet (mm)	Overlapping Width of Steel Sheet (mm)	Nugget Pitch (mm)	Applied Pressure (kgf)	ACR	Corrosion resistance	Appearance
	0.4	-	0.4			1.8	1.7	35	×	-	×
Comparative Example 2	<u>1.9</u>	-	3.0	20	0.32	<u>3.6</u>	1.2	60	○	×	○
Comparative Example 3	<u>0.2</u>	-	<u>0.2</u>	20	0.32	<u>1.8</u>	1.7	35	×	-	×
Comparative Example 4	<u>1.9</u>	-	3.0	20	0.32	<u>3.6</u>	1.2	<u>25</u>	×	-	○
Comparative Example 5	1.0	-	1.6	20	0.32	1.8	<u>1.9</u>	80	×	○	×
Comparative Example 6	1.0	-	1.6	20	0.32	1.8	<u>0.5</u>	80	△	○	×
Comparative Example 7	1.0	0.1	1.6	20	0.32	1.8	1.2	<u>155</u>	○	○	×
Comparative Example 8	1.0	0.05	1.6	20	0.32	1.8	1.2	<u>155</u>	○	○	×

*1 The width of the site where the wire is in contact with the steel sheet (In the case that the wire's external shape in the site contacted with the steel sheet has a linear portion in view of the width direction of the weld zone, it equals the length L of the linear portion.)

*2 The radius R of curvature of the arc portions formed in both end portions of the linear portion in the site contacted with the steel sheet, the linear portion being linear in view of the width direction of the weld zone.

※ The underlined signs and numeral values are out of the scope of the Embodiment 4.

Table 27

No.	Steel Sheet Used	Coating Weight of Metallic Chromium (mg/m ²) *1	Coating Weight of Chromium Hydrate Oxide (mg/m ²) *2	Coating Weight of Adhering Tin (g/m ²)	Type of Wire for Outer Side of Can Body *3	Type of Wire for Inner Side of Can Body *3	Width of Wire (mm)
Comparative Example 9	Non-Cleaned TFS	100	5	0	A	A	1.0
Comparative Example 10	Non-Cleaned TFS	100	5	0	A	A	1.0
Comparative Example 11	Non-Cleaned TFS	100	17	0	B	B	1.0
Comparative Example 12	Non-Cleaned TFS	260	12	0	B	B	1.0
Comparative Example 13	Non-Cleaned TFS	100	0.2	0	B	B	1.0
Comparative Example 14	#25 Blik	0	5	2.8	B	B	1.0
Comparative Example 15	Non-Cleaned TFS	27	2	0	B	B	1.0
Conventional Example	Non-Cleaned TFS	100	5	0	A	A	1.0

*1 Coating Weight of total chromium in the coating film.

*2 Coating Weight of adhesion in terms of metallic chromium

Table 28

No.	Contact Width of Wire (mm) *1	Wire Edge R (m) *2	Sectional Area of Wire (mm ²)	Wire Speed (m/min.)	Thickness of Steel Sheet (mm)	Overlapping Width of Steel Sheet (mm)	Nugget Pitch (mm)	Applied Pressure (kgf)	ACR	Corrosion resistance	Appearance
	0.6	-	1.6			1.8	1.2	60	×	-	×
Comparative Example 10	0.6	-	1.6	15	0.32	1.8	1.2	60	×	-	×
Comparative Example 11	1.0	-	1.6	25	0.32	1.8	1.2	60	×	-	×
Comparative Example 12	1.0	-	1.6	25	0.32	1.8	1.2	60	×	-	×
Comparative Example 13	1.0	-	1.6	20	0.32	1.8	1.2	60	○	×	○
Comparative Example 14	1.0	-	1.6	20	0.32	1.8	1.2	60	×	-	×
Comparative Example 15	1.0	-	1.6	25	0.32	1.8	1.2	60	○	×	○
Conventional Example	0.6	-	1.6	10	0.32	1.8	1.2	60	○	○	×

*1 The width of the site where the wire is in contact with the steel sheet (In the case that the wire's external shape in the site contacted with the steel sheet has a linear portion in view of the width direction of the weld zone, it equals the length L of the linear portion.)

*2 The radius R of curvature of the arc portions formed in both end portions of the linear portion in the site contacted with the steel sheet, the linear portion being linear in view of the width direction of the weld zone.

※ The underlined signs and numeral values are out of the scope of the Embodiment 4.

EMBODIMENT 5

Embodiment 5 provides a welding machine comprising a welding wire forming apparatus which is capable of forming a welding wire having a plurality of shapes, wherein the welding wire forming apparatus comprises a plurality of welding wire forming rolls consisting of upper and lower rolls arranged in the lengthwise direction of the welding wire and having different sectional shapes, for holding and pressing the welding wire, and the upper roll of the welding wire forming rolls is provided so that it can be moved upward and downward and brought into contact or non-contact with the welding wire, whereby the welding wire having a plurality of shapes can be formed by holding and pressing the welding wire by any one of the plurality of welding wire forming rolls.

In a resistance welding machine for a can material, welding wire forming rolls comprising plural pairs of upper and lower rolls are arranged on the same line in the lengthwise direction of the welding wire, the upper roll of each pair of the rolls can be moved upward and downward by providing a lifting mechanism, and the upper and lower rolls of each of the pairs can be driven by providing a driving function so that a welding wire can instantaneously be formed by holding and pressing between only one pair of

rolls of the plural pairs of rolls according to the shape of the welding wire, thereby solving the above problem.

An embodiment of the present invention will be
5 described below with reference to the drawings.

Fig. 10 is a drawing showing the whole construction of an example of welding wire forming rolls in accordance with an embodiment of the present invention, and Fig. 11 is a side view.

10 First, a welding wire 101 sent by a feeding device is formed by holding and pressing between a pair of upper and lower rolls 103 and 104 each having a wire forming groove under tension by a tension applying roll 102. The formed welding wire 101 is rotated through 180° by a wire reversing
15 device 105, passed through supporting rolls 106 and 107, further rotated through 180° by a wire reversing device 108, and supplied to a lower electrode roller 109. The wire 101 used for welding the outside of a can by the lower electrode ring 109 is passed through supporting rolls 10 and 11 and
20 a cleaning device 112, rotated for 180° by a wire reversing device 113, and supplied to an upper electrode roller 114 where the wire is used for welding the inside of the can.

After use, the wire 101 is guided to the outside of the welding machine by a supporting roll 115 and the like, cut
25 by a wire cutting device 116 and then recovered.

A material 125 to be welded is continuously transferred by a transfer device in the horizontal direction, i.e., from the left to the right and welded by the upper and lower electrode rollers 114 and 109 to form a can body.

5 Each pair of the welding wire forming rolls which constitute the welding wire forming apparatus H comprises two rolls (103 and 104, 118 and 119, or 120 and 121) disposed above and below the welding wire 101. Each pair of the welding wire forming rolls are arranged on the same line
10 in the lengthwise direction of the welding wire 101. The welding wire forming upper roll (on the side in contact with a material) 103 for can material A, the welding wire forming upper roll (on the side in contact with a material) 118 for can material B, and the welding wire forming upper roll (on
15 the side in contact with a material) 120 for can material n or C are provided with lifting mechanisms 122, 123 and 124, respectively, so that these rolls can be moved upward and downward. The welding wire forming lower roll (on the side in contact with the electrode roller) 104 for can
20 material A, the welding wire forming lower roll (on the side in contact with the electrode roller) 119 for can material B, and the welding wire forming lower roll (on the side in contact with the electrode roller) 121 for can material n or C are provided with driving mechanisms 122, 123 and 124,
25 respectively, having the same function so that these rolls

can be rotated synchronously with the speed of the welding wire 101.

The present invention comprising the plural pairs of the welding wire forming rolls (103 and 104, 118 and 119, 5 and 120 and 121) arranged on the same line as the welding wire 101, and the lifting devices 122, 123 and 124 respectively provided on the pairs has the excellent functions that any desired welding wire shape can be instantaneously selected and formed, that the time of 10 production stop for changing the wire shape is not required, that excess wire is not used for changing the wire shape, and that can materials having different welding properties can easily be used for welding steel fabrication.

Next, the apparatus for forming a welding wire having 15 a plurality of shapes in the welding machine of the present invention will be described with reference to Figs. 10 to 17 with respect to a case wherein the Embodiment 5 is applied to a welding machine for 18-liter cans. Fig. 12 is a sectional view showing welding wire forming rolls for can 20 material A in accordance with the Embodiment 5, Fig. 13 is a sectional view showing welding wire forming rolls for can material B, Fig. 14 is a sectional view showing welding wire forming rolls for can material C, Fig. 15 is a sectional view showing a welding wire for can material A, Fig. 16 is 25 a sectional view showing a welding wire for can material

B, and Fig. 17 is a sectional view showing a welding wire for can material C.

Specifically, description will be made of an embodiment in which in welding steel fabrication using n types of can materials A, B and n having different welding properties, the different welding wire shapes A, B and n are required for the respective materials.

The method of using the plural pairs of the welding wire forming rolls is as follows.

10 First, in welding steel fabrication using a first type of can material A, the upper roll 103 of the welding wire forming rolls A shown in Figs. 10 to 12 is moved downward to hold and press the wire between the upper roll 103 and the lower roll 104 to form welding wire 101A having a desired
15 shape. At this time, the upper forming rolls 118 and 120 of the welding wire forming roll B and n, respectively, are moved upward so as not to contact the welding wire 101. The lower rolls 104, 119 and 121 of the welding wire forming rolls A, B and n, respectively, are rotated synchronously
20 with the speed of the welding wire to perform welding steel fabrication using can material A.

