Method for producing a container tube (15), in particular a supporting means for a motor vehicle strut, with longitudinal sections of tube (I-IV) of different wall thicknesses and/or inner and/or outer diameters, following one after the other in the longitudinal direction, starting from a hollow and/or tubular blank (1), by means of repeated drawing and wall ironing by means of at least one drawing and wall ironing female die (6, 13, 16), applied to the outside of the blank, towards a male die (9, 19, 22), for example a punch or mandrel, in contact with the inside of the blank, wherein, for at least some of the longitudinal sections (I-IV), a change of the male die is carried out before they are drawn and wall ironed.
METHOD FOR PRODUCING DIFFERENT WALL THICKNESSES OF A CONTAINER TUBE

BACKGROUND OF THE INVENTION

[0001] The invention relates to a method for producing a container tube. The container tube, which is used as container, bracing and/or support means for a motor vehicle strut in the longitudinal direction, for example, comprises consecutive longitudinal sections of tube with different wall thicknesses and/or inner and/or outside diameters. The above-mentioned method starts out from a hollow or tubular blank, which is stretched by means of reperted drawing and wall ironing with the aid of at least one drawing and wall ironing female die applied to the outside of the blank towards a male die, for example a punch or a mandrel, in contact with the inside of the blank. During the drawing and wall ironing, the wall thickness and/or the inner and/or the outside diameter at least of a part of the longitudinal sections maybe reduced by a specified dimension at a time.

[0002] Proshafts produced according to the method of the previously mentioned type, are known (DE 10 2007 045 719 A1). According to that, the inner and/or outside diameter of the proshaft wall thickness are changed. In this known and so-called cold forming process, following the push on of the blank onto a mandrel, a female die is slid over the blank and the punch located therein. The mandrel used for this purpose comprises two different diameters as well as a transitional region, the design of which is conical. Up to the transitional region, the drawing and wall ironing takes place on the thinner diameter of the mandrel. Subsequently, starting from the transition region, the drawing and wall ironing is done across the thicker region of the mandrel by means of a diameter of opening in the larger female die. This results in increased strength for the deformed regions compared to the blank. Furthermore, because of the reduction of the wall thicknesses and the diameters of the blank, this will result in an extension in the axial direction. To obtain different wall thicknesses, different female dies are used during the aforementioned cold forming process that is already known. Using this method, there is however no possibility to adjust the desired inner and/or outside diameters independently from one another, as a result of which also no increase in wall thickness/wall thickness thickening can be obtained, if the outside diameter remains constant.

[0003] The materials normally used, such as steel with the quality factor E355-N (European Standard EN 10305-2 of November 2002 or EN 10305-3 of May 2010), are relatively costly for this known deformation process. For this reason, low material consumption is desirable. Moreover, a weight reduction is desirable in the automotive industry and thus component optimization.

[0004] A further printed specification (EP 1 190 784 A2) also addresses a process for producing a tube with wall thicknesses that are partially different. The fabrication of the different wall thicknesses also supports weight savings, wherein the wall thicknesses are sized appropriately for the loads to be encountered.

[0005] With this process disclosed in the printed specification (EP 1 190 784 A2), an output pipe is pushed onto a mandrel, which has a reduced axially centric diameter. A draw ring with an internal diameter smaller than the outside diameter of the tube is then drawn across the full-length of the tube. This will result in a reduction of wall thickness in the radially expanded regions of the mandrel as well as a wall thickness thickening in the radially reduced region of the mandrel. The mandrel is subsequently extracted from the tube. Therefore, a tube form is created that has thickened tube regions that are radially expanded to the outside. By slipping on the draw ring again, this in turn will finally result again in a smooth cylindric outer surface for the tube, i.e. the regions of the tube with greater wall thickness are pushed radially inward again. This involves disadvantages, since the thicker wall regions that are radially pushed inward must initially be pushed out or be deformed, in order to subsequently be pushed radially inward again. Furthermore, pursuant to this method, no different outside diameters of the tube can be produced.

[0006] Moreover, in the industry it is frequently necessary that components must be attached onto a tube by means of welding, for example. By attaching a component, the tube is weakened at these places. These so-called force and/or weld node regions must therefore be provided with a thicker wall in order to withstand the requirements or to satisfy their requirements.

