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(54) **Method for producing a metal can body**

(57) Method for producing a metal can body, comprising the steps:

- v. providing an intermediate cup (1) comprising a bottom section and a side wall, the intermediate cup being a result of a previous operation including at least a step of deep drawing a blank comprising a metal sheet, the metal sheet having a thickness t ;
- vi. placing the intermediate cup coaxially into a redrawing die (3), having, when viewed in its axial cross section, a blank holder face (2) connected to an axial inside peripheral surface via a redrawing radius (R_d);
- vii. inserting an annular blank holding member (5) inside the intermediate cup, the blank holder having, when viewed in its axial cross section, a counter blank holder face (4) connected to a peripheral face (7) via a holding radius (R_h), whereby the intermediate cup is clamped between the blank holder face and the counter blank holder face;
- viii. moving a punch (6) in axial direction relative to the redrawing die through the annular blank holding member into engagement with the intermediate cup, followed by redrawing the intermediate cup; whereby the holding radius (R_h) is chosen in dependence with thickness t in accordance with a condition $R_h / t > 4.35$.

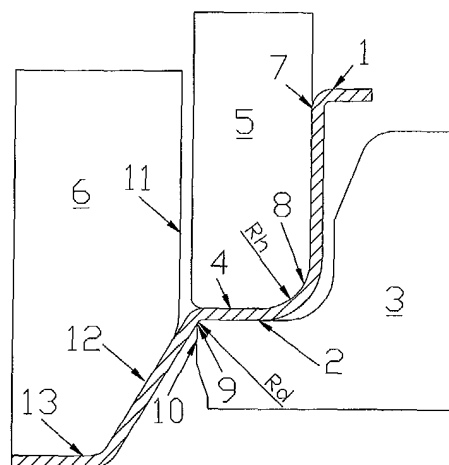


FIG. 1

Description

[0001] The invention relates to a method for producing a metal can body, comprising the steps:

- i. providing an intermediate cup comprising a bottom section and a side wall, the intermediate cup being a result of a previous operation including at least a step of deep drawing a blank comprising a metal sheet, the metal sheet having a thickness t ;
- ii. placing the intermediate cup coaxially into a redrawing die, having, when viewed in its axial cross section, a blank holder face connected to an axial inside peripheral surface via a redrawing radius;
- iii. inserting an annular blank holding member inside the intermediate cup, the blank holder having, when viewed in its axial cross section, a counter blank holder face connected to a peripheral face via a holding radius, whereby the intermediate cup is clamped between the blank holder face and the counter blank holder face;

moving a punch in axial direction relative to the redrawing die through the annular blank holding member into engagement with the intermediate cup, followed by redrawing the intermediate cup.

[0002] US patent 4,962,659 describes a method for producing a metal can body.

[0003] The known method starts with redrawing a drawn intermediate cup of a polymer coated metal sheet into a re-drawn cup. The drawn intermediate cup is held by an annular holding member inserted in the cup, and a redrawing die. The redrawing die is moved relatively to a redrawing punch arranged coaxially with the holding member and redrawing cup, the drawing punch being capable of going into the holding member and coming out from the holding member, so that the redrawing die and redrawing punch are engaged with each other, to form a re-drawn cup having a diameter smaller than that of the intermediate cup. When viewed in axial cross section, the side wall of the intermediate cup is introduced along a peripheral face of the annular holding member and is passed along a holding radius of the holding member, whereby the side wall is bent vertically inwardly in the radial direction, and the side wall portion is passed through a region defined by an upper blank holder face of the redrawing die and a counter blank holder face of the annular holding member, and the side wall portion is bent substantially vertically to the axial direction by redrawing radius of the redrawing die. The resulting re-drawn cup has a diameter smaller than that of the intermediate cup, and the thickness of the side wall is reduced by the re-drawing method as a result of the bending and elongating.

[0004] In the known method, the holding radius R_h is 4.1 to 12 times as large as the thickness of the metal sheet that was comprised in the blank from which the intermediate cup was drawn. It is said that when the holding radius R_h is too small and below 4.1, perforation of the polymer cover is readily caused.

