(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 584 382 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
12.10.2005 Bulletin 2005/41

(51) Int Cl.[7]: **B21C 37/06**, B21D 26/02

(21) Application number: **05075830.9**

(22) Date of filing: **08.04.2005**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR LV MK YU

(30) Priority: **09.04.2004 EP 04076086**

(71) Applicant: **Corus Staal BV**
1970 CA Ijmuiden (NL)

(72) Inventors:
- **Kelder, Maarten Hendrik**
  1011 BT Amsterdam (NL)
- **Klaassen, Maria Gemma Othilde**
  1441 JB Purmerend (NL)

(74) Representative: **Kruit, Jan et al**
Corus Technology BV
PO Box 10000
1970 CA IJmuiden (NL)

(54) Method for manufacturing a metal tubular blank, a tubular blank, and a product produced from said tubular blank

(57) This invention relates to a method for manufacturing a metal tubular blank suitable for forming into a product comprising the steps of

- providing an essentially planar blank, said planar blank having a first surface and a second surface;
- producing the tubular blank from the planar blank whereby the second surface of the planar blank becomes the outside of the tubular blank;

wherein a first layer with a first friction influencing function is applied to at least part of the first side of the planar blank and/or a second layer with a second friction influencing function is applied to at least part of the second side of the planar blank prior to forming the planar blank into a tubular blank, so as to influence the friction between the tubular blank and forming tools which can be used to form the tubular blank into the product, and wherein the first and/or second layer are applied in the form of a foil, a dry lubricant, a wax or an oil. The invention further relates to a tubular blank and a product produced from such a tubular blank.

EP 1 584 382 A1

Description

[0001] The invention relates to a method for manufacturing a metal tubular blank suitable for forming into a product. The invention further relates to a tubular blank and a product produced from such a tubular blank.

[0002] In the industry, and in particular in the automotive sector, forming is an important tool in manufacturing complex shapes with as main materials steel and aluminium. Suppliers are urged to improve the formability of their materials and to integrate their processes because of, amongst others, costs and environmental aspects. A part of this objective can be achieved using a relative novel forming technology such as hydroforming. A tubular blank is usually produced from a planar blank, which is cut from a metal sheet. This planar blank is formed into a tube which is then laser welded to form the tubular blank. In a typical hydroforming operation a tube, or a tubular blank, is bent into the overall shape desired for the final part, and then placed between a pair of dies. The dies provide a cavity around the tube or tubular blank which has an interior shape matching the exterior shape desired for the part. Then, the ends of the tube or tubular blank are sealed and it is internally pressurised to expand it into the shape of the dies' cavity. By means of hydroforming different forming steps can be integrated and much more complex shapes can be formed which in turn saves costs and efforts compared with conventionally made products. In order to obtain complex shapes, means to influence the friction between the tube or tubular blank and the forming tools are often used. These means may for instance comprise in-line lubrication stations in the hydroforming line. Friction influencing means may also be applied manually. These types of friction influencing means are complicated and/or expensive.

[0003] It is an object of the invention to influence the friction during forming which is economically attractive. It is also an object of the invention to reproducibly influence the friction during forming.

[0004] According to a first aspect of the invention, one or more of the objects are reached by a method for manufacturing a metal tubular blank suitable for forming into a product comprising the steps of

- providing an essentially planar blank, said planar blank having a first surface and a second surface;
- producing the tubular blank from the planar blank whereby the second surface of the planar blank becomes the outside of the tubular blank;

wherein a first layer with a first friction influencing function is applied to at least part of the first side of the planar blank and/or a second layer with a second friction influencing function is applied to at least part of the second side of the planar blank prior to forming the planar blank into a tubular blank, so as to influence the friction between the tubular blank and forming tools which can be used to form the tubular blank into the product, and wherein the first and/or second layer are applied in the form of a foil, a dry lubricant, a wax or an oil.

