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(54) **METHOD OF PRODUCING CAN BODIES**

(57) This invention relates to an improved method of producing can bodies from a polymer coated metal substrate by the drawing and wall-ironing process.

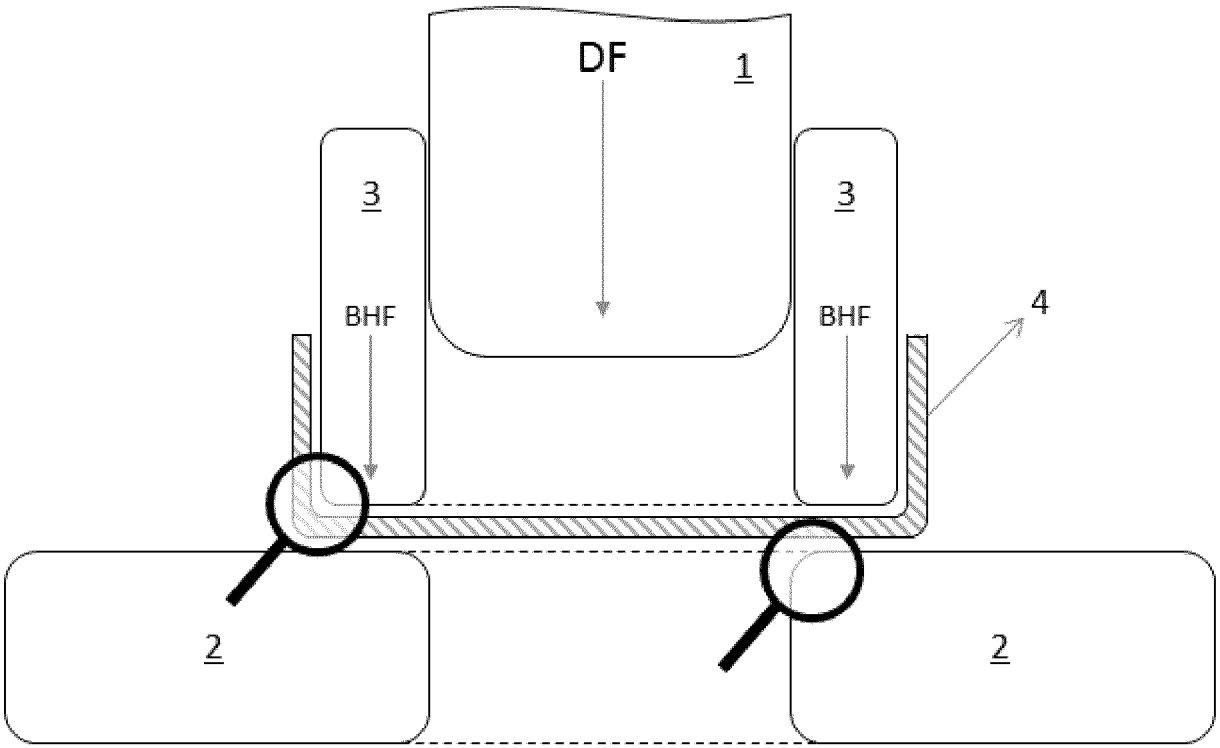

FIGURE 1

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Description

[0001] This invention relates to an improved method of producing can bodies from a polymer coated metal substrate by the drawing and wall-ironing (DWI) process.

[0002] The principle of draw- and wall ironing technology is well-known. The technology requires a circular blank for forming the (usually) cylindrical can body. The metal for the can bodies is usually supplied in coiled form. The coiled metal is uncoiled and blanks are stamped from the metal and produced into a so-called initial cup by a deep-drawing operation. This cup is deep drawn until no flanges are present. The cup is then redrawn in one or more redrawing steps to the final can diameter. In each redrawing step the maximum reduction of diameter is determined by the limiting drawing ratio, which is defined as the ratio of the maximum blank diameter that can be safely drawn into a cup without flange to the punch diameter. In any case the diameter of the initial cup is significantly larger than the diameter of the redrawn cup. In the final stage the thickness of the redrawn cup wall is reduced by wall-ironing the cup and produce a can body for a 2-piece can. This process involves pushing the redrawn cup through one or more ironing rings by means of a punch. The gap between the punch and the ironing ring determines the final thickness of the wall of the can body. For instance, a wall thickness of 0.30 mm in the redrawn cup may be reduced to 0.10 to 0.14 mm. Of course the height of the wall increases as a result.