[0005] Subsequent to the above described redrawing operation, a bottom profile is provided in the bottom portion of the re-drawn cup in a separate operation, in order to form the metal can body from the re-drawn cup.

[0006] The bottom profile generally comprises an inwardly protruding dome, separated from the side wall by a chime zone. The chime zone is a transition zone between the bottom of the metal body and its side wall.

[0007] It is a drawback of the known method, that a separate operation is used to form the bottom profile in the re-drawn can.

[0008] By simply performing both steps of re-drawing and bottom profiling in the above described method simultaneously, it has been found that chime wrinkling occurs in the chime zone. Chime wrinkling is evident from wrinkles that are present in the chime zone, and a metal can body suffering from chime wrinkling is rendered unacceptable for commercial use.

[0009] It has now surprisingly been found, that the bottom profile can be formed simultaneously to the re-drawing, in a method according to the invention which is defined in the first paragraph of this description, provided that the holding radius R_h is chosen in dependence with thickness t in accordance with a condition $R_h / t < 4.35$, preferably $R_h / t \leq 4$.

[0010] It has been found, that with the method according to the invention, the bottom profiling does not have to be performed in a separate operation subsequent to the re-drawing operation.

[0011] It is believed that the relatively small holding radius results in an increase in the tension between the holding radius and the initial contact point of the cup with the punch, which helps to avoid chime wrinkling.

[0012] Particularly in the first stage of re-drawing the tension caused by the holding radius is of importance, because in that stage the redrawing radius is not yet fully effective in contributing to the tension in the cup.

[0013] It is surprisingly found that the method according to the invention does not lead to perforation of the polymer layer when it is applied to a blank of polymer coated packaging steel sheet, having a polymer layer at least up to 15 μm thick on the side becoming the inside of the metal can body. Besides polymer coated blanks, the invention is also found advantageous when applied to other types of blanks, including a tin plate blank and an aluminium alloy blank, for chime wrinkling is also reduced when the method is applied to such other types of blanks.

[0014] In each case, the relevant thickness t for determining the ratio R_h / t is the thickness of the bare metal sheet.

[0015] It is another advantage of the invention that the difference of the thickness between a lower and an upper

portion of the side wall is reduced compared to the case where $R_h/t > 4$. This is particularly an advantage in an optional subsequent wall ironing operation if it is performed.

[0016] The more uniform wall thickness in the lower part of the cup results in a more uniform wall ironing reduction of the part of the redraw cup that will become the mid wall of a wall-ironed can. The increase in wall thickness at the edge of the redraw cup will become the thicker top wall of the wall-ironed can. The net result is that the total wall iron reduction for both the mid wall as well as the top wall is less critical.

[0017] In one embodiment, the redrawing radius R_d is chosen in dependence with t in accordance with a condition $1 \leq R_d/t \leq 2.9$, preferably $1.5 \leq R_d/t \leq 2.9$. It is advantageous to restrict to one of these ranges in order to remedy, as a result of the additional tension introduced in the cup, any wrinkles that might have been introduced even though a sufficiently small holding radius is provided. It is remarked that in particular in later stages of redrawing, the drawing radius becomes effective in controlling the tension in the cup. Moreover, reduction of the thickness of the side wall by bending and elongating can be even more effectively accomplished, and furthermore, the difference of the thickness between the lower and upper portions of the side wall can be reduced even more uniformly throughout the side wall.

[0018] In an embodiment, R_h is chosen in accordance with a condition $R_h \leq 0.80$ mm. An advantage of this embodiment is that metal blanks as thin as 0.20 mm can be re-drawn with very low risk of chime wrinkling. Preferably, $R_h \leq 0.72$ mm, enabling metal blanks as thin as 0.18 mm to be redrawn with very low risk of chime wrinkling. More preferably, $R_h \leq 0.56$ mm, enabling metal blanks as thin as 0.14 mm to be redrawn with very low risk of chime wrinkling.