Next, in welding steel fabrication using a second type of can material B, the upper roll 118 of the welding wire forming rolls B shown in Figs. 10 to 12 is moved downward
25 to hold and press the wire between the upper roll 118 and

the lower roll 19 to form welding wire 101B having a desired shape. At this time, the upper forming rolls 103 and 120 of the welding wire forming roll A and n, respectively, are moved upward so as not to contact the welding wire 101.

- 5 The lower rolls 104, 119 and 121 of the welding wire forming rolls A, B and n, respectively, are rotated synchronously with the speed of the welding wire to perform welding steel fabrication using can material B.

Finally, a type n of can material n is welded by the
10 same method as described above.

Example

Description will be made of an example in which the apparatus for forming a welding wire having different shapes in the welding machine of the Embodiment 5 is applied to
15 a welding machine for 18-liter cans with reference to Figs. 10 to 17.

Specifically, description will be made of an example in which in welding steel fabrication using three types of can materials A, B and C having different welding properties,
20 the welding wire shapes A, B and C respectively shown in Fig. 15 to 17 are required for the respective materials.

The method of using the plural pairs of the welding wire forming rolls is as follows.

First, in welding steel fabrication using a first type
25 of can material A, the upper roll 103 of the welding wire

forming rolls A shown in Figs. 10 to 12 is moved downward to hold and press the wire between the upper roll 103 and the lower roll 104 to form welding wire 101A (refer to Fig. 15) having a desired shape. At this time, the upper forming
5 rolls 118 and 120 of the welding wire forming roll B and C, respectively, are moved upward so as not to contact the welding wire 101. The lower rolls 104, 119 and 121 of the welding wire forming rolls A, B and n, respectively, are rotated synchronously with the speed of the welding wire
10 to perform welding steel fabrication using can material A.

Next, in welding steel fabrication using a second type of can material B, the upper roll 118 of the welding wire forming rolls B is moved downward to form welding wire 101B (refer to Fig. 16) having a desired shape. At this time,
15 the upper forming rolls 103 and 120 of the welding wire forming roll A and C, respectively, are moved upward so as not to contact the welding wire 101. The lower rolls 104, 119 and 121 of the respective welding wire forming rolls are rotated synchronously with the speed of the welding wire
20 to perform welding steel fabrication using can material B (refer to Figs. 10, 11 and 13).

Finally, in welding steel fabrication using a second type of can material C, the upper roll 120 of the welding wire forming rolls C is moved downward to form welding wire
25 101C (refer to Fig. 17) having a desired shape. At this

time, the upper forming rolls 103 and 118 of the welding wire forming rolls A and B, respectively, are moved upward so as not to contact the welding wire 101. The lower rolls 104, 119 and 121 of the respective welding wire forming rolls
5 are rotated synchronously with the speed of the welding wire to perform welding steel fabrication using can material C (refer to Figs. 10, 11 and 14).

In order to prevent the use of excess welding wire, the fall timing for these forming rolls 103, 118 and 120
10 can be set so that the second type of welding wire shape is changed to the third type of welding wire shape immediately after completion of last can welding of the second type of material. As an example of the set time, if the completion time of last can welding of the second
15 type of material is t_1 , the distance between the lower electrode ring 109 and the wire forming roll 118 is L_1 , and the speed of the welding wire is V_w , the fall time t_2 of the welding wire forming roll 120 for the third type of material is set to $t_2 = t_1 - L_1/V_w$ so that optimum welding can be carried
20 out without using excess welding wire for continuous steel fabrication using different materials.

When a common driving device is used for the forming rolls 103, 104, 118, 119, 120 and 121, the synchronous function and driving mechanism can be minimized, and the
25 installation space and installation cost can also be

minimized.

As described above, in the Embodiment 5, an apparatus for forming a welding wire having different shapes in a resistance welding machine for can materials comprises a plurality of welding wire forming rolls which are arranged on the same line in the lengthwise direction of a welding wire so that each of the upper rolls of the welding wire forming rolls can be moved upward and downward. Therefore, it is possible to instantaneously change the wire shape, prevent deterioration in productivity of welding steel fabrication, eliminate the use of excess welding wire, significantly decrease the time and labor required for changing the welding wire shape, which are great problems of a conventional machine, prevent deterioration in productivity due to the change of the welding wire shape, and permit industrial production of can materials having different welding properties, thereby causing a useful industrial effect.



What is claimed is:

1. A method for wire-seam-welding two overlapping edges
5 of an electrolytically chromate-treated steel sheet at a wire feeding speed of at least 15 m/min. without cleaning the edges, thereby manufacturing a can body,

characterized in that:

a first wire electrode is used inside the can body and
10 a second wire electrode is used outside the can body;

the first wire electrode has a sectional area of 0.5 to 3.0 mm² perpendicular to the longitudinal direction of the can body;

the first wire electrode has a linear portion in contact
15 with said electrolytically chromate-treated steel sheet to be welded relative to the width direction of the weld zone, said linear portion having a length of 1.0 to 4.0 times the thickness of said electrolytically chromate-treated steel sheet to be welded;

20 the second wire electrode has an arc shape portion in contact with said electrolytically chromate-treated steel sheet to be welded relative to the width direction of the weld zone; and

$L \leq W < L + 1.5$ is satisfied in the relationship between
25 the overlapping width W (mm) of said electrolytically



chromate-treated steel sheet to be welded and the length
L (mm) of said linear portion of said first wire electrode.

2. The method of claim 1, characterized in that the first
5 wire electrode has arc portions at both ends of the linear
portion in contact with said electrolytically chromate-
treated steel sheet to be welded relative to the width
direction of the weld zone, each of said arc portions having
a radius R of curvature of 0.1 mm or more.

10

3. The method of claim 1, characterized in that
a pressure of 30 to 150 kgf is applied between the first
wire electrode and the second wire electrode; and
a nugget pitch is 0.6 to 1.8 mm in the welded zone.

15

4. The method of claim 3, characterized in that the first
wire electrode has arc portions at both ends of the linear
portion in contact with said electrolytically chromate-
treated steel sheet to be welded relative to the width
20 direction of the weld zone, each of said arc portions having
a radius R of curvature of 0.1 mm or more.

5. A method for wire-seam-welding two overlapping edges
of a tin free steel sheet at a wire feeding speed of at least
25 15 m/min. without cleaning the edges, thereby manufacturing



a can body, said tin free steel sheet comprising a steel sheet and a coating film, said coating film having a metallic chromium layer on the steel sheet and a chromium hydrate oxide layer on the metallic chromium layer, the total
5 coating weight of said coating film being 30 to 250 mg/m² for each surface of the steel sheet in terms of metallic chromium, and the coating weight of said chromium hydrate oxide being 0.5 to 15 mg/m² for each surface of the steel sheet in terms of metallic chromium,

10 characterized in that:

a first wire electrode is used inside the can body and a second wire electrode is used outside the can body;

the first wire electrode and the second wire electrode have sectional areas of 0.5 to 3.0 mm² perpendicular to the
15 longitudinal direction of the can body;

the first wire electrode and the second wire electrode have linear portions in contact with said tin free steel sheet to be welded relative to the width direction of the weld zone, said linear portion having a length of 1.0 to
20 4.0 times the thickness of said tin free steel sheet to be welded; and

$L \leq W < L + 1.5$ is satisfied in the relationship between the overlapping width W (mm) of said tin free steel sheet to be welded and the length L (mm) of said linear portions
25 of said first wire electrode and said second wire electrode.



6. The method of claim 5, characterized in that the first wire electrode and the second wire electrode have arc portions at both ends of the linear portions in contact with said tin free steel sheet to be welded relative to the width direction of the weld zone, each of said arc portions having a radius R of curvature of 0.1 mm or more.

7. The method of claim 5, characterized in that
a pressure of 30 to 150 kgf is applied between the first wire electrode and the second wire electrode; and
a nugget pitch is 0.6 to 1.8 mm in the welded zone.

8. The method of claim 7, characterized in that the first wire electrode and the second wire electrode have arc portions at both ends of the linear portions in contact with said tin free steel sheet to be welded relative to the width direction of the weld zone, each of said arc portions having a radius R of curvature of 0.1 mm or more.

20

9. A welding machine having a welding wire forming device, characterized in that:

the welding wire forming device comprises a plurality pair of welding wire forming rolls which are arranged in the lengthwise direction of the welding wire;



the plurality pair of welding wire forming rolls have different sectional shapes;

the pair of welding wire forming rolls comprises an upper roll and a lower roll for holding and pressing the
5 welding wire, the upper roll being movable in a vertical direction; and

the welding wire is held and pressed by any one of the plurality of the welding wire forming rolls to form a welding wire having a plurality of shapes.

10

15

20

ABSTRACT OF THE DISCLOSURE

In a method for wire-seam-welding two overlapping edges
5 of a steel sheet, the wire electrode has a sectional area
of 0.5 to 3.0 mm² perpendicular to the longitudinal direction
of the can body; and the wire electrode has a linear portion
in contact with said steel sheet to be welded relative to
the width direction of the weld zone, said linear portion
10 having a length of 1.0 to 4.0 times the thickness of said
steel sheet to be welded.

$L \leq W < L + 1.5$ is satisfied in the relationship between
the overlapping width W (mm) of said steel sheet to be welded
and the length L (mm) of said linear portion.