[0003] After the DWI stage the edge of the can body has to be trimmed, because as a result of the inherent anisotropy of the metal the height of the can body is not the same everywhere on the circumference of the edge of the can body. This trimming also allows the final height of the can body to be tailored and prepared for the necking and flanging operation that is needed to receive the lid (the second piece of the two-piece can) after filling the can. Nowadays this lid is usually an easy open end, but it may also be a conventional lid which is to be opened by a can opener.

[0004] This type of can used to be made from tinplate. In order to be able to produce DWI cans from tinplate copious amounts of lubricants are needed, not only to 'cool away' the heat generated by the work-hardening of the material, but also to prevent tool surface wear and surface damage, and to provide a good can surface. Any swarf needs to be removed very thoroughly from the can body and therefore a very thorough washing is required. The copious amounts of lubricant and the need for a washing stage leads to the identification of the DWI-process as a 'wet DWI' process.

[0005] Recently alternative substrates have been developed for producing DWI can bodies: polymer coated metal sheet. This metal sheet, which may be aluminium sheet or steel sheet, can be produced as coiled metal and be provided with a polymer coating on one or both sides by film lamination or direct extrusion or the like.

[0006] This polymer coated metal sheet is suitable for producing can bodies by DWI and it is even possible to perform this with a minimum or even no lubricant. The polymer coating layer acts as lubricant. Also, because there is no exposed metal surface, there is also no risk of producing swarf, and therefore the need to wash the can bodies after the DWI-process is removed. Consequently this DWI process is referred to as a 'dry DWI' process.

[0007] There is an increased demand for DWI-cans with higher walls. A higher wall can be achieved with a larger reduction in the wall ironing step. However, a larger reduction during wall ironing of a polymer coated metal sheet also results in a higher risk of damage of the polymer layer.

[0008] It is therefore the object of the invention to improve the production of can bodies from polymer coated metal sheet by the dry-DWI by allowing higher can body walls without increasing the wall-ironing reduction.

[0009] The object of the invention is reached by the method according to claim 1. Preferred embodiments are provided in the dependent claims.

[0010] A schematic drawing of the set-up for redrawing an initial cup is provided in figure 1. The operative part of the redraw die as well as the operative part of the redraw sleeve are highlighted in figure 1 with the magnifying glass. These parts are depicted in more detail in figure 2a and 2b. The operative part is the part described by the radius R and delimited by the dashed lines. Preferably the angle over which the radius R angle is provided is 90°, i.e. the operative part is a quarter circle as seen in cross-section in figure 2a and 2b. For the sake of clarity it should be noted that the redraw die 2 as depicted in cross section in figure 1 is provided with a circular hole through which the initial cup 4 is pushed by a cylindrical punch 1 while being held to the flat area of the redraw die by the annular redraw sleeve 3. Figure 1 is schematic also in the sense that there is room between the cup, sleeve and redraw die, while in practice the redraw sleeve will push the initial cup onto the redraw die to prevent wrinkling

[0011] To provide a can body with sufficient height from a polymer coated metal sheet the inventors found that it is beneficial to decrease the radius R_{rs} of the operative part of the redraw die or the radius R_{rs} of the operative part of the redraw sleeve (OPRS).

[0012] The method of the invention with a decreased radius of the operative part of the redraw die R_{rd} or the radius of the operative part of the redraw sleeve R_{rs} allows to stretch-draw the polymer coated metal substrate. The reduction of the radius or radii is essential if the can body is required to have a certain height. Without the reduction of the radius or radii the polymer coated metal sheet would slip as a result of the reduced friction as compared with the same sheet with a metallic surface. To make it possible to stretch draw the polymer coated metal sheet a degree of tension must be built up in the metal sheet, and the building up of this tension is possible as a result of the reduced radius or radii.