[0019] The invention will now be illustrated with reference to the following figures:

FIG. 1 is a schematic cross sectional view of an apparatus for redrawing in accordance with the invention;

FIG. 2 is a schematic cross sectional view of a punch provided with a dome profile;

FIG. 3 (parts a to d) shows photographic images of redrawn cups 0.20 mm with a chime zone obtained using various holding radii in a range from 3.2 mm down to 0.55 mm;

FIG. 4 (parts a and b) shows photographic images of redrawn cups 0.18 mm with a chime zone obtained using holding radii in a range from 0.87 mm down to 0.55 mm;

FIG. 5 shows a photographic image of a redrawn cup 0.20 mm with a chime zone obtained using a holding radius of 0.72 mm;

FIG. 6 shows a photographic image of a redrawn cup 0.18 mm with a chime zone obtained using a holding radius of 0.72 mm;

FIG. 7 shows measured side wall thickness profiles of redrawn cups 0.20 mm obtained using a holding radius of 1.4 mm and of 0.72 mm.

[0020] Referring to FIG. 1 illustrating a schematic cross sectional view of an apparatus for redrawing embodying the method of the present invention, a preliminarily drawn intermediate cup 1 formed from a blank of a polymer coated metal sheet, the sheet having a thickness gauge t , is held between a blank holder face 2 of a redrawing die 3 and a counter blank holding face 4 of an annular blank holding member 5 that is inserted into the intermediate cup 1 and located above the redrawing die 3. A redrawing punch 6 is arranged coaxially with the holding member 5 and redrawing die 3 so that the redrawing punch 6 can move in axial direction relative to the holding member 5.

[0021] By this arrangement, the side wall portion of the intermediate cup 1 is introduced from a peripheral face 7 of the annular holding member 5 and is passed through a holding radius part 8 of the holding member 5, whereby the side wall portion is bent inwardly in the radial direction of the annual holding member 5, and the side wall portion is passed through the region defined by the blank holder face 2 and the counter blank holder face, and the side wall portion is bent back in the axial direction by a redrawing radius part 9 that connects the blank holder face 2 to an axial inside peripheral surface 10 of the redrawing die 3.

[0022] The punch 6 is provided with a cylindrical section 11 and a tapered chime section 12 that separates a bottom section 13 from the cylindrical section 11. The function of the tapered chime section 12 is to provide a desired tapered bottom profile to the metal can body. Other bottom profiles can be introduced using alternative punches, of which a typical example is shown in FIG. 2.

[0023] Referring again to FIG. 1, when the tapered chime section 12 of the punch 6 is moved past the redrawing radius part 9 of the redrawing die 3, the peripheral outer surface of the punch 6 in its cylindrical part 11 will work together with the axial inside peripheral surface 10 and support the redrawn section of the side wall.

[0024] However, between that moment and the moment that the punch 6 reaches engagement with the intermediate cup when it is moved relative to the redrawing die 3, the side wall is not supported because of a space between the tapered chime section 12 and the axial inside peripheral surface 10.

[0025] The present invention is based on the finding that if the value of the holding radius R_h in the holding radius part 8 of the holding member 5 is chosen sufficiently small compared to the metal thickness t , chime wrinkling is reduced or even avoided. This is further illustrated in the following examples, with reference to FIGs. 3 to 5.

Example 1

[0026] First, intermediate cups were deep drawn from blanks made from polyethylene terephthalate (PET) coated packaging steel sheet, using a drawing radius of 1.4 mm. The thickness gauge of the packaging steel sheet was 0.20 mm, and the thickness of the PET coating was 15 μm on the face forming the outside wall of the intermediate cup and 30 μm on the face forming the inner wall.

[0027] These intermediate cups had a diameter of 90.42 mm. The intermediate cups were redrawn in an apparatus similar to that shown in FIG. 1, wherein the punch diameter was 65.652 mm, the inside diameter of the redrawing die was 66.413 mm, and the redrawing radius R_d was 1.0 mm.

[0028] Different holding radii were tried. FIG. 3 shows photographic images of redrawn cups having a chime zone obtained using various holding radii in a range from 3.2 mm down to 0.55 mm.

[0029] FIG. 3(a), (b), and (c) each show the redrawn cup whereby the holding radius R_h was 3.2 mm, 1.4 mm, and 0.87 mm, respectively. Chime wrinkling is observed in each case, whereby the most severe case of chime wrinkling corresponds to the largest holding radius. When the holding radius was further reduced to 0.55 mm, corresponding to FIG. 3(d), the chime wrinkling disappeared.