[0007] The objective of the invention therefore is to indicate a method, with which the desired wall thicknesses as well as the inner and/or outside diameters can be produced more flexibly with respect to the required strength, for example a more moderate strength in the force and weld node regions by means of a thicker wall, without reworking and without additional processing steps. Moreover, as a result of the produced, partially different wall thicknesses of the container tube, a weight reduction or optimization that is desired by the industry will be achieved.

SUMMARY OF THE INVENTION

[0008] In order to solve the problem, reference is made to the method cited in claim 1. Favorable optional embodiments of the invention result from the dependent claims as well as from the subsequent description and the drawings.

[0009] According to that, during the production of a container tube, a change of the male die is performed on at least a part of the longitudinal sections to be reduced prior to its drawing and wall ironing. This means that a previously used male die is replaced with a male die that is designed differently and/or specifically adapted. The axi-symmetric male die to be used, for example, has got at least one cross-sectional variation in the longitudinal profile. According to that the male die has a smaller and/or thinner as well as a larger and/or thicker cross-section/outside diameter. These two cross-sections or outside diameters are connected to one another by means of at least one male die shoulder. The male die shoulder can be realized in different embodiments. On the one hand, a transition region and therefore a conical embodiment can be developed here, and on the other this shoulder can be obtained simply by a perpendicular increase in the diameter of the male die towards the axial direction.

[0010] The front face of the smaller diameter of the male die will always be introduced first into the blank. This means, that the first introduced and/or smaller diameter or cross-section of the male die is located in the region of the driver edge. The largest diameter or cross-section of the male die, on the other hand, is always positioned farthest relative towards the driver edge. The male dies to be used comprise at least two different diameters or cross-sections in the radial direction. It therefore is also possible that male die shoulders can be available. In this process it is important, however, that the
diameters or the cross-sections of the male die are arranged according to size, so that only ascending male die shoulders are present in the axial direction. The male die therefore has a form that continuously tapers in the axial direction and does not expand again.

[0011] In an exemplary production variant according to the invention, a first longitudinal section with reduced wall thickness is formed in a first drawing and wall ironing operation. If a driver edge is molded on one end of the blank, on which a reduction in wall thickness is generated, this is considered as pro-reduction. It is not mandatory that a driver edge is molded. The blank can also be designed cup-shaped, i.e. the blank has only one frontal aperture and is closed on the other side/on the other end. It is mandatory, however, in order to make use of the method as taught by the invention, to mold a stop for the male die in some form inside the tube, or have it already. The actual drawing and wall ironing operation starts only, if a drawing and wall ironing female die with a smaller diameter of opening or with a smaller inner diameter compared to the outside diameter of the blank is pulled/pushed over the blank that comprises an inserted male die, up to a certain axial length.

[0012] It is useful, if the respective wall thickness of the tube is sized using the one or the multiple male dies and the respectively assigned and/or opposite interior dimensions of the one or multiple drawing and wall ironing female dies. The diameter or the cross-section of the male die is thus selected such that the difference between the outside diameter of the male die and the inner diameter of the drawing and wall ironing female die correspond to the wall thicknesses. The drawing and wall ironing female die is fitted onto the container tube section by section up to a certain axial length and is then retracted again, in each case.

[0013] According to an exemplary embodiment of the invention, one or multiple strip off means are provided on a frontal aperture of the container tube serving the insertion of the male die or the change of the male dies. Stripping jaws or similar can be used as strip off means, for example. This will facilitate changing of the male dies by at least one stripping means attached to the opposite end of the driver edge. In this instance, the stripping jaws for example engage radially behind the blank or the container tube, so that they have a smaller diameter of opening than the outside diameter of the blank and/or container tube, but will not be in contact with the inserted male die. Subsequently, the male die, situated in the container tube and/or blank, is retracted, so that the stripping jaws, cited as an example, and which were engaged in the radial direction abut against the front face of the container tube and/or blank and fixing it while the male die is further retracted and is thus removed from the container tube or the blank.

[0014] According to a further exemplary embodiment of the invention, the number of male die changes depends on the number of the desired changes in wall thickness. An infinitive number of changes in the wall thicknesses of the container tube can be obtained with each male die. It is however possible that only successive increases in the inner diameter can be accomplished. As soon as a reduction in the inner diameter is desired, a male die change must take place. With the female die, on the other hand, a change must always be performed when a modification in the outside diameter of the container tube is desired.