[0013] The method according to the invention has the advantage that in comparison to conventional practice, the elongation of the can wall by redrawing of the polymer coated redrawn cup takes place to a larger extent in the cupping stage and redrawing stage and to a lesser extent in the ironing stage.

[0014] The effect of the reduction of only the radius of the operative part of the redraw die or only of the radius of the operative part of the redraw sleeve is already very effective. By the reduction of radius of the operative part of both the redraw die and the redraw sleeve the maximum effect is reached, leading to the highest possible redrawn cup, which will then lead to the drawn and ironed can body with the largest possible wall height thereby allowing a reduced ironing step.

[0015] The reduced radius or radii of OP and/or OPRS has to be combined with a higher force imposed though the redraw sleeve upon the flange of the initial cup during the redraw step (this force is referred to as blank holder force or BHF, because the initial cup can be considered as a blank for the redrawing step). The redraw sleeve is cylindrical to achieve tension in the material as soon as possible during the redrawing. In conventional redraw processes the redraw sleeve is not cylindrical but tapered (see figure 3a).

[0016] In an embodiment the process according to the invention is performed with only one wall-ironing ring in the wall-ironing step. This process benefits from a maximum shift of deformation to the cupping and redrawing stage. The stretching of the wall of the initial cup during the redrawing step(s) is maximised, so that the only one wall-ironing ring is sufficient to finish the can body with the desired wall height. With the conventional methods the wall of the redrawn cup is not stretched to the same extent, or not at all, so that more reduction needs to be generated by the wall-ironing step, and this step then requires at least two rings. The use of one wall-ironing ring in combination with an increased elongation of the wall during the redrawing step(s) simplifies the wall-ironing process considerably thereby making it also more robust and easier to control in terms of temperature and deformation. The heat generated during the wall-ironing is also reduced if the wall-ironing reduction is smaller. In a dry-process, without external coolant, temperature control is especially important.

[0017] When producing can bodies from the polymer coated metal sheet by deep-drawing there is a risk of formation of hairs at the edge of the can body, i.e. at the open end of the can body. As the polymer coating layer is softer than the metal substrate upon which the polymer coating layer is provided, the polymer coating layer deforms more easily than the metal substrate, and the polymer may be scraped off at the end. This manifests itself usually in the form or thread-like 'hairs'. If this happens then the DWI tooling may be polluted with hairs becoming dislodged from the edge, or the hairs may end up in the can body, and potentially in the cans contents when filled later. This is undesirable, and requires the can bodies to be rinsed, thus negating one of the advantages of the dry process. The higher the wall-ironing reduction, the higher the chances of this happening. Therefore the process according to the invention, with a significantly reduced wall-ironing reduction and a considerably higher elongation of the wall during the redrawing addresses this issue very effectively. The risk of hair formation is reduced because of the limitation of the amount of ironing.

[0018] The radius R_{rd} or R_{rs} is expressed in terms of the initial thickness of the polymer coated metal sheet, which is also the thickness of the circular blank used to produce the initial cup from. The radius is at most 3 times the thickness of the polymer coated metal sheet or blank, preferably one radius or both radii is at most 2.75 times the thickness of the polymer coated metal sheet or blank, and more preferably at most 2.5 times. Even more preferably the radius or both radii is at most 2.25 or 2.0 times the thickness of the polymer coated metal sheet or blank. In an embodiment both R_{rd} and R_{rs} have the same value.

[0019] In an embodiment a burnishing step is provided by pushing the can body after the ironing operation through a burnishing ring. This relieves the tension in the can body wall and allows the can body to be stripped off easily.

[0020] In an embodiment of the invention the blank holder force is reduced just before the edge of the initial cup enters the OP of the redraw die by reducing the BHF partly or completely, e.g. by lifting the redraw sleeve. Ideally this lifting of the redraw sleeve is performed while the edge of the initial cup is less than 5 mm away from the OP. This ensures that the edge of the polymer coated metal is not pinched and this prevents the formation of hairs. It is clear that this process is more controlled the lower the anisotropy of the metal. If the metal is very anisotrope, then the so-called ears may be too large to enable the timely lifting of the redraw sleeve because the edge of one part may have already entered the OP while the ears are still more than 5 mm removed from the OP.