15

Fig. 1

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FIG. 1

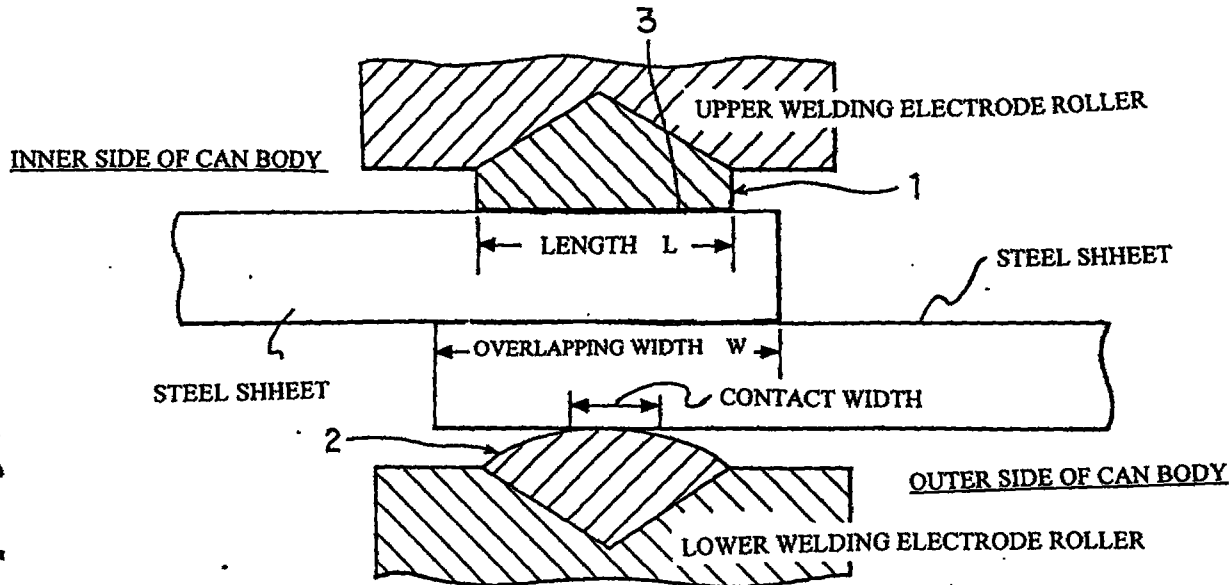
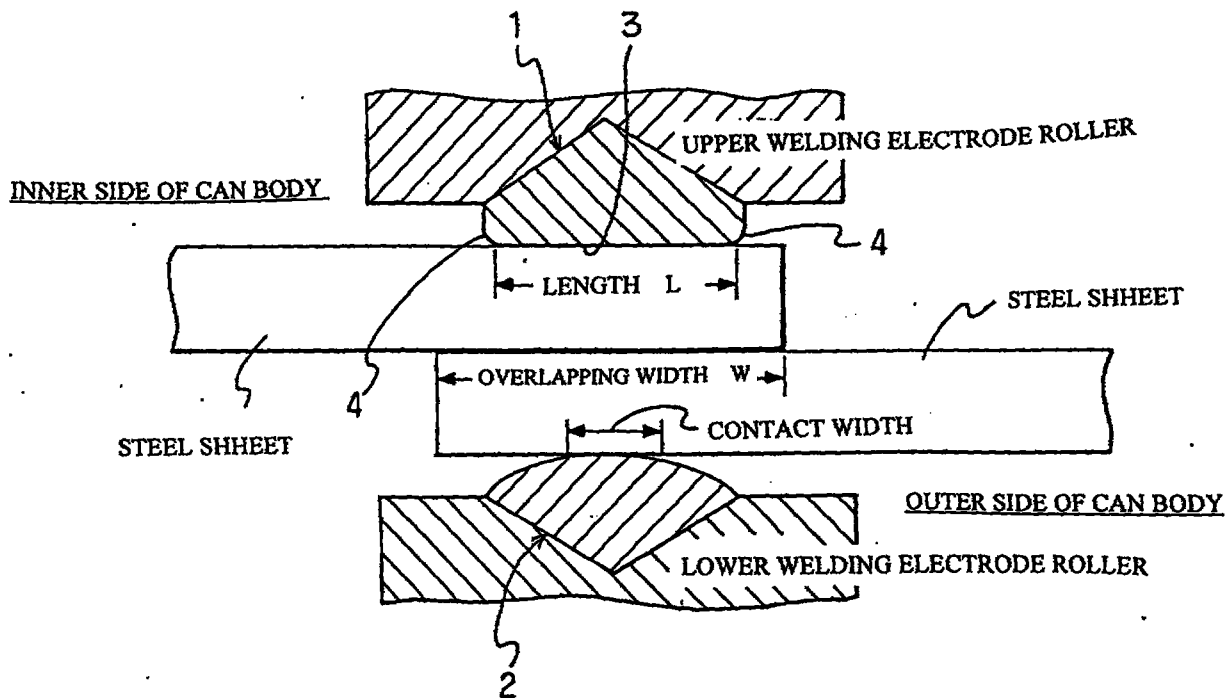