[0015] The wall thickness of the container tube or the blank can also be increased or thickened without changing the male die, in that a female die with a greater diameter of opening/inner diameter is pushed on. The male die change is independent of a female die change. This means, the wall thickness can already change by means of a male die with different cross-sections and/or diameters when using a female die. When using additional female dies and/or male dies, the number of the possible changes in wall thicknesses is infinite.

[0016] Furthermore, by means of this method, each tube longitudinal section must be processed once only. After the drawing and wall ironing female die has been pulled across a respective axial length of the blank, this wall ironed region does not have to be processed again. This means, that the wall ironed region of a drawing and wall ironing female die that was wall ironed only once represents a finished section of the container tube.

[0017] A further possibility consists in that the container tube be realized using a lightweight structural material. Aluminum is an example of lightweight structural material. By using such material, the container tube produced by means of the method as taught by the invention will again be optimized in weight as well as also in its strength. For the fabrication of an aluminum container tube, an extruded pre-pipe or a hollow and/or tubular blank is used, for example. Because of the lower mechanical strength properties of aluminum alloys compared to steel, for example, the wall thicknesses and/or the differences between outside and inner diameters of the container tube are developed stronger when using a lightweight structural material.

[0018] An advantageous development of the invention is the is production of an angular profile and/or tube, such as a square tube, with likewise differently varying wall thicknesses. This can be obtained, if square dimensions and/or cross-sections are used instead of the previously mentioned diameters. The male die for example can be designed as a square solid profile, instead of a round profile. In addition to the differently designed male die, the drawing and wall ironing female die must also have a design that matches the male die. This means that the male die as well as the associated drawing and wall ironing female die can be round and/or square as well as axissymmetric or asymmetric.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0019] Further particulars, features, combination of features and effects based upon the invention result from the following description of preferred exemplary embodiments of the invention as well as from the drawings. The drawings show as follows:

[0020] FIG. 1 is a hollow and/or tubular blank for the manufacturing process as taught by the invention, as a cross-section;

[0021] FIG. 2 molding a driver edge onto the hollow and/or tubular blank from FIG. 1, as a cross-section;

[0022] FIG. 3 is a stretching operation of a first longitudinal section of tube with outside diameter increase of the blank, as a cross-section;

[0023] FIG. 4 is a stretching operation of a second longitudinal section of tube with prior female die change, as a cross-section;

[0024] FIG. 5 is a stretching operation of a third longitudinal section of tube with prior male die change, as a cross-section;
FIG. 6 is a stretching operation of a fourth longitudinal section of tube with prior male die change, as a cross-section;

FIG. 7 is an embodiment as taught by the invention of a container tube with a machined end, as a cross-section;

DETAILED DESCRIPTION OF THE INVENTION

The Fig. 1 to Fig. 7 show an exemplary embodiment of the special and inventive drawing and wall ironing method for producing a container tube optimized in terms of weight and strength.

Fig. 1 illustrates a hollow and/or tubular blank 1, from which a container tube is produced by means of the method as taught by the invention. The hollow and/or tubular blank 1 comprises a certain or predefined outside diameter 2 as well as an inner diameter 3. The two ends of the hollow and/or tubular blank 1 are referred to as frontal apertures 4.

Pursuant to Fig. 2, a plunger 5 is inserted on one end or on a frontal aperture 4 of the hollow and/or tubular blank 1 into the inside of the tube up to the stop of the plunger 5. The part of the plunger 5 that is inside the tube has a same-sized or smaller outside diameter, compared to the inner diameter 3 of the blank 3. Subsequently, a drawing and wall ironing female die 6 is inserted on the opposite frontal aperture 4 of the inserted plunger 5 and is pushed onto the blank 1 for a certain or desired axial length. As a result, a pre-reduction of the blank 1 is obtained and also a driver edge 7 is molded. The plunger 5 is subsequently extracted or retracted. The hollow and/or tubular blank 1 is pushed out of the drawing and wall ironing female die 8 by means of an ejector 8 that is fitted on the molded driver edge 7. Another possibility consists in fitting the ejector 8 in front of the driver edge 7 and pulling down the drawing and wall ironing female die 8.