[0030] Also, the porosity of the redrawn cups was measured in accordance with the so-called enamel rating standard ER 470. The following Table I shows the results for 10 test redrawn cans and the average ER 470 values (in mA).

Table I:

ER 470 test results (in mA)			
Can number	$R_h = 1.4$ mm (FIG. 3(b))	$R_h = 0.87$ mm (FIG. 3(c))	$R_h = 0.55$ mm (FIG. 3(d))
1	0.01	0.01	0.03
2	0.00	0.01	0.01
3	0.01	0.01	0.01
4	0.00	0.01	0.01
5	0.00	0.00	0.01
6	0.01	0.00	0.04
7	0.01	0.01	0.00
8	0.00	0.00	0.01
Average	0.01	0.01	0.02

[0031] As can be seen, the invention does not lead to substantial perforation of the polymer layer.

[0032] The above given results are summarised in the following Table II. Legend: ++ indicates severe chime wrinkling; + indicates chime wrinkling; 0 indicates acceptable; — indicates chime wrinkling not apparent.

Table II:

summary of re-drawing results.					
Identifier	t (mm)	R_h (mm)	R_h/t	Chime wrinkles	ER470 (mA)
FIG.3(a)	0.20	3.2	16.0	++	<i>p.m.</i>
FIG.3(b)	0.20	1.4	7.0	+	0.01
FIG.3(c)	0.20	0.87	4.35	+	0.01
FIG.3(d)	0.20	0.55	2.75	-	0.02

[0033] As can be seen, the chime wrinkling disappears when the ratio R_h / t is chosen 4 or lower.

Example 2

[0034] Additional tests, similar to those described above, were also performed using intermediate cups that were deep drawn from PET coated packaging steel sheet blanks, of which the thickness gauge of the packaging steel sheet

was 0.18 mm, and the thickness of the PET coating was 15 μm on the face forming the outside wall of the intermediate cup and 30 μm on the face forming the inner wall. The drawing radius was 1.4 mm.

[0035] These intermediate cups had a diameter of 90.42 mm. The intermediate cups were redrawn in an apparatus similar to that shown in FIG. 1, wherein the punch diameter was 65.724 mm, the inside diameter of the redrawing die was 66.413 mm, and the redrawing radius R_d was 1.0 mm.

[0036] FIG. 4 shows photographic images of redrawn cups having a chime zone obtained using a holding radius of 0.87 mm (FIG. 4(a)) and 0.55 mm (FIG. 4(b)). The first mentioned shows severe chime wrinkles, whereas the last mentioned is acceptable.

[0037] These results are also summarised in the following Table III.

Table III:

summary of re-drawing results				
Identifier	t (mm)	R_h (mm)	R_h / t	Chime wrinkles
FIG.4(a)	0.18	0.87	4.8	++
FIG.4(b)	0.18	0.55	3.1	0

[0038] As can be seen, the chime wrinkling is present when the ratio R_h / t is chosen above 4, and it is acceptable with the ratio being 4 or lower.

Example 3

[0039] Using an intermediate cup of the same material as those of Example 1, drawn with a drawing radius of 1.2 mm, a similar test as in Example 1 was performed. However, in this example, the redrawing radius R_d of 0.40 mm was chosen, significantly lower than that of Example 1. The holding radius is 0.72 mm.

[0040] The result is shown in FIG. 5 and in the following Table IV. Table IV also includes a reference cup for which a holding radius of 1.4 mm was used.

Table IV:

summary of re-drawing results, $R_d = 0.40$ mm.				
Identifier	t (mm)	R_h (mm)	R_h / t	Chime wrinkles
Reference	0.20	1.4	7.0	+
FIG.5	0.20	0.72	3.6	0

[0041] Also in this case, where $R_h / t \leq 4$, the chime wrinkles were acceptable.

[0042] The thickness of the side wall in these redrawn cups was measured as a function of height starting from the bottom.

