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(54) **APPARATUS AND METHOD FOR MANUFACTURING A LARGE-CALIBER PRODUCT USING HYDROFORMING**

(57) The present invention relates to an apparatus and method for manufacturing using a hydroforming process. The apparatus includes: upper and lower molds; first and second axial punches which are disposed on opposite sides of the steel substance so as to be movable towards each other and which have front surfaces configured so as to be insertable into each other; first and second pressurization cylinders which move the first and second axial punches towards each other and insert them into each other, thus forming a sealing space defined by the first and second axial punches and a pressurization space defined by the steel substance and the first and second axial punches; and a control unit which, through an oil-pressure passage formed in at least one of the first and second axial punches, supplies fluid into the pressurization space to pressurize the steel substance, thus forming the large caliber product.

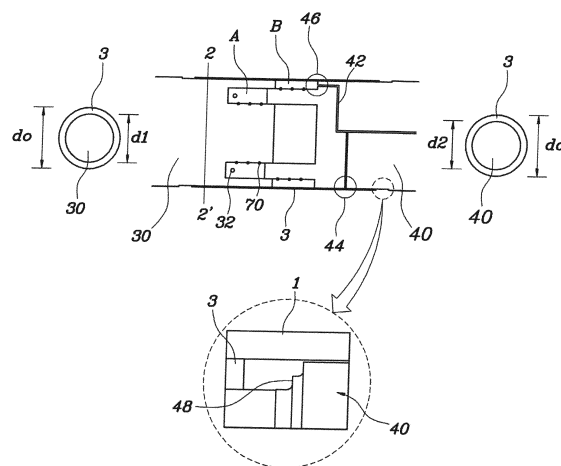


Fig. 3

Description

Technical Field

[0001] The present invention relates, in general, to an apparatus and method for manufacturing a large-caliber product using a hydroforming process and, more particularly, to an apparatus and method for manufacturing a large-caliber product which can minimize a sealing force that acts in an axial direction of the large-caliber product when the product is manufactured.

Background Art

[0002] Generally, large-caliber products such as wheel rims for vehicles are produced mainly by roll forming processes. In such a roll forming process, a tube is shaped by several stepwise roll forming operations such that a flange is expanded to reach an area at which a wheel rim makes contact with a tire. Thereafter, the expanded tube is shaped by an additional two or three roll forming operations using rolls which are disposed inside and outside the tube. Subsequently, a size compensation operation using an expander is carried out, thus completely forming a wheel rim for vehicles.

[0003] However, in the case where the roll forming process is used to manufacture a wheel rim for vehicles, because a tubular steel substance is processed by several stepwise roll forming operations, the productivity is comparatively low. In addition, a heat treatment process such as an annealing process must accompany the roll forming process, since severe local work hardening is induced during the roll forming process which is carried out at room temperature.

[0004] In an effort to overcome the above-mentioned problems of the apparatus using the roll forming process, methods for manufacturing large-caliber products such as wheel rims for vehicles using hydroforming processes are being studied.

[0005] A typical hydroforming process which is used to manufacture a torsion beam for vehicles includes: an operation of bending a tubular steel substance in response to the shape of a final product; an operation of forming the bending-processed steel substance through press work into a shape in which it can be seated into a hydroforming mold; and a hydroforming operation of supplying fluid onto an inner surface of the steel substance and pressurizing the inner surface thereof to expand the diameter of the steel substance, thus completing a final product.

[0006] In the case of a large-caliber product that is comparatively short and has a simple shape, such as a wheel rim, it can be formed only by the simple hydroforming process. Therefore, compared to the manufacturing process using the roll forming process which requires several steps to be carried out, the apparatus using the hydroforming process can markedly enhance the productivity. Furthermore, fluid applies hydrostatic pressure

to the entirety of the inner surface of the steel substance, thus making it possible to uniformly shape the steel substance without causing local work hardening. Therefore, a separate heat treatment process is not required.

[0007] As such, the method for manufacturing a large-caliber product using the hydroforming process can provide several advantages, compared to the method using the roll forming process. However, there is a problem that must be solved in order to manufacture a large-caliber product using the hydroforming manufacturing apparatus. The problem is that because sealing force that acts in the axial direction of a steel substance when the large-caliber product is formed is very large, it is not easy to manufacture an axial pressurization cylinder or mold which can withstand the large sealing force.