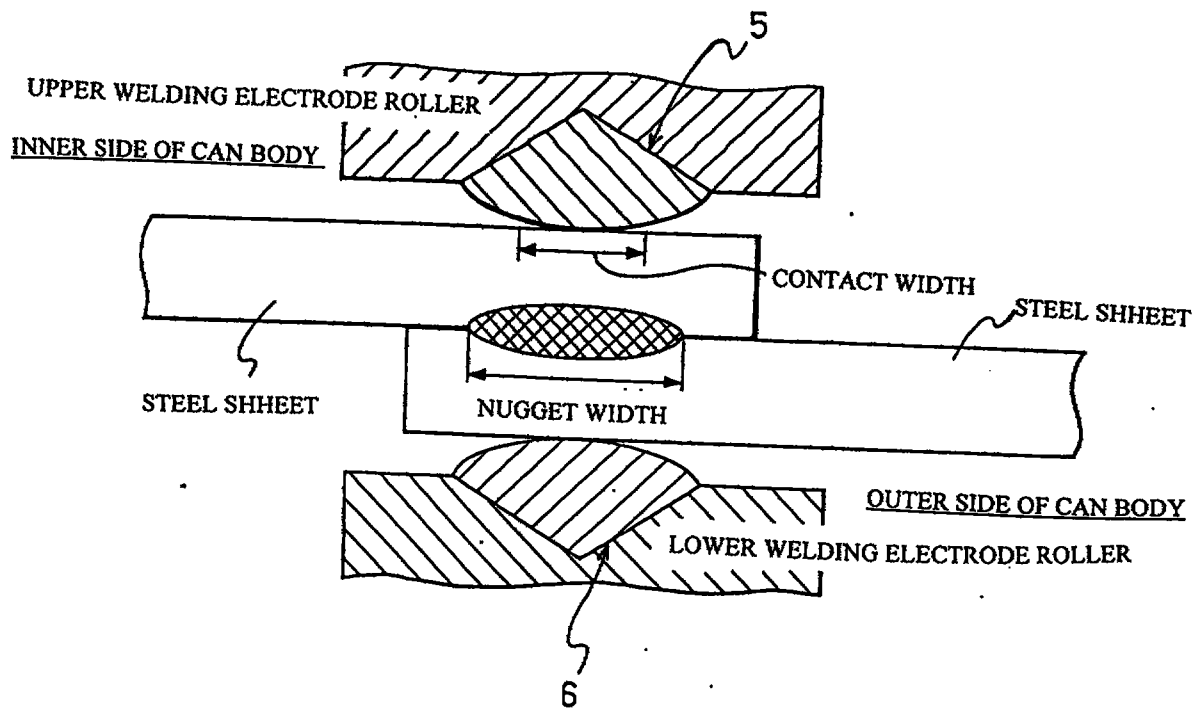
FIG. 2



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FIG. 3



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FIG. 4

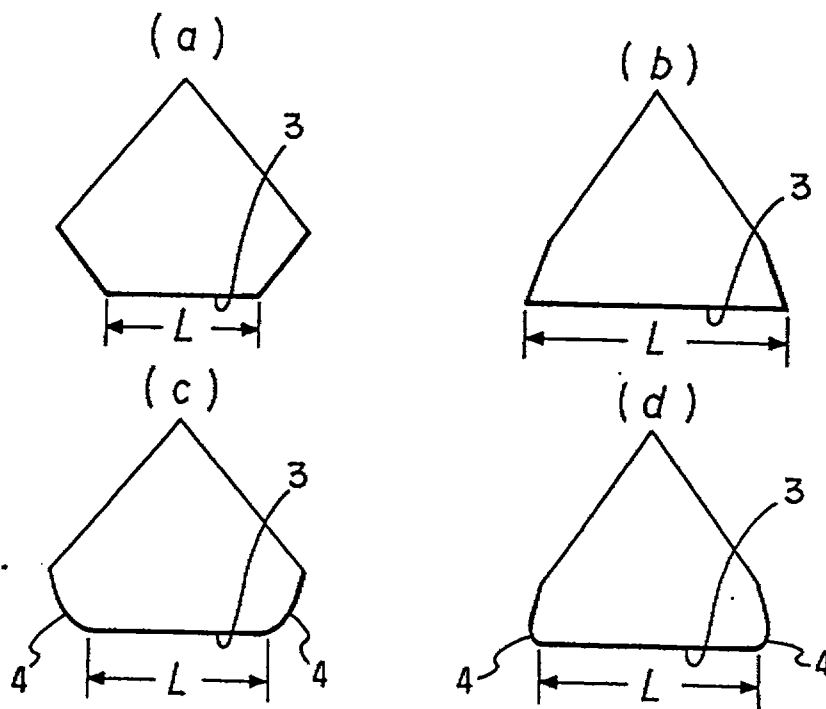
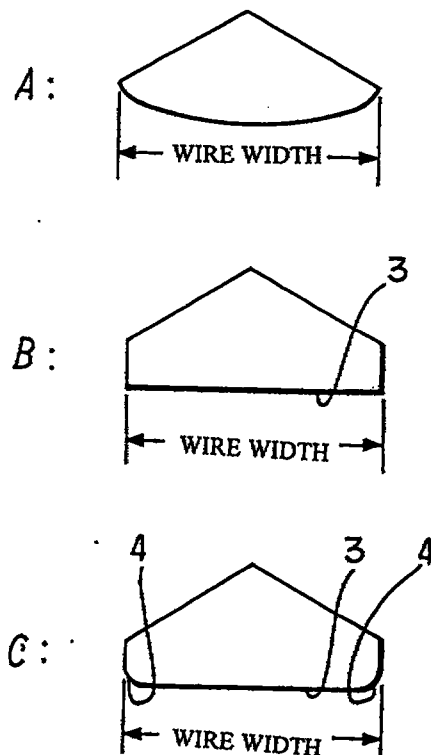


FIG. 5



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FIG. 6

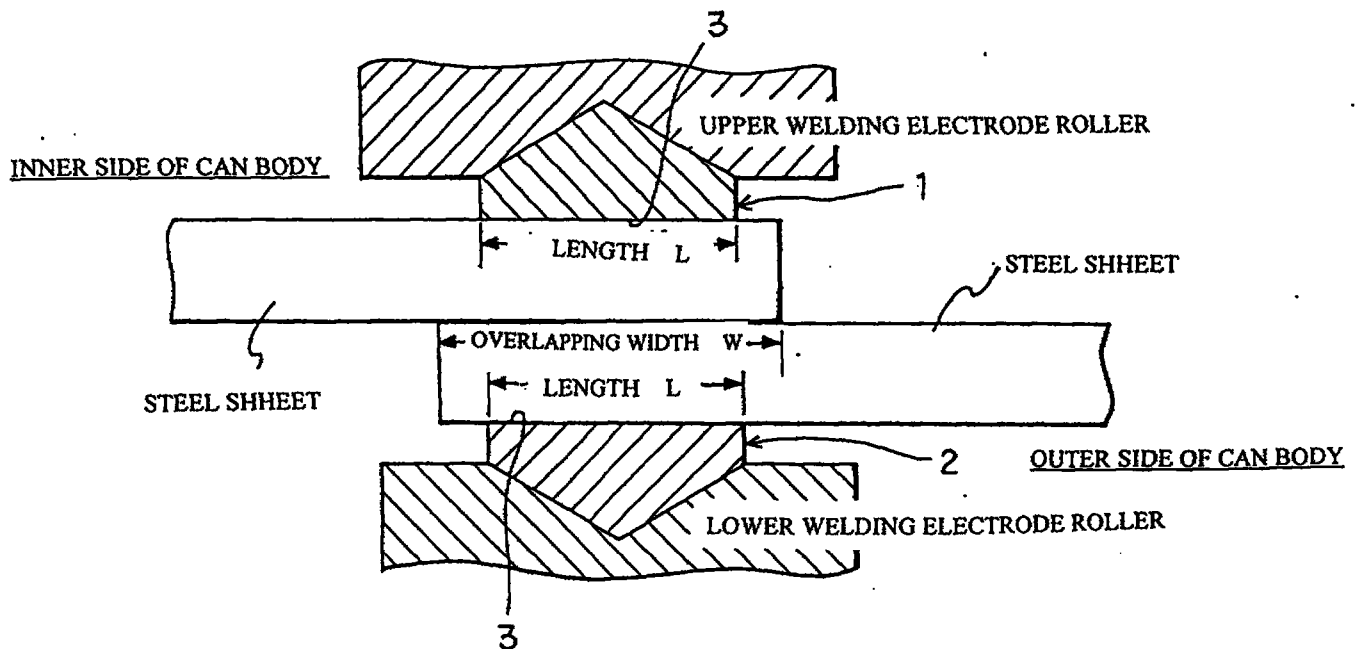
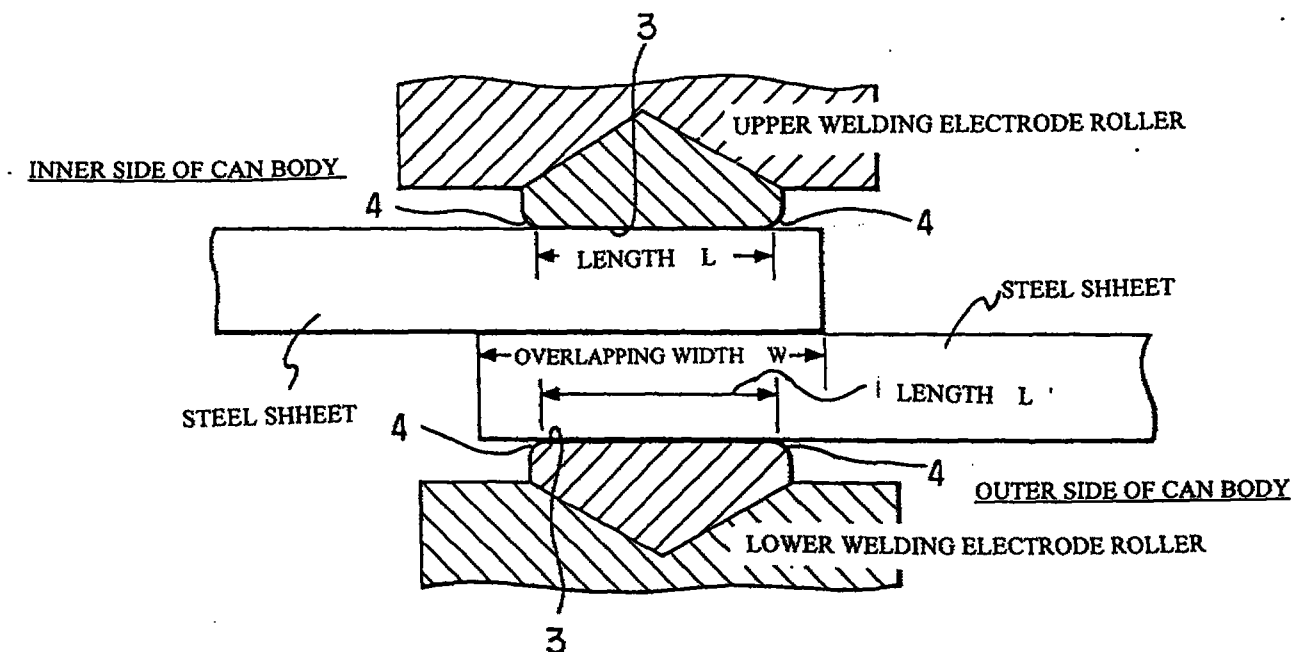


FIG. 7



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FIG. 8

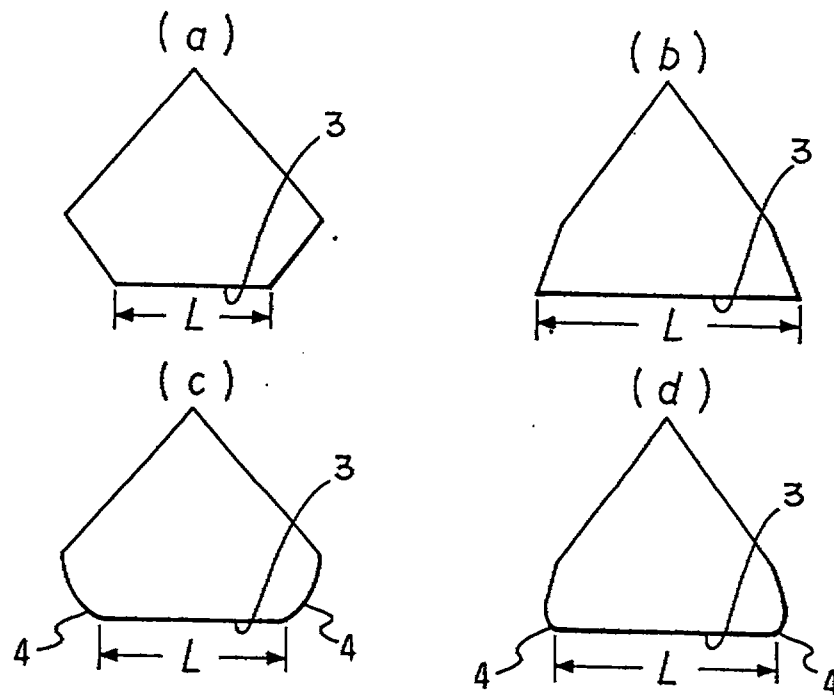
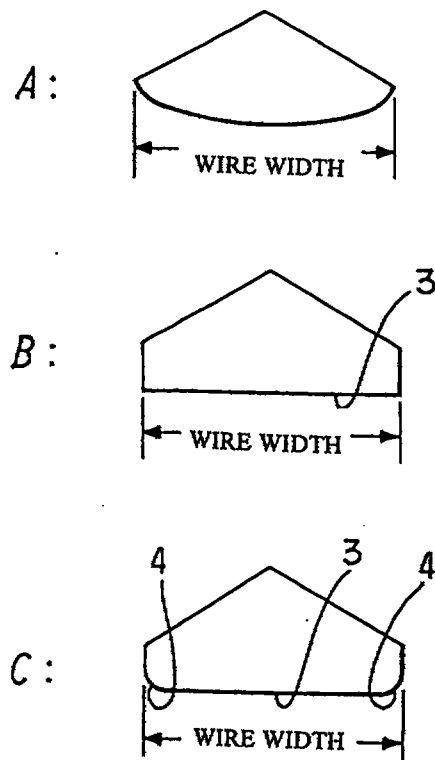