In Fig. 3, a male die 9, such as a plunger or a mandrel, is inserted on the frontal aperture 4 of the hollow and/or tubular blank 1, until the front face of the male die 9 abuts against the driver edge 7. The male die 9 is provided with a raised part that partially extends in the axial direction, a so-called male die shoulder 10. The outside dimension 11 of the male die 9 towards the driver edge 7 is smaller than the outside dimension 12 furthest away from the driver edge 7, and is connected with a certain pre-defined or predetermined male die shoulder 10. Pursuant to Fig. 3, a first tube longitudinal section 1 is formed in the axial direction from the driver edge 7 with another or further drawing and wall ironing female die 13, which has another predetermined inner diameter 14. The thereby resulting drawn and wall ironed region already represents a section of the container tube 15 that is finished or to be produced.

Pursuant to Fig. 4, a second tube longitudinal section 2 is produced. For this purpose, a further drawing and wall ironing female die 16 is used, which has a larger inner diameter 14 than the previously used female die. As a result of utilizing a drawing and wall ironing female die 16 which has a larger inside diameter 14, a raised shoulder and/or an increased outside diameter 17 of the container tube 15 is created. The drawing and wall ironing female die 16 is pushed in a direction away from the driver edge 7 over the blank 1 and the male die 9 with two different outside dimensions 11, 12 as well as a male die shoulder 10 located inside said blank 1, up to the end of the second tube longitudinal section 2. The male die shoulder 10 is located inside of the second tube longitudinal section 2, so that a desired reduction in wall thickness results in this section. The different wall thicknesses of the container tube 15 result from the inner diameters 14 of the drawing and wall ironing female dies and the thereto opposite and/or allocated axially extending outside diameter/outer dimension 10, 11, 12 of the male die 9. On the opposite side of the molded driver edge 7, therefore on the frontal aperture 4 of the blank 1, two stripping means 18, such as stripping jaws, are located, which are utilized during a male die change, in order to strip off the container tube 15 and/or the blank 1 from the male die 9. Pursuant to Fig. 4, a male die change takes place after the produced stretched tube longitudinal section II, as a result of which a subsequent increased wall thickness is obtained.

In Fig. 5, a further tube longitudinal section III is produced by means of the drawing and wall ironing female die 16 that was previously used. For this purpose, a further male die 19, which in the axial direction comprises multiple different outside dimensions 11, 12 and thus also a male die shoulder 10, which, compared to the previously utilized male die 9, is axially shifted in the direction of the frontal aperture 4, and is inserted into the blank up to the driver edge 7. The male die shoulder 10 is therefore located in the third tube longitudinal section III. The smaller region or the outside dimension 11 of the male die 19 corresponds to the smallest internal dimension and/or the smallest inner diameter of the container tube 15. Because of the smaller outside dimension 11 in the front third partially subdivided tube longitudinal section III, this results in a reduction of the inner diameter 20 of the container tube 15. The male die shoulder 10 corresponds to the desired inner diameter increase 21 of the container tube 15. The drawing and wall ironing female die 16 that was already previously used is pushed on further by a predefined region or up to the desired end of the third tube longitudinal section III in direction of the frontal aperture of the blank 1. After the desired length of the reduced wall thickness has been reached, a male die change occurs again aided by the stripping means 18.

In Fig. 6, the last drawing and wall ironing operation of the special manufacturing process is performed. For this purpose, another male die 22, that in turn has multiple outside dimensions 11, 12 and therefore a male die shoulder 10 displaced in the axial direction, is inserted into the inside of the tube. Subsequently, the drawing and wall ironing female die 16 is pushed pulled over the blank 1 up to the end. The drawing and wall ironing process and the associated reduction in wall thickness results in stretching the container tube 15.

An exemplary, finished container tube is illustrated according to Fig. 7. The two ends 23 of the container tube 15 are machined at the conclusion of every drawing and wall ironing process. An increase in the outside diameter 17 of the container tube 15 was accomplished in the first tube longitudinal section I by means of a drawing and wall ironing female die change. The drawing and wall ironing female die 16 with a certain or predetermined inner diameter or a predetermined internal dimension 14 is pushed over the tube longitudinal section II, III, IV. The same drawing and wall ironing female die 16 is used, until a change in the outside dimension or outside diameter 17, 24 of the container tube 15 is to occur.