Disclosure

Technical Problem

[0008] Accordingly, the present invention has been made keeping in mind the above problems occurring in the prior art, and an object of the present invention is to provide an apparatus and method for manufacturing a large-caliber product using a hydroforming process which is configured such that axial punches which are disposed at opposite sides of the apparatus so as to be movable towards each other can be coupled to each other, whereby sealing force that acts in the axial direction when the large-caliber product is manufactured can be minimized.

Technical Solution

[0009] In order to accomplish the above object, in an aspect, the present invention provides an apparatus for manufacturing a large-caliber product using a hydroforming process, including: upper and lower molds into which a tubular steel substance having a large caliber is seated; a first axial punch and a second axial punch disposed on opposite sides of the steel substance so as to be movable towards each other, the first and second axial punches having front surfaces configured so as to be insertable into each other; a first pressurization cylinder and a second pressurization cylinder respectively moving the first axial punch and the second axial punch towards each other and inserting the first and second axial punches into each other, thus forming a sealing space defined by the first and second axial punches and a pressurization space defined by an inner surface of the steel substance and the first and second axial punches; and a hydroforming control unit supplying fluid into the pressurization space through an oil-pressure passage formed in at least one of the first and second axial punches so as to pressurize the inner surface of the steel substance, thus forming the large caliber product.

[0010] In another aspect, the present invention provides a method for manufacturing a large-caliber product

using a hydroforming process, including: a hydroforming preparation operation of seating a steel substance having a large caliber onto a lower mold and moving an upper mold downwards, thus closing an entirety of the upper and lower molds; an axial punch setting operation of moving a first axial punch and a second axial punch towards each other from opposite sides of the steel substance and inserting the first and second axial punches into each other, thus forming a sealing space defined by the first and second axial punches, and a pressurization space defined by an inner surface of the steel substance and the first and second axial punches; and a hydroforming operation of supplying fluid into the pressurization space through at least one of the first and second axial punches and pressurizing the inner surface of the steel substance, thus forming the large-caliber product.

Advantageous Effects

[0011] In an apparatus and method for manufacturing a large-caliber product using a hydroforming process according to the present invention, it is possible to produce a final product using only a single process. Thanks to a reduced number of processes, the production cost can be reduced, and the productivity of the apparatus can be markedly enhanced.

[0012] Furthermore, the hydroforming manufacturing apparatus is advantageous in that a steel substance can be uniformly shaped by hydrostatic pressure of fluid without local work hardening being caused. Therefore, a separate heat treatment process is not required.

[0013] Moreover, the hydroforming manufacturing apparatus makes it possible to precisely shape the steel substance. Thus, the products produced by the present invention are superior in terms of shape uniformity and roundness (the center of gravity).

Description of Drawings

[0014]

Fig. 1 is a view showing a conventional apparatus for manufacturing a large-caliber product using a hydroforming process;

Fig. 2 is a view illustrating an apparatus for manufacturing a large-caliber product using a hydroforming process, according to the present invention;

Fig. 3 is an enlarged view showing an axial punch of the apparatus of Fig. 2;

Fig. 4 is a view illustrating a hydroforming manufacturing method, according to the present invention; and

Fig. 5 is a view showing an example of a large-caliber product manufactured by the method according to the present invention.

[0015] ※ Description of the Reference Numerals in

the Drawings ※

1: upper mold 2: lower mold

3: steel substance 30: first axial punch

40: second axial punch 50: first pressurization cylinder

60: second pressurization cylinder 70: sealing member

80: vehicle wheel rim

Best Mode

[0016] As described above, if a large-caliber product such as a wheel rim for vehicles is manufactured by the conventional hydroforming manufacturing apparatus, sealing force acting in the axial direction markedly increases, thus making it difficult to operate the apparatus normally. The reason for this will be explained with reference to Fig. 1.

[0017] A hydroforming manufacturing apparatus includes upper and lower molds 1 and 2 into which a steel substance 3 is seated, first and second axial punches 10 and 20 which are moved from opposite sides of the upper and lower molds 1 and 2 into the upper and lower molds 1 and 2 to seal the steel substance 3, and first and second pressurization cylinders 15 and 25 which respectively move the first and second axial punches 10 and 20 in the horizontal direction. The operation method of the hydroforming manufacturing apparatus will be described below.