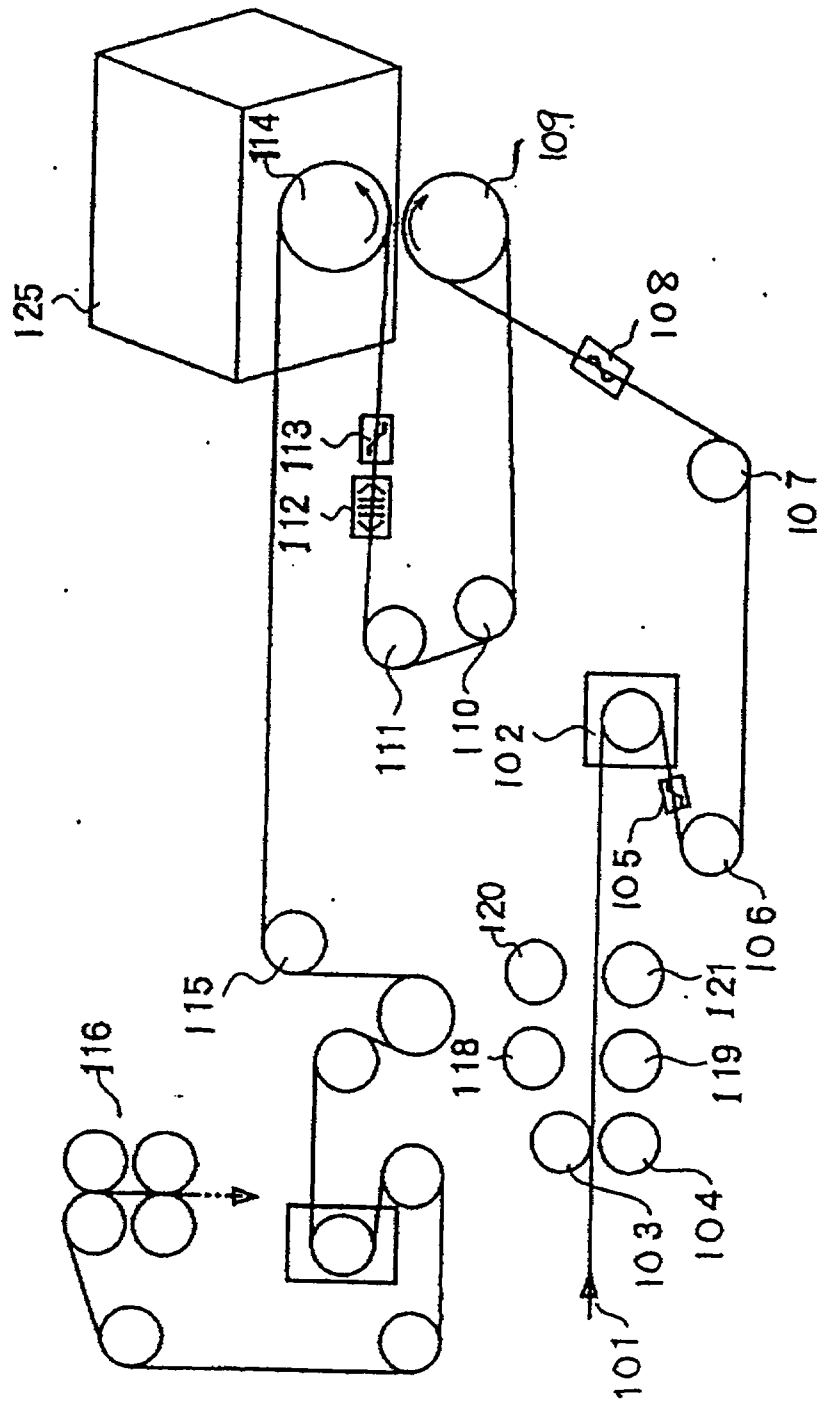
FIG. 9



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FIG. 10



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FIG. 11

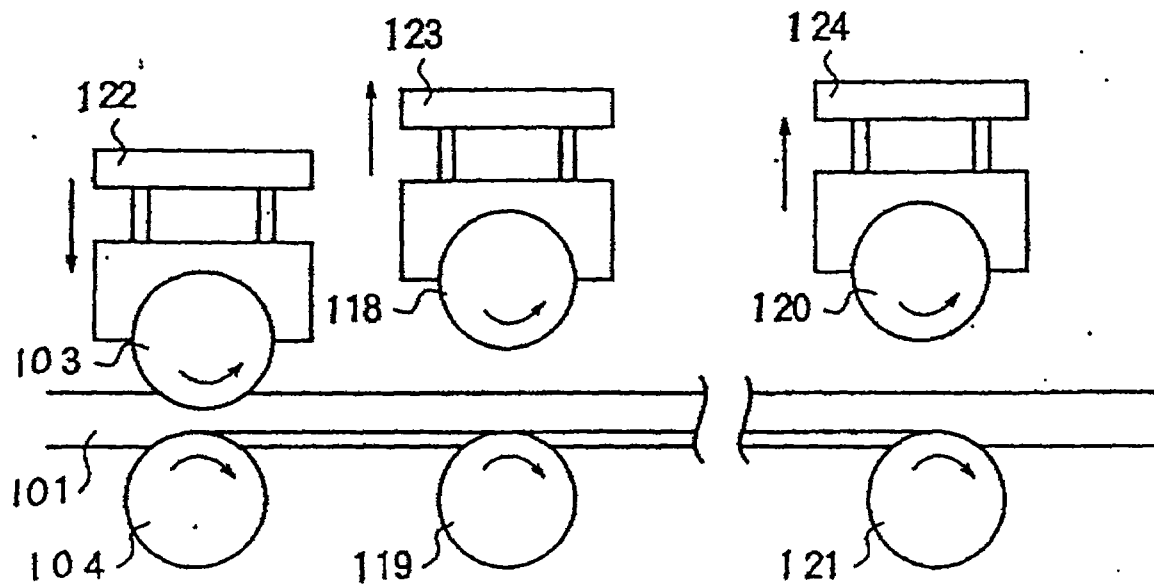


FIG. 12

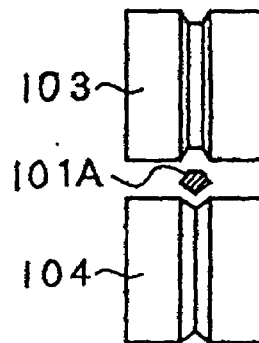
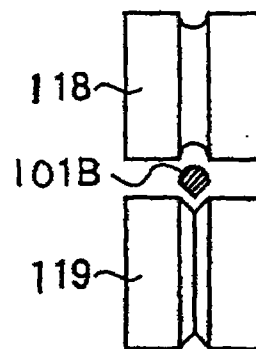


FIG. 13



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FIG. 14

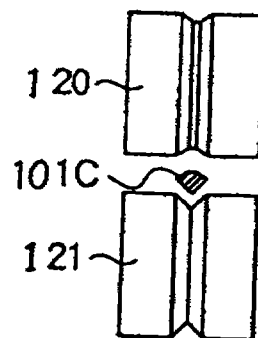


FIG. 15

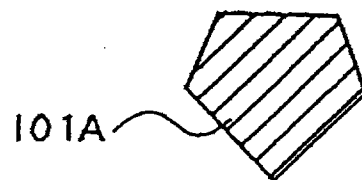


FIG. 16

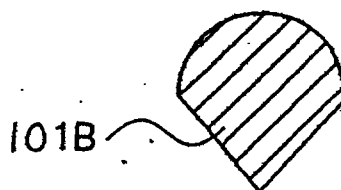
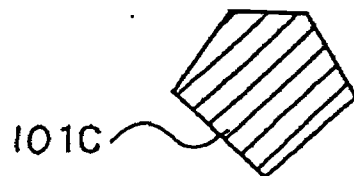


FIG. 17



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☐	Claim(s) : paged	to paged
☒	Drawing(s) : paged 1...	to paged 8..
☒	Abstract : paged 101	to paged
DATE OF RECEIPT		17/01/98

WIRE-SEAM-WELDING METHOD AND APPARATUS THEREFOR

ABSTRACT OF THE DISCLOSURE

In a method for wire-seam-welding two overlapping edges
 5 of a steel sheet, the wire electrode has a sectional area
 of 0.5 to 3.0 mm² perpendicular to the longitudinal direction
 of the can body; and the wire electrode has a linear portion
 in contact with said steel sheet to be welded relative to
 the width direction of the weld zone, said linear portion
 10 having a length of 1.0 to 4.0 times the thickness of said
 steel sheet to be welded.