[0021] The polymer coated steel substrates that can be processed by the process according to the invention are preferably based on polycondensates, such as polyesters, copolyesters (including PET, PBT, polyethylene furanoate (PEF), poly(lactic acid) (PLA)) or polyamides, polyolefins, elastomers, crystallisable polyaddition polymers, or any other polymer that can be formed in a film by extrusion. The polymer coating may consist of one or more layers. Preferably the polymer coating layer comprises or consists of polyethylene terephthalate, IPA-modified polyethylene terephthalate, CHDM-modified polyethylene terephthalate, polybutylene terephthalate, polyethylene naphthalate, polyethylene furanoate, poly (lactic acid) or copolymers or blends thereof.

[0022] The sheet metal preferably is tin coated steel sheet (tinplate), chromium-chromiumoxide coated steel sheet (ECCS), tinplate which was diffusion annealed to form an iron-tin alloy consisting of at least 80% of FeSn (50 at.% iron and 50 at.% tin) thereupon, or a chromium-

chromiumoxide coated steel sheet produced by electroplating from a trivalent chromium electrolyte

Example

[0023] A 65 mm diameter can body is produced from 0.25 mm steel sheet with a polyester coating of 25 μm on both sides, leading to a total thickness t of 0.30 mm. The steel is a common extra low carbon (ELC) steel (see table #). Blanks were produced therefrom and these were processed into initial cups. Using a redraw die with R_{rd} of 1.0 mm and of R_{rd} of 0.425 mm redraw cups were made in a single redraw step.

Table #: Composition of ELC-steel (in wt.%, bal. Fe and residual elements)

C	Mn	N	Alsol	P	S	B
23	146	1.9	18	12	8	1.7

[0024] Wall thickness at 10 mm from bottom of redrawn cup (values including coating):

R_{rd} = 1.0 mm = 0.284 mm
R_{rd} = 0.425 mm = 0.238 mm

[0025] Wall thickness at mid height of the wall of the redrawn cup (values including coating):

R_{rd} = 1.0 mm = 0.275 mm
R_{rd} = 0.425 mm = 0.230 mm

[0026] The redrawn cup wall thickness is presented in figure 4. The height increases towards the top because of the material flow during deep drawing and the compressive forces in the material in the circumference. This increased thickness is subsequently ironed 'out' in the subsequent ironing step. From figure 4 it can be seen that the height of the cup wall increases from 69 mm at R_{rd} 1 mm to 80 mm at R_{rd} of 0.425 mm, which is a 17% increase. This increase in wall height is the result of the stretch-draw operation.

[0027] In combination with one ironing ring an overall wall reduction of 50% was reached.

Claims

1. Method for manufacturing a can body by drawing and ironing a polymer coated metal sheet comprising the steps of producing an initial cup from a circular blank in a cupping step, redrawing said initial cup into a redrawn cup in one or more redraw steps, and wall ironing said redrawn cup into a can body to a wall height in a wall ironing step, wherein the wall-ironing is performed by using one or more drawing rings in the wall ironing step to produce the can body wherein the redraw step is performed by pushing the initial cup through a redraw die by means of a punch, and wherein a cylindrical redraw sleeve is positioned around the punch for pushing the bottom of the initial cup against the redraw die to provide the blank holder force to prevent wrinkling of the can body during the redraw step and wherein the radius R_{rd} of the operative part (OP) of the redraw die is at most 3 x t, wherein t is the thickness of the polymer coated metal sheet.

2. Method according to claim 1 wherein the radius R_{rs} of the operative part of the redraw sleeve (OPRS) is at most 3 x t.

3. Method according to claim 1 wherein the radius of the operative part (OP) of the redraw die R_{rd} is at most 2.75 x t.

4. Method according to claim 1 wherein the radius R_{rd} of the operative part (OP) of the redraw die is at most 2.5 x t.

5. Method according to claim 1 wherein the radius R_{rs} of the operative part of the redraw sleeve (OPRS) is at most 2.75 x t.

6. Method according to claim 1 wherein the radius R_{rs} of the operative part of the redraw sleeve (OPRS) is at most 2.5 x t.

7. Method according to any one of the preceding claims wherein only one drawing ring is used.

8. Method according to any one of the preceding claims wherein only one redraw step is performed to produce the redrawn cup.