[0018] First, the steel substance 3 is placed onto the lower mold 2. The upper mold 1 is moved downwards to close the entirety of the molds. Thereafter, the first and second pressurization cylinders 15 and 25 respectively move the first and second axial punches 10 and 20 towards each other from the opposite sides of the upper and lower molds 1 and 2, thus sealing opposite sides of the steel substance 3. As shown in sectional view 1-1' of Fig. 1, a diameter ϕ of each of the first and second axial punches 10 and 20 is the same as a diameter ϕ of the steel substance 3 so that the opposite sides of the steel substance 3 can be sealed.

[0019] After the steel substance 3 has been sealed, fluid is supplied into the steel substance 3 through an oil-pressure passage 22 which is formed in at least one of the first and second axial punches 10 and 20, thus pressurizing an inner surface of the steel substance 3. Hydrostatic pressure of the fluid that is applied to the steel substance 3 expands the diameter of the steel substance 3. As a result, the steel substance 3 is brought into close contact with the upper and lower molds 1 and 2 and thus shaped into a shape of a wheel rim for vehicles. Here, when the steel substance 3 is being shaped by hydrostatic pressure of fluid, high pressure is also applied to the first and second axial punches 10 and 20. Sufficient sealing force to withstand the high pressure must be applied to the first and second axial punches 10 and 20 so

that hydrostatic pressure of the fluid can be continuously applied to the inner surface of the steel substance 3.

[0020] The sealing force applied to the first and second axial punches 10 and 20 is increased in proportion to a cross-sectional area of a portion to which fluid is applied. In more detail, the sealing force is increased in proportion to the square of the diameter of the steel substance 3. The reason for this is due to the fact that if the diameter of the steel substance 3 is d_0 , fluid is applied to the entirety of the cross-sectional area (πd_0^2) of the first or second axial punch which has the same diameter as that of the steel substance 3. Therefore, when a large-caliber product such as a wheel rim for vehicles is manufactured, sealing force applied to the first and second axial punches 10 and 20 is exponentially increased as the diameter of the product is increased.

[0021] However, because the maximum pressure of the first and second pressurization cylinders 15 and 25 of the hydroforming manufacturing apparatus that has been commercialized is comparatively low, the apparatus must be remodeled to have high-pressure cylinders which are required to manufacture a large-caliber product. For this, a massive remodeling process is required, and this process is expensive. In the worst case, a layout of the apparatus would be changed in such a way that the molds are not installed, making it impossible to produce a large-caliber product.

[0022] To solve the above-mentioned problems, the inventor of the present invention introduces a method in which the sealing force can be effectively reduced by changing the shaft of the axial punches rather than remodeling the cylinders. Hereinafter, an apparatus and method for manufacturing a large-caliber product using a hydroforming process according to the present invention will be described in detail with reference to the attached drawings.

[0023] As shown in Figs. 2 and 3, a hydroforming manufacturing apparatus according to the present invention includes: upper and lower molds 1 and 2 into which a steel substance 3 having a large caliber is seated; a first axial punch 30 and a second axial punch 40 which are disposed on opposite sides of the steel substance 3 so as to be movable towards the steel substance 3 and respectively have front surfaces that are configured so as to be insertable into each other; a first pressurization cylinder 50 and a second pressurization cylinder 60 which respectively move the first axial punch 30 and the second axial punch 40 and inserts the first and second axial punches 30 and 40 into each other to form a sealing space A defined by both axial punches and a pressurization space B defined by an inner surface of the steel substance and both axial punches; and a hydroforming control unit (not shown) which supplies fluid into the pressurization space through an oil-pressure passage 42 formed in at least one of the first and second axial punches 30 and 40 so as to pressurize the inner surface of the steel substance 3, thereby forming a large caliber product.

[0024] Comparing Figs. 1 and 2 to each other, the construction of the hydroforming manufacturing apparatus according to the present invention is the same as that of the conventional hydroforming manufacturing apparatus in terms of the fact that the apparatus includes the upper and lower molds 1 and 2 into which the steel substance 3 is seated, the first and second axial punches 30 and 40 which are moved from the opposite sides of the upper and lower molds 1 and 2 towards the steel substance 3 so as to seal the steel substance, and the first and second pressurization cylinders 50 and 60 which horizontally move the first and second axial punches 30 and 40.