[0005] By the method according to the invention, the tubular blank is already provided with a layer with a friction influencing function prior to entering the forming line. Consequently there is no need to apply means with a friction influencing function, such as a lubricant, in the forming line, making in-line stations or manual application of means with a friction influencing function obsolete. The method according to the invention also enables to apply the means with a friction influencing function in a controlled manner thereby making the application of the means more reproducible, and thereby also making the behaviour of the tubular blank during forming more reproducible. This increases the stability and reproducibility of the forming process and results in a more reproducible formed product. Application of the layers with the friction influencing function to the planar blank is relatively straightforward and easily controlled, leading to an improved efficiency and quality of the friction behaviour of the tubular blank during forming. By applying the first and/or second layer with a friction influencing function in the form of a foil, a dry lubricant, a wax or an oil, a very controlled and reproducible application is obtained.

[0006] In an embodiment of the invention the planar blank is produced from a coil and the first and/or second layer with a friction influencing function is applied to the coil prior to producing the planar blank. The first and/or second layer with a friction influencing function may have been applied to the coil immediately prior to forming of the planar blank, i.e. between decoiling and blanking, but it may also have been applied prior to coiling of the coil. The advantage of this embodiment is that the first and/or second layer with a friction influencing function is applied to a large surface, thereby facilitating quality control and reproducible application of the layer or layers. This embodiment also enables to produce planar blanks and hence tubular blanks at a lower cost.

[0007] In an embodiment of the invention the foil is a hydrocarbon such as polyethylene or a fluorocarbon such as polytetrafluorethylene. This type of layer with a friction influencing function functions as a lubricant. The foil enables easy application to the coil or the planar blank, for instance by known methods such as laminating or coextrusion of the foil, whereas it provides excellent adhesion to the planar blank prior to or during forming of the tubular blank and also during storage, handling and forming of the tubular blank.

[0008] In an embodiment of the invention the blank is essentially quadrangular, such as essentially rectangular or essentially tapered. This type of lubricated blank will result in an essentially cylindrical tubular blank or an essentially conical tubular blank. The latter facilitates forming sloping shapes in the formed product.

[0009] In a further embodiment of the invention the planar blank comprises at least a first blank portion and

a second blank portion and wherein the first blank portion has different geometrical dimensions than the second blank portion and/or wherein the first blank portion is made from a different material than the second blank portion and/or wherein the material of the first blank portion has different properties than the material of the second blank portion. After producing a tubular blank from this planar blank, this tubular blank enables combining portions having different characteristics in terms of response to the forming and/or the properties of the formed product. It will be clear that the invention also encompasses tubular blanks made from planar blanks having more than two blank portions, which blank portions may all have different characteristics. In principle, there is no limit to the number of blank portions in a planar blank for a tailored tubular blank. The planar blanks comprising a plurality of blank portions, i.e. at least two, can be produced by joining together a corresponding number of planar blank portions, each produced from metal sheet, by means of a joining technique such as welding for example laser-welding.

[0010] This embodiment enables to choose the geometry, for instance the thickness of the blank portion, or the type of material, or the properties of the material, independently of the geometry, the type of material, or the properties of the material of the second blank portion. As an example, the strength of the first blank portion may be chosen differently from that of the second blank portion because of local strength requirements in the final formed product. Also it may be desired to use material for the first blank portion having different resistance to corrosion than the material of the second blank portion because of local requirements for corrosion resistance in the final formed product. Again it will be clear that the invention also encompasses tubular blanks made from planar blanks having more than two blank portions, which blank portions may all have different characteristics.

[0011] In an embodiment of the invention, the aim of at least one of the layers with a friction influencing function is to decrease the friction between the tubular blank and the forming tools which can be used to form the tubular blank into a product. Decreasing the friction facilitates forming the tubular blank into a product. It may also reduce the forces required to form the tubular blank into a product during the forming process. In a preferred embodiment of the invention at least the function of the second layer with a friction influencing factor is to decrease the friction between the tubular blank and the forming tools which can be used to form the tubular blank into a product. The second layer, being on the outer surface of the tubular blank, is likely to benefit from a reduced friction in terms of reducing the process forces during forming, but also in terms of a reduced wear of the outer surface and the forming tools.

[0012] In an embodiment of the invention the tubular blank, manufactured as described hereinabove, is formed into a product at least partly by hydroforming. The tailored friction on the inside and/or the outside provides a hydroformed product with the required surface, dimensions and properties.