9. Method according to any one of the preceding claims wherein a burnishing ring is used in addition to the one or more drawing rings to remove tension in the can body thereby facilitating the stripping of the can body from the punch.

10. Method according to any one of the preceding claims wherein the blank holder force is reduced just before the edge of the initial cup enters the OP of the redraw die.

11. Method according to claim 8 wherein the blank holder force is reduced while the edge of the initial cup being redrawn is less than 5 mm away from the OP.

12. Can body produced according to the method of any one of claim 1 to 11.

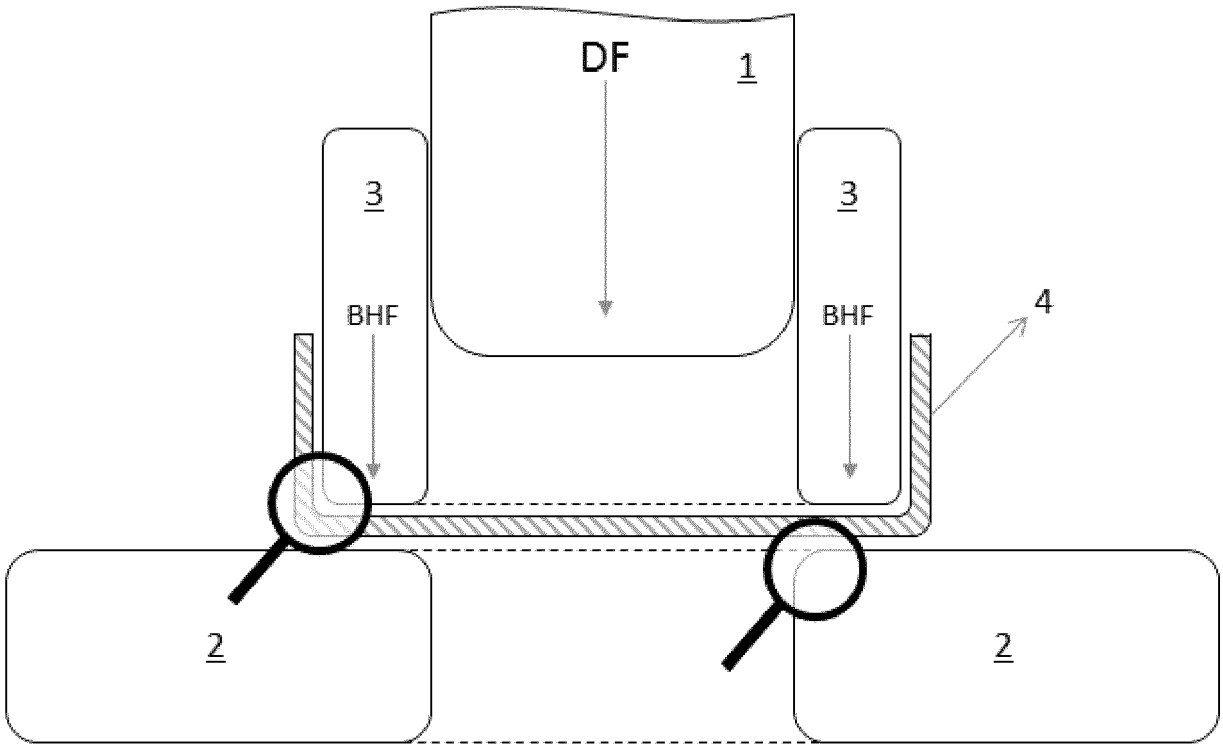

FIGURE 1

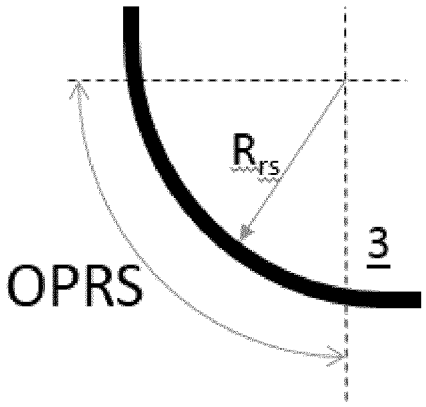

FIGURE 2A

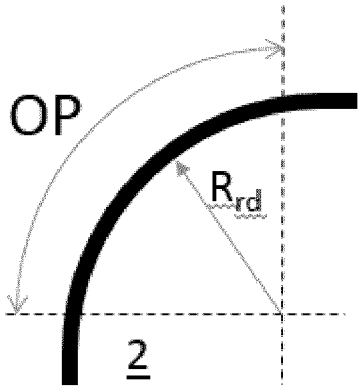

FIGURE 2B

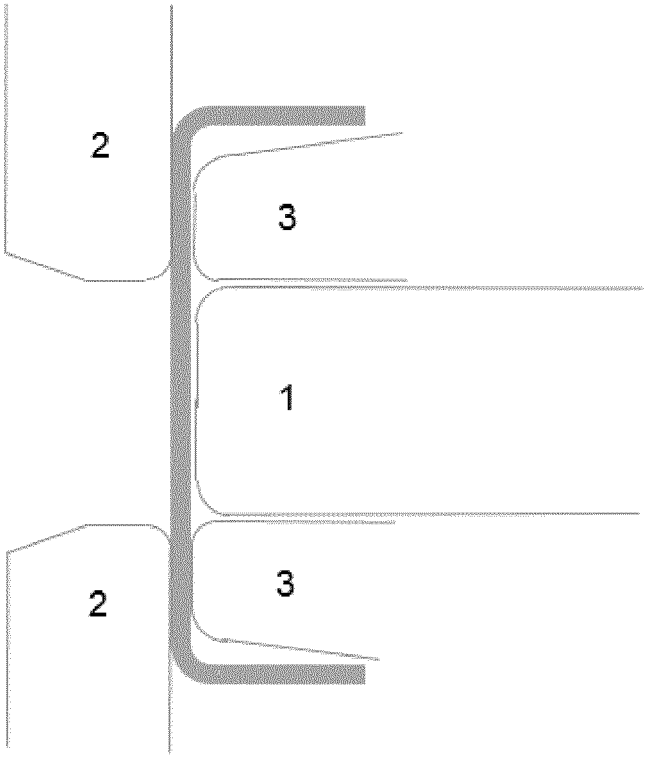

FIGURE 3A

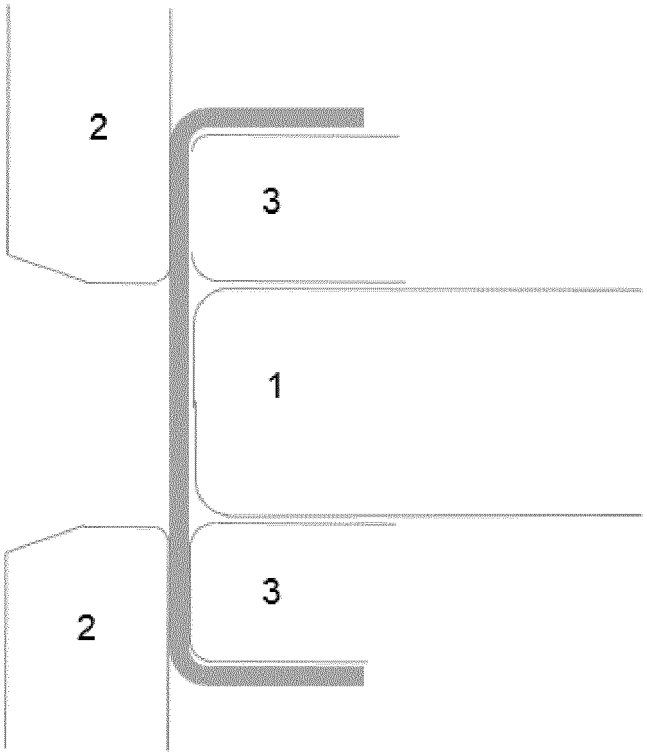

FIGURE 3B

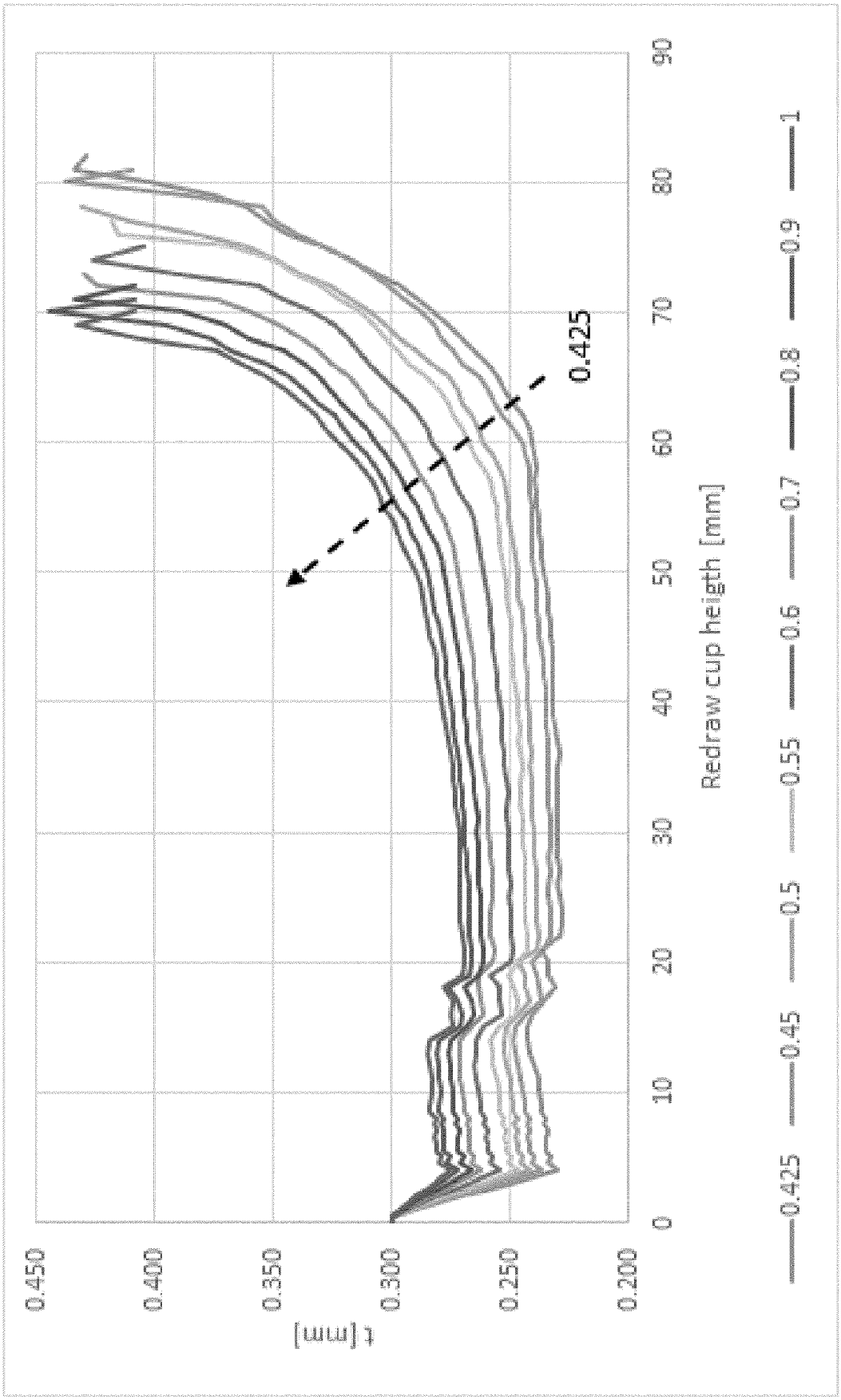
0.425
t [mm]
0.450
0.400
0.350
0.300
0.250
0.200
0
10
20
30
40
50
60
70
80
90
Redraw cup heigth [mm]
0.425
0.45
0.5
0.55
0.6
0.7
0.8
0.9
1

FIGURE 4

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EUROPEAN SEARCH REPORT

Application Number
EP 17 20 5574

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			B21D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	8 May 2018	Cano Palmero, A

CATEGORY OF CITED DOCUMENTS

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