[0025] However, unlike in the conventional technique, the hydroforming manufacturing apparatus according to the present invention is configured such that the first axial punch 30 and the second axial punch 40 can be moved towards each other and inserted into the steel substance 3. In other words, as shown in sectional view 2-2' of Fig. 3, a diameter d_1 of the first axial punch 30 is smaller than the diameter d_0 of the steel substance 3. A diameter d_2 of the second axial punch 40 is also smaller than the diameter d_0 of the steel substance 3. In more detail, the diameter of each of the first axial punch 30 and the second axial punch 40 is formed such that a distance between the axial punch and the steel substance is minimized without making contact therebetween.

[0026] Furthermore, the hydroforming manufacturing apparatus according to the present invention is configured such that the first axial punch 30 and the second axial punch 40 are inserted into each other in the steel substance 3. For this, a protrusion and a depression are formed in the front surface of each axial punch such that the axial punches can correspond to each other. When the first axial punch 30 and the second axial punch 40 are moved towards each other by the first pressurization cylinder 50 and the second pressurization cylinder 60 and are coupled to each other, the sealing space A is defined by both axial punches, and the pressurization space B is defined by the inner surface of the steel substance and both axial punches are formed. As such, the protrusion and the depression of each axial punch can be formed in any shapes, so long as the sealing space A and the pressurization space B can be formed when the axial punches are coupled to each other.

[0027] After the sealing space A and the pressurization space B have been formed by coupling the first and second axial punches 30 and 40 to each other, fluid is supplied, under the control of the hydroforming control unit, into the pressurization space B through the oil-pressure passage 42 which is formed in at least one of the first and second axial punches 30 and 40, thereby pressurizing the inner surface of the steel substance 3. At this time, the fluid does not enter the sealing space A. Therefore, hydrostatic pressure applied by the fluid is limited to the pressurization space B. As a result, a cross-sectional area of a portion to which the hydrostatic pressure is applied is markedly reduced. The sealing force applied to the first axial punch 30 and the second axial punch 40

can also be markedly reduced.

[0028] As such, the axial punches are coupled to each other, whereby space into which fluid is drawn is limited. Thereby, the cross-sectional area of a portion of each axial punch that makes with fluid can be reduced. As a result, the sealing force corresponding to the hydrostatic pressure of fluid can be reduced. The present invention is based on this technical idea. The inventor of the present invention introduces the following additional elements to embody the above-stated technical idea.

[0029] Separate sealing members 70 are provided on portions of the first and second axial punches 30 and 40 which form the sealing space A. As stated above, the technical idea of the present invention is that the sealing space A into which no fluid flows is formed by coupling the first and second axial punches 30 and 40 to each other. Therefore, if fluid enters the sealing space A during the hydroforming process, the effect of reducing the sealing force cannot be obtained. To prevent this, the sealing members 70 are preferably provided on the portions that form the sealing space A.

[0030] Given the fact that each axial punch has a cylindrical shape, each sealing member 70 is preferably an O-ring. Furthermore, any member can be used as the sealing member 70, so long as it can provide a sealing effect that can prevent fluid from entering the sealing space A.

[0031] Preferably, an air hole 32 is formed in at least one of the first and second axial punches 30 and 40 so that air can be discharged to the outside from the sealing space A through the air hole 32. Because the first axial punch 30 and the second axial punch 40 are continuously moved towards each other during the hydroforming process, if the air hole 32 is not formed, air that has been in the sealing space A is compressed, thus acting as reaction force which impedes movement of the first and second axial punches 30 and 40. Since fluid does not enter the sealing space A, the air hole 32 may be configured such that it communicates with the outside of the axial punch.

[0032] As shown in the lower portion of Fig. 3, the oil-pressure passage 42 may be formed such that fluid is supplied through a junction 44 between a body of the second axial punch 40 and the inner surface of the steel substance 3. As stated above, the body of the axial punch and the inner surface of the steel substance are spaced apart from each other by the minimum distance without making contact therebetween. Therefore, when fluid is supplied through the junction between the body of the second axial punch and the inner surface of the steel substance 3, the fluid can be drawn into the pressurization space B through the space between the second axial punch and the steel substance. To increase the rate at which fluid is supplied into the pressurization space B, as shown in the upper portion of Fig. 3, the oil-pressure passage 42 may be configured such that it communicates with the pressurization space B at a portion 46 that directly meets the pressurization space B.