[0043] The result is shown in FIG. 7. As can be seen, in both redrawn cups the thickness increases with height in the cup. Of the redrawn cup of FIG. 5, for which $R_h = 0.72$ mm, the thickness profile at heights between 20 and 60 mm from bottom is below and less steep than that of the reference redrawn cup. Towards the open end at heights between 60 and 70 mm from bottom, the thickness increases for both redrawn cups. However, in the case of the redrawn cup of FIG. 5, the increase sets in more abruptly and more towards the open end than is the case for the reference.

Example 4

[0044] A similar experiment as that of Example 3 was performed using intermediate cups that were deep drawn from PET coated packaging steel sheet blanks, of which the thickness gauge of the packaging steel sheet was 0.18 mm instead of 0.20 mm. The coating thickness was 15 μm on the face forming the outside wall of the intermediate cup and 30 μm on the face forming the inner wall. The holding radius was 0.72 mm, the drawing radius was 0.40 mm.

[0045] The result is shown in the following Table V.

Table V:

summary of re-drawing results, $R_d = 0.40$ mm.				
Identifier	t (mm)	R_h (mm)	R_h / t	Chime wrinkles
FIG. 6	0.18	0.72	4.0	0

[0046] As can be seen, also in this case where $R_h / t = 4$, the chime wrinkling is acceptable.

Claims

1. Method for producing a metal can body, comprising the steps:

- i. providing an intermediate cup comprising a bottom section and a side wall, the intermediate cup being a result of a previous operation including at least a step of deep drawing a blank comprising a metal sheet, the metal sheet having a thickness t ;
- ii. placing the intermediate cup coaxially into a redrawing die, having, when viewed in its axial cross section, a blank holder face connected to an axial inside peripheral surface via a redrawing radius;
- iii. inserting an annular blank holding member inside the intermediate cup, the blank holder having, when viewed in its axial cross section, a counter blank holder face connected to a peripheral face via a holding radius, whereby the intermediate cup is clamped between the blank holder face and the counter blank holder face;
- iv. moving a punch in axial direction relative to the redrawing die through the annular blank holding member into engagement with the intermediate cup, followed by redrawing the intermediate cup;

characterised in that,

the holding radius R_h is chosen in dependence with thickness t in accordance with a condition $R_h / t < 4.35$.

2. Method according to claim 1, wherein $R_h / t \leq 4$.

3. Method according to claim 1 or 2, wherein the redrawing radius R_d is chosen in dependence with t in accordance with a condition $1 \leq R_d / t \leq 2.9$.

4. Method according to claim 1, 2, or 3, wherein R_h is chosen in accordance with $R_h \leq 0.80$ mm.

5. Method according to any one of the previous claims, wherein the intermediate cup is provided with a polymer coating on at least the inside surface.