$L \leq W < L + 1.5$ is satisfied in the relationship between
 the overlapping width W (mm) of said steel sheet to be welded
 and the length L (mm) of said linear portion.

15

Fig. 1

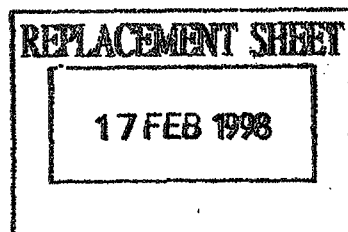


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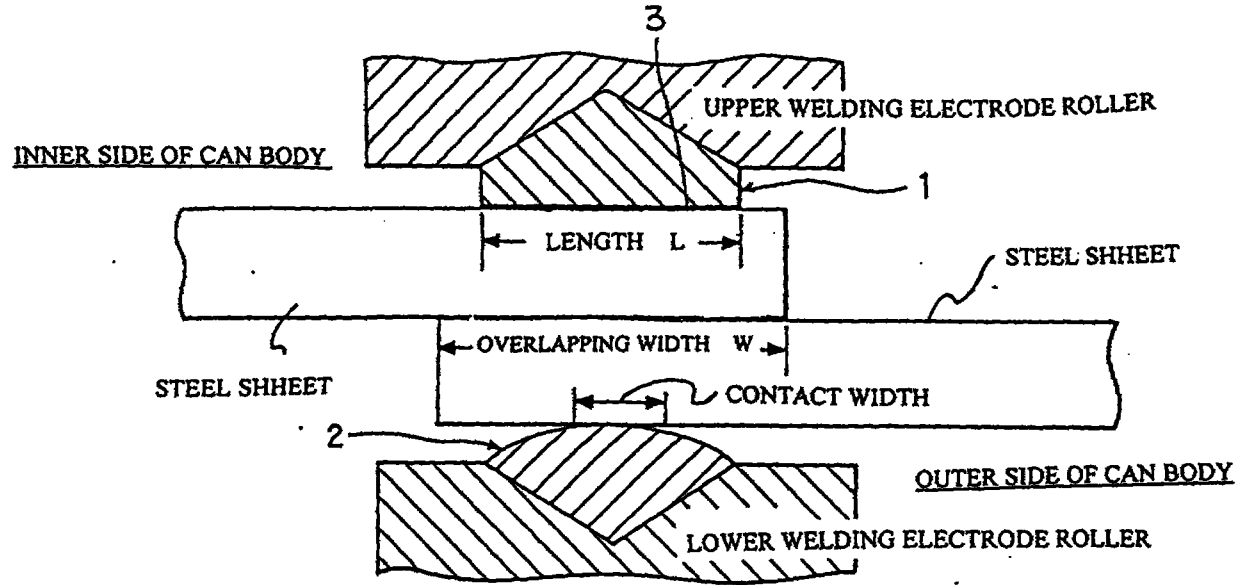
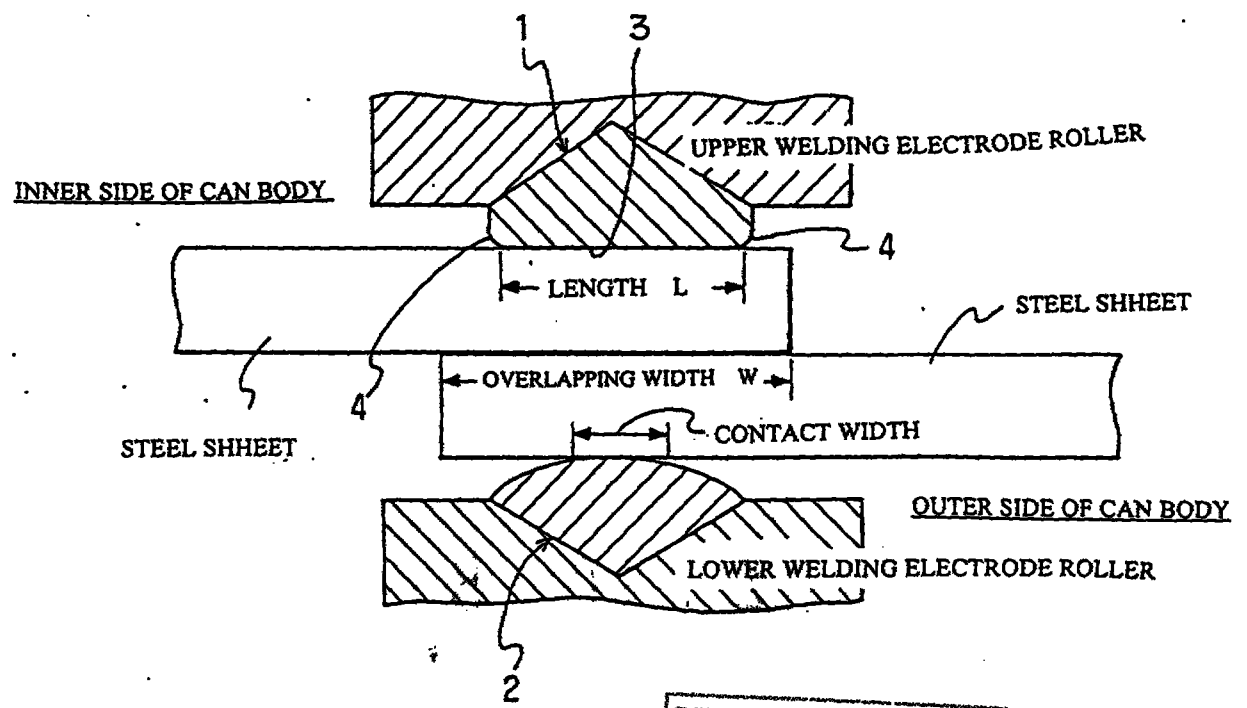


FIG. 2



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FIG. 3

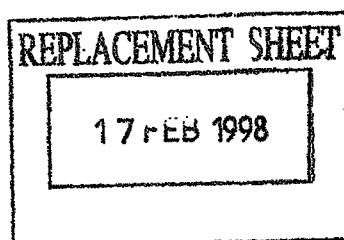
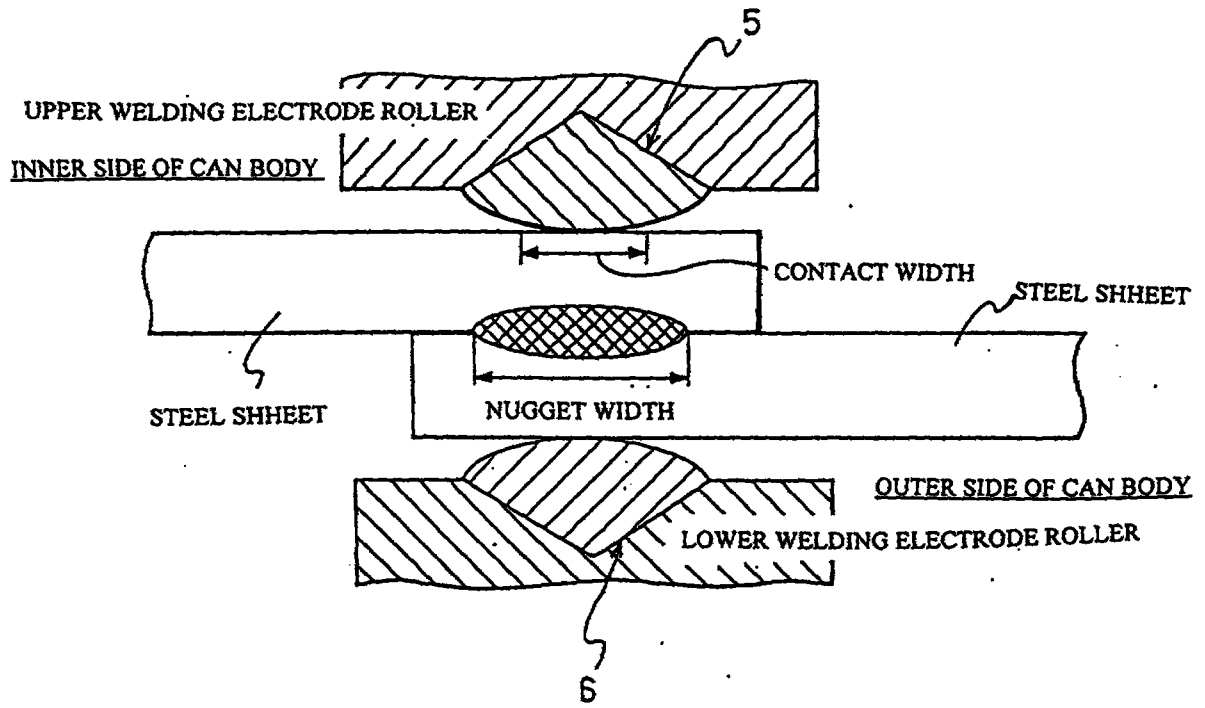