[0033] As shown in Fig. 3, when fluid is supplied through the oil-pressure passage 42 into the junction between the body of the second axial punch 40 and the inner surface of the steel substance 3, some of the fluid flows forwards and enters the pressurization space B, but the rest may flow backwards and leak out of the second axial punch 40. To prevent the leakage, as shown in the enlarged view of Fig. 3, a stepped portion 48 is preferably provided on the second axial punch 40 to seal the corresponding side end of the steel substance 3.

[0034] Hereinafter, the method for manufacturing the large-caliber product using the hydroforming process according to the present invention will be described in detail with reference to Fig. 4.

[0035] First, the steel substance 3 having a large-caliber is seated onto the lower mold 2, and the upper mold 1 is moved downwards to close the entirety of the molds. Thereafter, the first and second axial punches 30 and 40 which have the front surfaces that can be coupled to each other are respectively disposed on the opposite sides of the steel substance 3 [(a) of Fig. 4].

[0036] Subsequently, the first axial punch 30 and the second axial punch 40 are moved towards the steel substance 3 from the opposite sides of the steel substance 3 and then inserted into each other. Thereby, the sealing space A which is defined only by the first and second axial punches 30 and 40, and the pressurization space B which is defined by the inner surface of the steel substance 3 and the first and second axial punches 30 and 40 are formed [(b) of Fig. 4].

[0037] Because the air hole 32 is formed in at least one of the first and second axial punches 30 and 40, when the first and second axial punches 30 and 40 move forwards, air can be discharged out of the sealing space A through the air hole 32. The reason for this is due to the fact that, if air is compressed in the sealing space A, the compressed air may impede the operation of the first and second axial punches 30 and 40.

[0038] Thereafter, fluid is supplied into the pressurization space B through at least one of the first and second axial punches 30 and 40, thus pressurizing the inner surface of the steel substance 3 [(c) of Fig. 4]. Fig. 4 shows an embodiment in which fluid is supplied into the junction between the body of the second axial punch 40 and the inner surface of the steel substance 3 through the oil-pressure passage 42 and then drawn into the pressurization space B that is defined in front of the junction.

[0039] In this case, because some of the fluid may flow backwards and leak out of the second axial punch 40, the stepped portions 48 are respectively provided on the first and second axial punches 30 and 40 so that the opposite side ends of the steel substance 3 can be reliably sealed.

[0040] Meanwhile, the fact that the oil-pressure passage 42 may be configured such that it directly communicates with the pressurization space B has been illustrated with reference to Fig. 3.

[0041] After the diameter of the steel substance 3 has

started to be expanded by hydrostatic pressure of fluid, the first axial punch 30 and the second axial punch 40 gradually move forwards to enable the fluid to compensate for expanded space and continuously pressurize the inner surface of the steel substance 3 [(d) of Fig. 4]. As a result, a large-caliber product formed by the hydroforming method is ultimately produced.

[0042] Fig. 5 shows the result of analysis on the formation of a wheel rim 80 for vehicles produced by the manufacturing method according to the present invention. As described above, thanks to the characteristics that hydrostatic pressure of fluid is uniformly applied to the entirety of a steel substance, the present invention makes it possible to more precisely form the steel substance compared to that of the typical roll forming process. Therefore, the products produced by the present invention are superior in terms of shape uniformity and roundness (the center of gravity).

[0043] Although the preferred embodiment of the present invention has been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

Claims

1. An apparatus for manufacturing a large-caliber product using a hydroforming process, comprising:

upper and lower molds into which a tubular steel substance having a large caliber is seated;
 a first axial punch and a second axial punch disposed on opposite sides of the steel substance so as to be movable towards each other, the first and second axial punches having front surfaces configured so as to be insertable into each other;
 a first pressurization cylinder and a second pressurization cylinder respectively moving the first axial punch and the second axial punch towards each other and inserting the first and second axial punches into each other, thus forming a sealing space defined by the first and second axial punches and a pressurization space defined by an inner surface of the steel substance and the first and second axial punches; and
 a hydroforming control unit supplying fluid into the pressurization space through an oil-pressure passage formed in at least one of the first and second axial punches so as to pressurize the inner surface of the steel substance, thus forming the large caliber product.