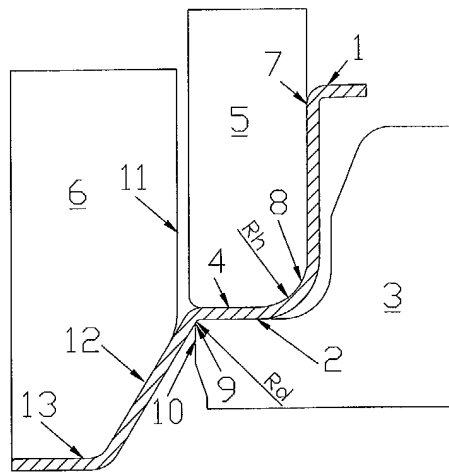


FIG. 1

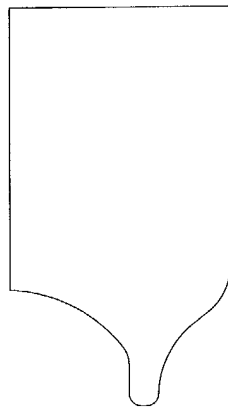


FIG. 2

FIG. 3a

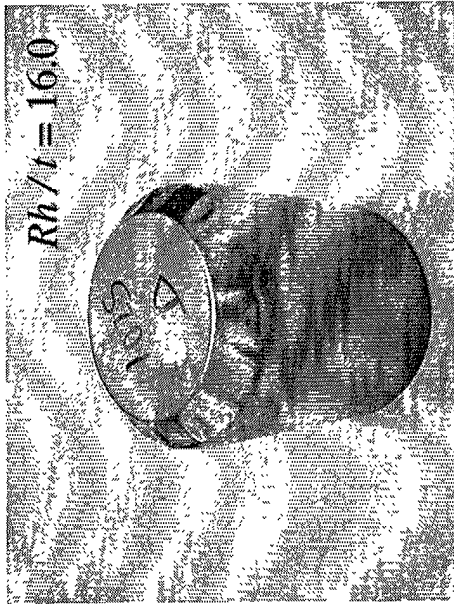


FIG. 3b

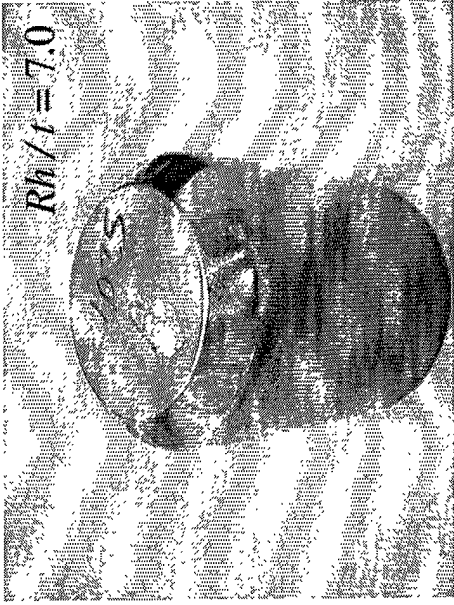


FIG. 3c

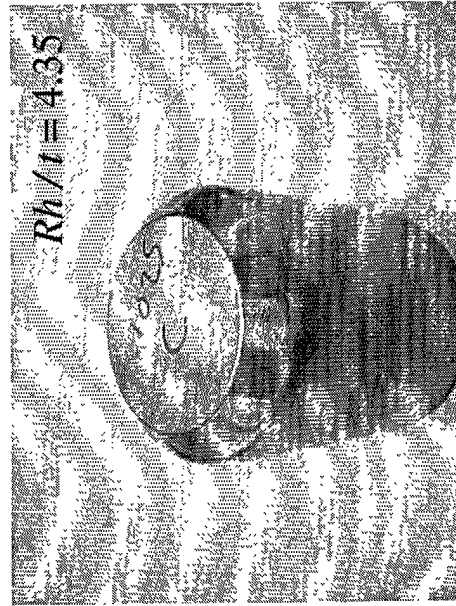


FIG. 3d