FIG. 4

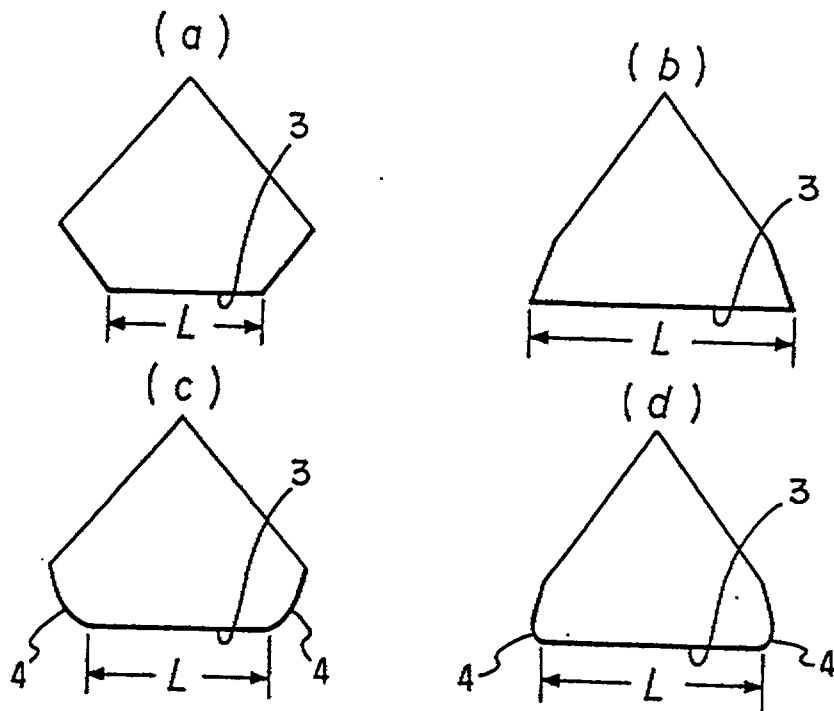
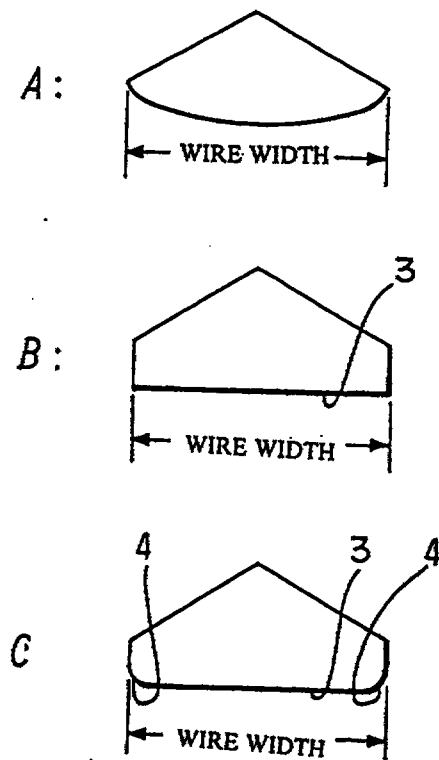


FIG. 5



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FIG. 6

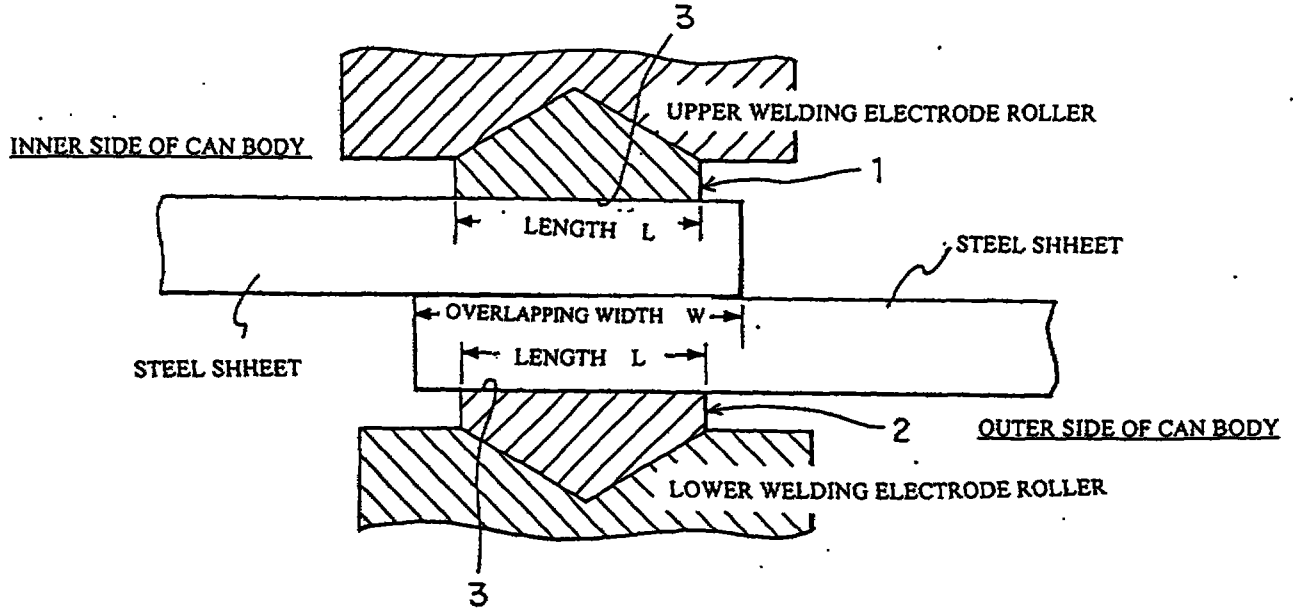
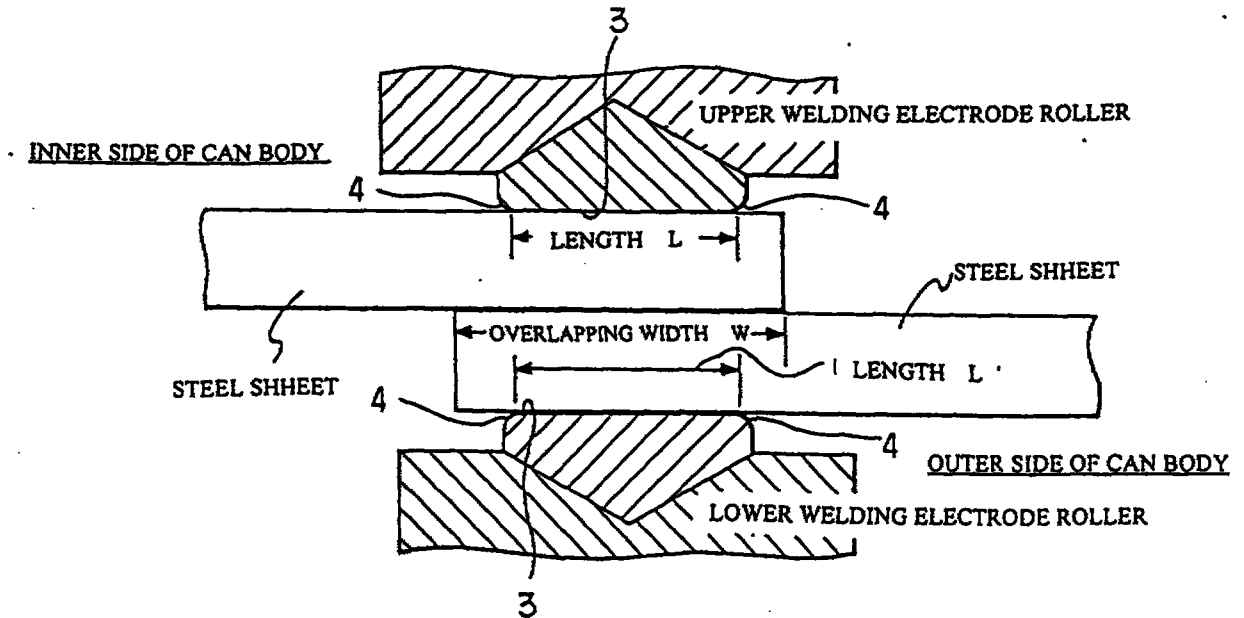


FIG. 7



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FIG. 8

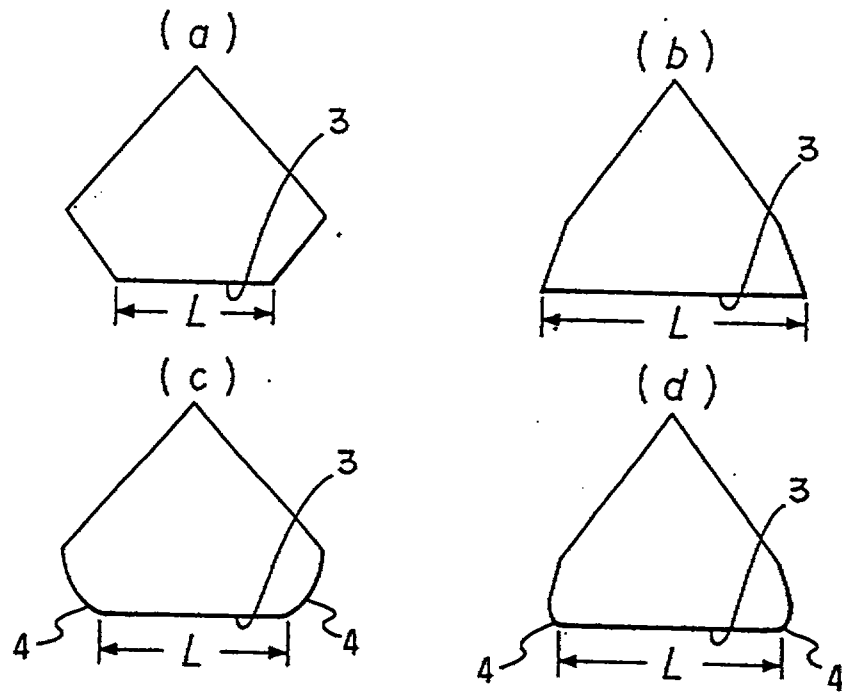
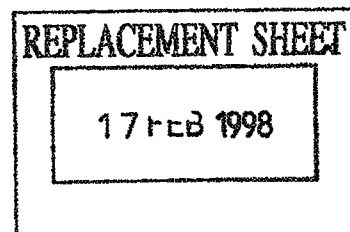
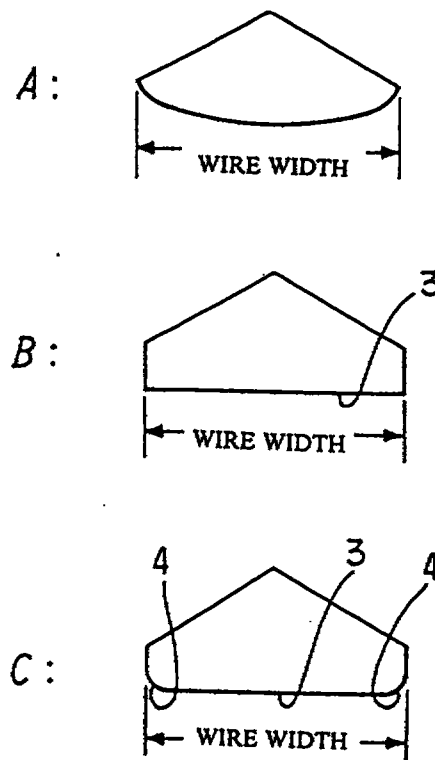