2. The apparatus for manufacturing a large-caliber product using a hydroforming process according to claim 1, wherein sealing members are respectively provided on portions of the first and second axial

punches that form the sealing space.

3. The apparatus for manufacturing a large-caliber product using a hydroforming process according to claim 1, wherein an air hole is formed in at least one of the first and second axial punches so that air can be discharged out of the sealing space through the air hole.
4. The apparatus for manufacturing a large-caliber product using a hydroforming process according to claim 1, wherein the oil-pressure passage directly communicates with the pressurization space.
5. The apparatus for manufacturing a large-caliber product using a hydroforming process according to claim 1, wherein stepped portions are respectively provided on the first and second axial punches to seal opposite side ends of the steel substance.
6. A method for manufacturing a large-caliber product using a hydroforming process, comprising:

a hydroforming preparation operation of seating a steel substance having a large caliber onto a lower mold and moving an upper mold downwards, thus closing an entirety of the upper and lower molds;

an axial punch setting operation of moving a first axial punch and a second axial punch towards each other from opposite sides of the steel substance and inserting the first and second axial punches into each other, thus forming a sealing space defined by the first and second axial punches, and a pressurization space defined by an inner surface of the steel substance and the first and second axial punches; and
 a hydroforming operation of supplying fluid into the pressurization space through at least one of the first and second axial punches and pressurizing the inner surface of the steel substance, thus forming the large-caliber product.

7. The method for manufacturing a large-caliber product using a hydroforming process according to claim 6, wherein the axial punch setting operation comprises discharging air out of the sealing space by moving the first and second axial punches towards each other.
8. The method for manufacturing a large-caliber product using a hydroforming process according to claim 6, wherein the hydroforming operation comprises sealing opposite side ends of the steel substance using the first axial punch and the second axial punch.