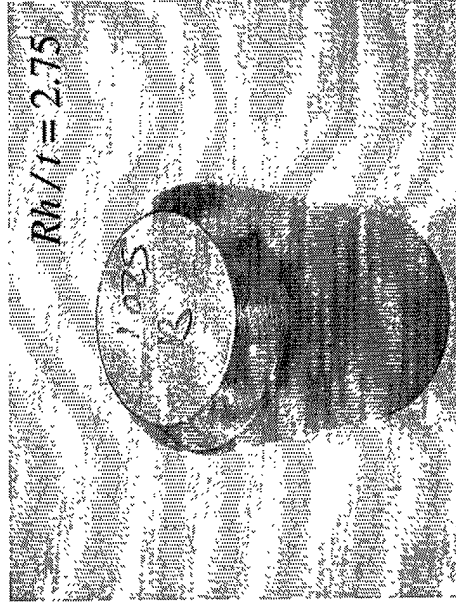


FIG. 4a

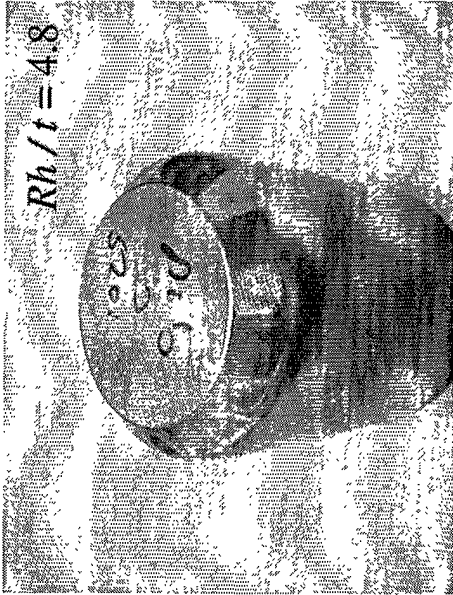


FIG. 4b

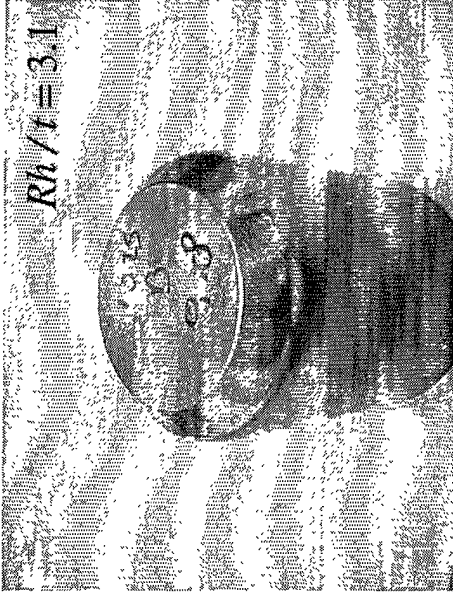


FIG. 5

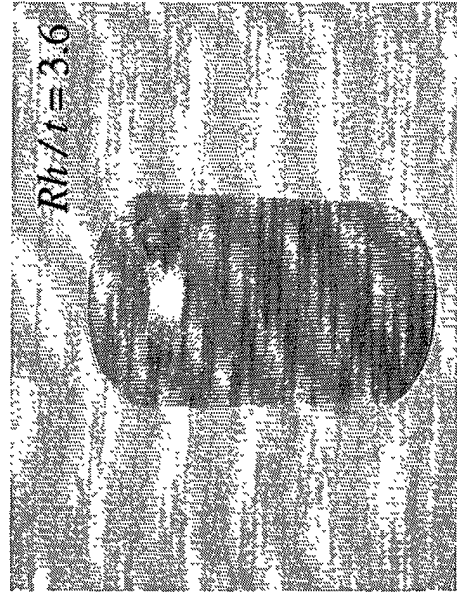


FIG. 6

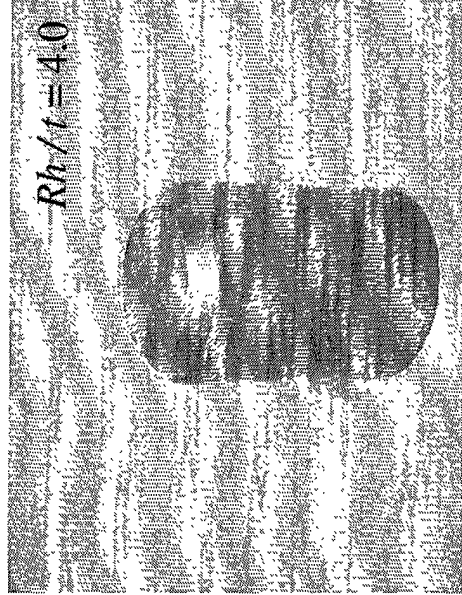
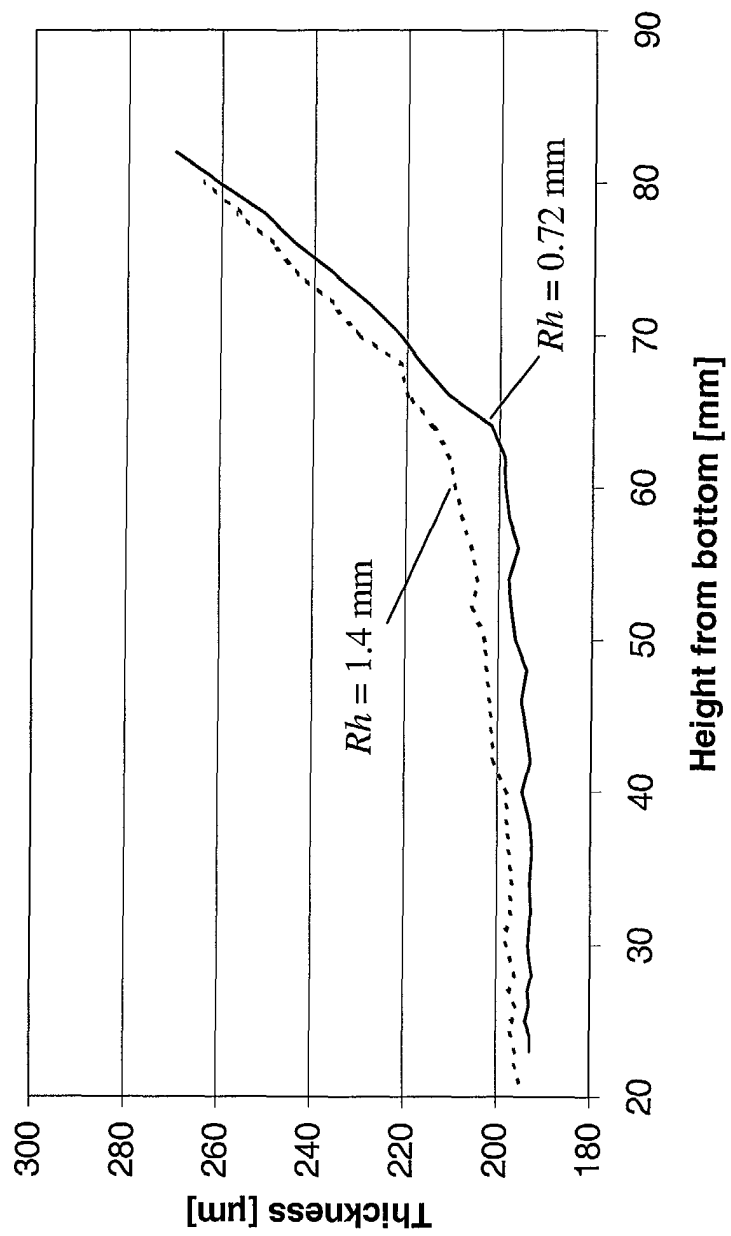