The male die 9 is used from the front of the tube longitudinal section I up to the end of the tube longitudinal section II. The male die 9 used comprises a male die shoulder 10, as a result of which an increase in the inner diameter 21 of the container tube 15 occurs. Subsequently, a male die change takes place, as a result of which an increase in the wall
thickness and thus a reduction in the inner diameter 20 of the container tube 15 in the next tube longitudinal section III is accomplished. The male die 19 used for the production of the tube longitudinal section III also comprises a male die shoulder 10, as a result of which an increase in the inner diameter 21 of the container tube 15 is accomplished again. Pursuant to FIG. 7, a male die change occurs again after the tube longitudinal section III. Because of that, the male die shoulder 10 of the newly used male die 22 results in increasing the inner diameter 21 of the container tube 15. This produced wall thickness will be retained up to the end of the container tube 15.

Because of the described deforming process, the radially thicker wall thickness region undergoes a degree of deformation of 5% to 20%, for example, and the thinner wall thickness region undergoes a degree of deformation from 40% to 60%, for example. The higher the degree of deformation, the greater the strain hardening. As a result, a lower breakdown in strength and therefore a desirable low strain hardening is accomplished for the thicker wall thickness regions. On the other hand, a high strain hardening is accomplished in the thinner wall thickness region because of the degree of deformation. This is a desirable result, because it saves weight.

LIST OF REFERENCE SYMBOLS

1 Hollow and/or tubular blank
2 Outside diameter of the blank
3 Inner diameter of the blank
4 Frontal aperture
5 Plunger
5' Stop of the plunger
6 drawing and wall ironing female die 1
7 Driver edge
8 Ejector
9 Male die 1
10 Male die shoulder
11 Male die outside dimension 1
12 Male die outside dimension 2
13 Drawing and wall ironing female die 2
14 Internal dimension/inner diameter of the drawing and wall ironing female die
15 Container tube
16 drawing and wall ironing female die 3
17 Outside diameter increase of the container tube
18 Strip off means
19 Male die 2
20 Inner diameter reduction of the container tube
21 Inner diameter increase of the container tube
22 Male die 3
23 Machined ends

1. A method for producing a container tube (15) with consecutive longitudinal sections of tube (kV) in the longitudinal direction of different wall thicknesses or inner and/or outer diameters, for use as a container, bracing or a support for a motor vehicle strut, starting from a hollow or tubular blank (1), which by means of repeated drawing and wall ironing by means of at least one drawing and wall ironing female die (6, 13, 16) applied to the outside of the blank towards a male die (9, 19, 22) in contact with the inside of the blank, said tube is stretched for at least a part of the longitudinal sections (1-IV) and its wall thickness or its inner or outer diameter is reduced by a specified dimension each time the tube is stretched, wherein for at least some of the longitudinal sections (kV) to be reduced, a change of the male die is carried out before the tube is drawn and wall ironed.

2. The method according to claim 1, in which in a first drawing and wall ironing operation a first longitudinal section with reduced wall thickness is formed.

3. The method according to claim 2, wherein the respective wall thickness of the tube is sized by using the one or multiple outside dimensions (11, 12) of one or multiple male dies (9, 19, 22) and respectively assigned or opposite interior dimensions (14) of one or multiple drawing and wall ironing female dies (6, 13, 16).

4. The method according to claim 3, wherein one or multiple strip off means (18) are provided on a frontal aperture (4) of the container tube (15) aiding the insertion of the male die (9, 19, 22) or a change of the male dies.

5. The method according to claim 4, wherein the number of male die changes depends on the number of desired changes in wall thickness.

6. The method according to claim 5, wherein the container tube (15) is realized with a lightweight structural material.

7. A method for producing a container tube (15) with consecutive longitudinal sections of tube (kV) in the longitudinal direction having different wall thicknesses or inner or outer diameters, the method comprising:

starting from a hollow or tubular blank (1), repeatedly drawing and wall ironing the blank by means of at least one drawing and wall ironing female die (6, 13, 16) applied to the outside of the blank towards a male die (9, 19, 22) in contact with the inside of the blank, the blank being stretched for at least a part of the longitudinal sections (kV) and its wall thickness or its inner or outer diameter being reduced by a specified dimension each time the blank is stretched, wherein for at least some of the longitudinal sections (kV) to be reduced in wall thickness or diameter, a change of the male die is carried out before at least one of the repeated drawings and wall ironings of the blank.

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