[0013] According to a second aspect of the invention, a tubular blank is provided which is obtained using the method in accordance with any one of the methods described hereinabove.

[0014] According to a third aspect of the invention, a product is provided obtained by hydroforming a tubular blank which tubular blank is obtained using any one of the methods described hereinabove.

[0015] Specific embodiments of the present invention will now be explained by the following non-limitative examples.

[0016] In the forming process of a bent tube, a tubular blank may be produced from a planar blank produced from a metal sheet such as a steel with a thickness of about 1.3 mm, which is provided with a first layer with a first friction influencing function on the first side of the planar blank and a second layer with a second friction influencing function is applied to the second side of the planar blank prior to forming the planar blank into a tubular blank. The friction influencing function is chosen so as to reduce the friction on the second surface (i.e. the outside of the tubular blank) and to increase the friction on the first surface (i.e. the inside of the tubular blank), so as to influence the friction between the tubular blank and forming tools which can be used to form the tubular blank into the product. When inserting a bending rod into the tubular blank, the increased friction on the inside of the tubular blank provides a firm grip of the bending rod to the tubular blank, whereas the reduced friction on the outside of the tubular blank provides a smooth surface. It should be noted that there are also instances where bending requires low friction on the inside of the tube. High friction levels on the outside may be beneficial for obtaining more grip during bending. It will be clear that the nature of the friction influencing layer may be chosen so as to obtain the required friction properties during processing of the tubular blank.

[0017] In the forming process of a hydroformed product, a tubular blank may be produced from a planar blank, which is provided with a layer with a friction influencing function on the second side of the planar blank prior to forming the planar blank into a tubular blank. The friction influencing function is chosen so as to reduce the friction on the second surface (i.e. the outside of the tubular blank) so as to influence the friction between the tubular blank and the hydroforming tools used to form the tubular blank into the hydroformed product. The reduced friction on the outside of the tubular blank provides a smooth surface whilst also limiting the process forces.

[0018] In the forming process of a hydroformed product, a tubular blank may be produced from a planar blank, wherein the planar blank has a plurality of blank portions. In a specific example, a planar blank may comprise three blank portions, such as a first blank portion

of 2 mm aluminium with a proof stress of 150 MPa, a second blank portion comprising a 1 mm high strength low alloy steel with a tensile strength of above 600 MPa and a third blank portion comprising an 1.5 mm austenitic stainless steel with excellent corrosion resistance. The tubular blank, and the final product which is made from it, is provided with a layer of friction influencing function which is applied to the second surface of the planar blank comprising a plurality of blank portions, and which function is chosen so as to reduce the friction. When forming the tubular blank into a product by hydroforming, the choice of the layer with the friction influencing function, enables perfect process control and yields a product with the required surface properties, dimensions and properties.

[0019] It will be clear to the skilled person that the number and characteristics of the blank portions is to be tailored to the needs of the final product and the forming process.

[0020] In the forming process of a hydroformed product, a tubular blank may be produced from a planar blank, which is provided on its second surface with a first layer with a first friction influencing function on part of the first side and with another layer with a another friction influencing function on at least part of the second surface wherein the two layers each with their respective friction influencing function may at least partly overlap. This way a combination of friction influencing functions may be obtained on the same surface, thereby further extending the possibilities for improvement of process control and quality of the hydroformed product as to the required surface properties, dimensions and properties.

[0021] It will be clear that similar or different combination of friction influencing functions may be obtained on the first surface as well. It is even possible to obtain similar or different combination of friction influencing functions on both surfaces of the tubular blank. This combination of friction influencing functions on the same surface may also be combined with tubular blanks made from planar blanks comprising a plurality, for instance two, or three or four, or even more, blank portions. It may be beneficial to choose a friction influencing function of a layer depending on the properties or material of the respective blank portion. It should be noted that it is also part of the invention to provide one or more layers with a friction influencing function on the first side or the second side of the planar blank only. This enables a reduction in the use of the layer with a friction influencing function such as a lubricant, thereby also reducing costs.

[0022] It should be noted that the layer or layers with the friction influencing function can be used to increase the friction in certain areas of the tubular blank, thus enabling a controlled material flow, which could be beneficial to reduce or increase strain levels in certain areas of the product.