FIG. 9



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FIG. 10

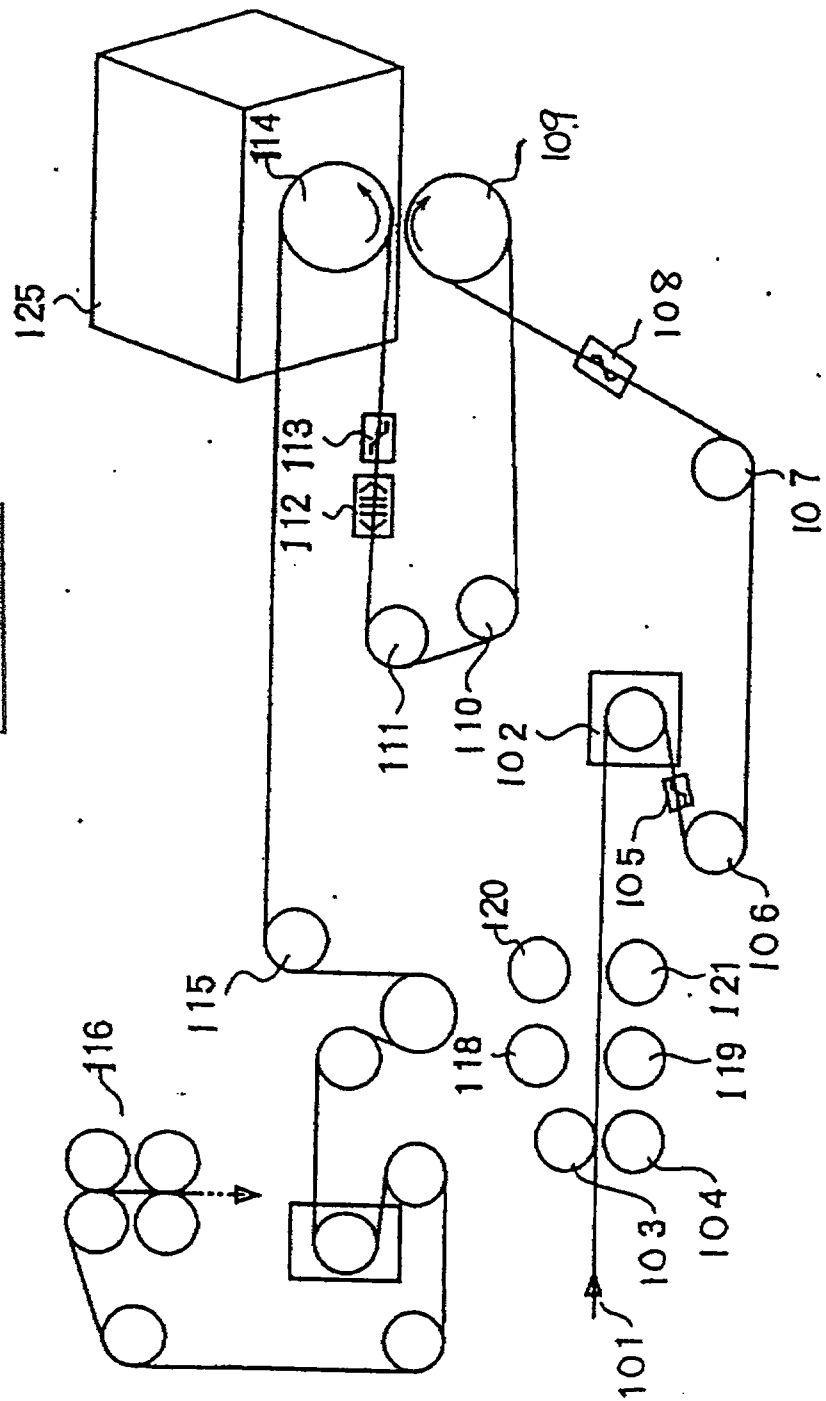


FIG. 11

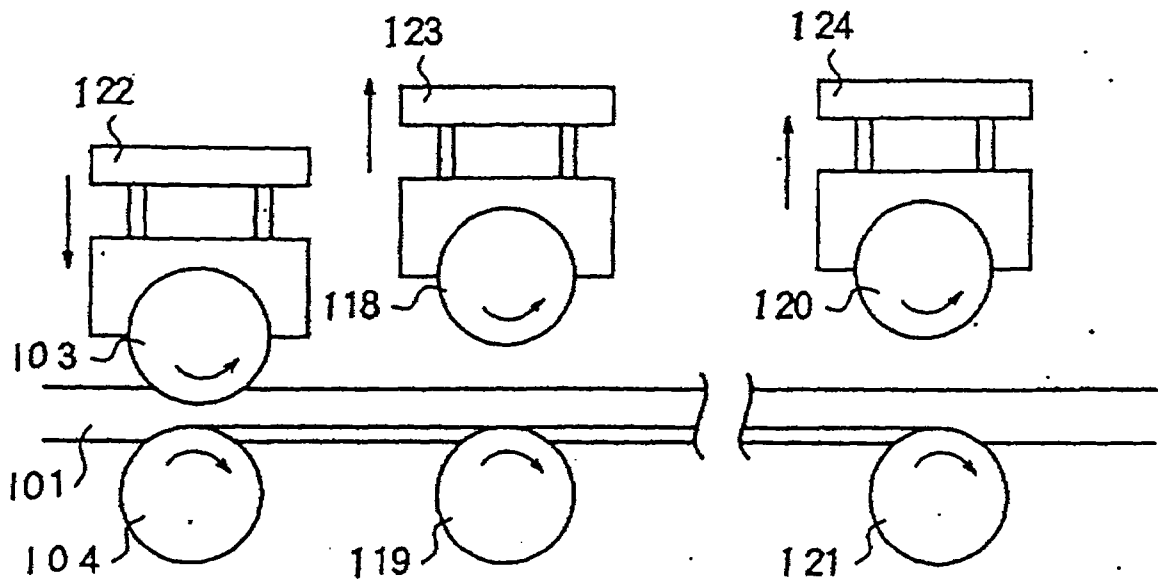


FIG. 12

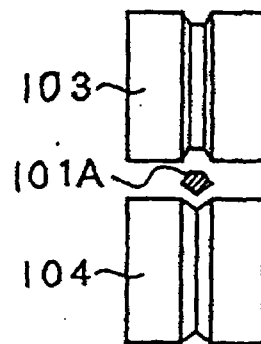


FIG. 13

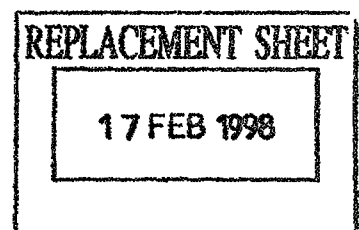
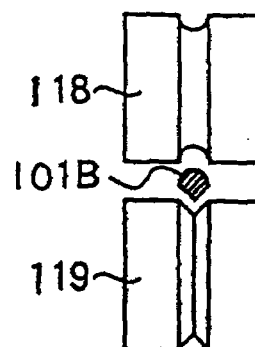


FIG. 14

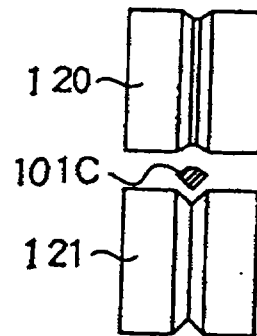


FIG. 15

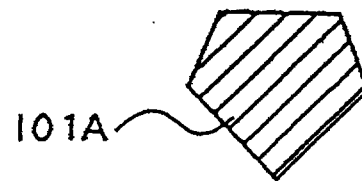


FIG. 16

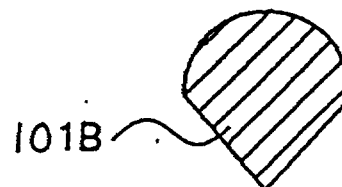


FIG. 17