FIG. 7





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 07 9802

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 5 105 645 A (IMAZU KATSUHIRO ET AL) 21 April 1992 (1992-04-21) * claims 3,4 *	1-3,5	B21D22/28 B21D22/30
X	US 4 425 778 A (FRANEK JOSEF T ET AL) 17 January 1984 (1984-01-17) * column 6, line 23-32; claim 2 *	1,2,4,5	
X	EP 0 664 169 A (TOYO KOHAN CO LTD) 26 July 1995 (1995-07-26) * claims 3,4 *	1,3	
A	EP 0 425 704 A (TOYO SEIKAN KAISHA LTD) 8 May 1991 (1991-05-08) * claim 4 *	3	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			B21D
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		14 March 2003	Ris, M
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 02 07 9802

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14-03-2003

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
US 5105645	A	21-04-1992	JP	2023921 C	26-02-1996
			JP	3155419 A	03-07-1991
			JP	7057390 B	21-06-1995
			GB	2241184 A ,B	28-08-1991
US 4425778	A	17-01-1984	GB	2061790 A	20-05-1981
			CA	1146018 A1	10-05-1983
			DE	3070075 D1	14-03-1985
			DK	278981 A ,B,	24-06-1981
			EP	0038811 A1	04-11-1981
			ES	8201042 A1	01-03-1982
			FI	811813 A	10-06-1981
			WO	8101259 A1	14-05-1981
			IN	153726 A1	11-08-1984
			JP	1020931 B	19-04-1989
			JP	56501442 T	08-10-1981
			NO	812220 A ,B	29-06-1981
			NO	154787 C	29-12-1986
			ZA	8006745 A	25-11-1981
EP 0664169	A	26-07-1995	JP	6312223 A	08-11-1994
			CA	2132049 A1	23-06-1995
			DE	69417001 D1	15-04-1999
			DE	69417001 T2	11-11-1999
			EP	0664169 A1	26-07-1995
			US	5544517 A	13-08-1996
EP 0425704	A	08-05-1991	JP	2067412 C	10-07-1996
			JP	2303634 A	17-12-1990
			JP	7106394 B	15-11-1995
			EP	0425704 A1	08-05-1991
			WO	9014179 A1	29-11-1990
			US	5179854 A	19-01-1993