[0023] It is of course to be understood that the present invention is not limited to the described embodiments and examples described above, but encompasses any and all embodiments within the scope of the description and the following claims.

Claims

1. Method for manufacturing a metal tubular blank suitable for forming into a product comprising the steps of

   - providing an essentially planar blank, said planar blank having a first surface and a second surface;
   - producing the tubular blank from the planar blank whereby the second surface of the planar blank becomes the outside of the tubular blank;

   wherein a first layer with a first friction influencing function is applied to at least part of the first side of the planar blank and/or a second layer with a second friction influencing function is applied to at least part of the second side of the planar blank prior to forming the planar blank into a tubular blank, so as to influence the friction between the tubular blank and forming tools which can be used to form the tubular blank into the product, and wherein the first and/or second layer are applied in the form of a foil, a dry lubricant, a wax or an oil.

2. Method according to claim 1, wherein the blank is produced from a coil and wherein the first and/or second layer is applied to the coil prior to producing the blank.

3. Method according to claim 1 or 2, wherein the foil is a hydrocarbon such as polyethylene or a fluorocarbon such as polytetrafluorethylene.

4. Method according to any of the claims 1 to 3., wherein the planar blank is essentially quadrangular such as essentially rectangular or essentially tapered.

5. Method according to any of the claims 1 to 4, wherein the planar blank comprises at least a first blank portion and a second blank portion and wherein the first blank portion has different geometrical dimensions than the second blank portion and/or wherein the first blank portion is made from a different material than the second blank portion and/or wherein the material of the first blank portion has different properties than the material of the second blank portion.

6. Method according to any of the claims 1 to 5, wherein at least one of the layers with a friction influencing function decreases the friction between the tubular

blank and the forming tools which can be used to form the tubular blank into a product.

7. Method according to claim 6, wherein at least the second layer with a friction influencing factor decreases the friction between the tubular blank and the forming tools which can be used to form the tubular blank into a product.

8. Tubular blank obtained using the method in accordance with any one of claims 1 to 7.

9. Product obtained by hydroforming a tubular blank according to claim 8.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 07 5830

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	DATABASE WPI Derwent Publications Ltd., London, GB; AN 1975-28492W XP002288732 -& SU 431 934 A (KRASAVIN V N) 15 June 1974 (1974-06-15) * abstract * -----	1,2,4, 6-8	B21C37/06 B21D26/02
A	PATENT ABSTRACTS OF JAPAN vol. 1995, no. 10, 30 November 1995 (1995-11-30) -& JP 07 178460 A (NIPPON STEEL CORP), 18 July 1995 (1995-07-18) * abstract * -----	1	
A	DE 560 341 C (YOUNGSTOWN SHEET AND TUBE CO) 1 October 1932 (1932-10-01) * page 1, line 1 - line 10 * * page 5, line 99 - page 6, line 1 * -----	1,4,6-8	
A	US 2001/016625 A1 (LAHIJANI JACOB) 23 August 2001 (2001-08-23) * page 1, paragraph 4 * -----	3	TECHNICAL FIELDS SEARCHED (Int.Cl.7) B21C B21D B23K F16C
A	DE 102 10 156 A (BAYERISCHE MOTOREN WERKE AG) 25 September 2003 (2003-09-25) * the whole document * -----	5	
A	PATENT ABSTRACTS OF JAPAN vol. 2002, no. 06, 4 June 2002 (2002-06-04) & JP 2002 035854 A (NIPPON STEEL CORP), 5 February 2002 (2002-02-05) * abstract * -----	9	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 June 2005	Ritter, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 07 5830

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

03-06-2005

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
SU 431934 A	15-06-1974	SU 431934 A1	15-06-1974
JP 07178460 A	18-07-1995	NONE	
DE 560341 C	01-10-1932	NONE	
US 2001016625 A1	23-08-2001	US 6265492 B1 TW 568919 B	24-07-2001 01-01-2004
DE 10210156 A	25-09-2003	DE 10210156 A1	25-09-2003
JP 2002035854 A	05-02-2002	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82