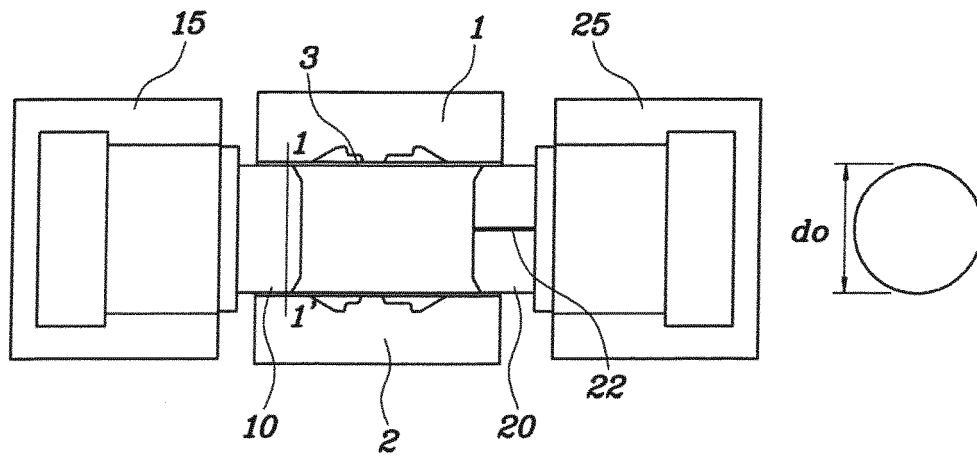


Fig. 1

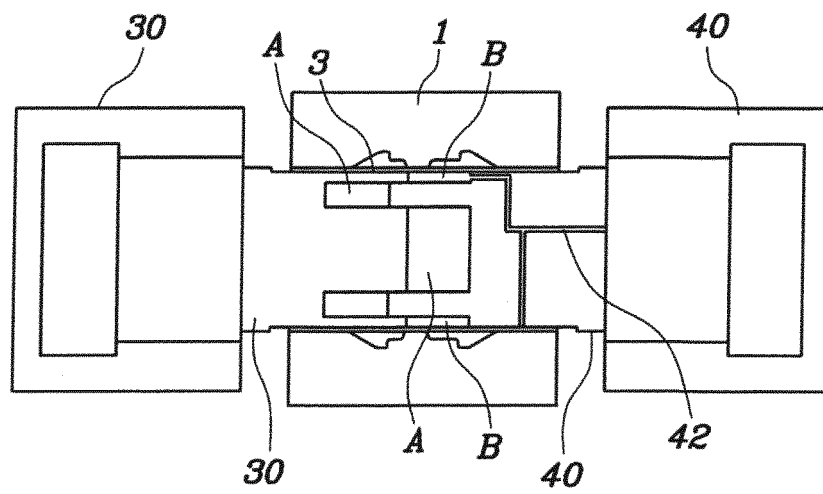


Fig. 2

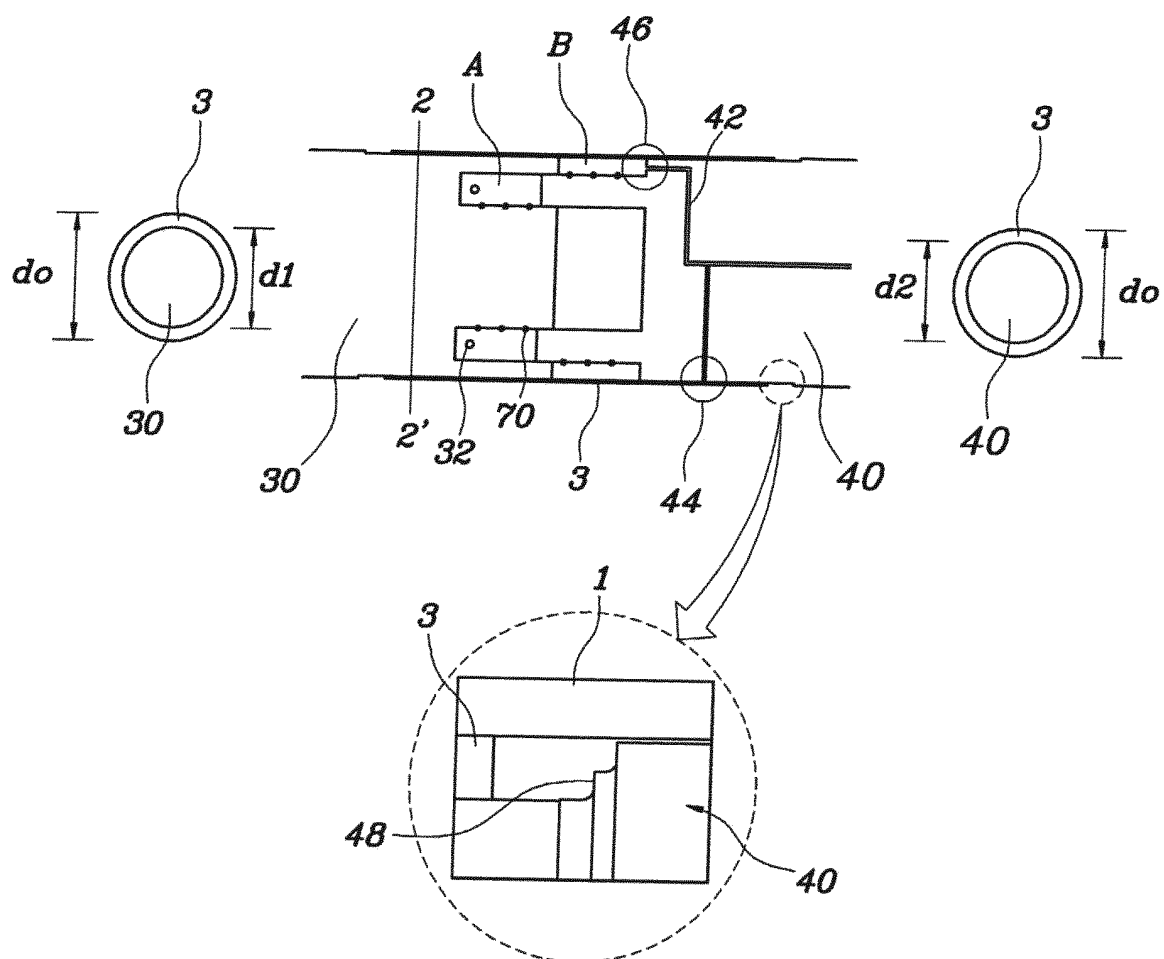


Fig. 3

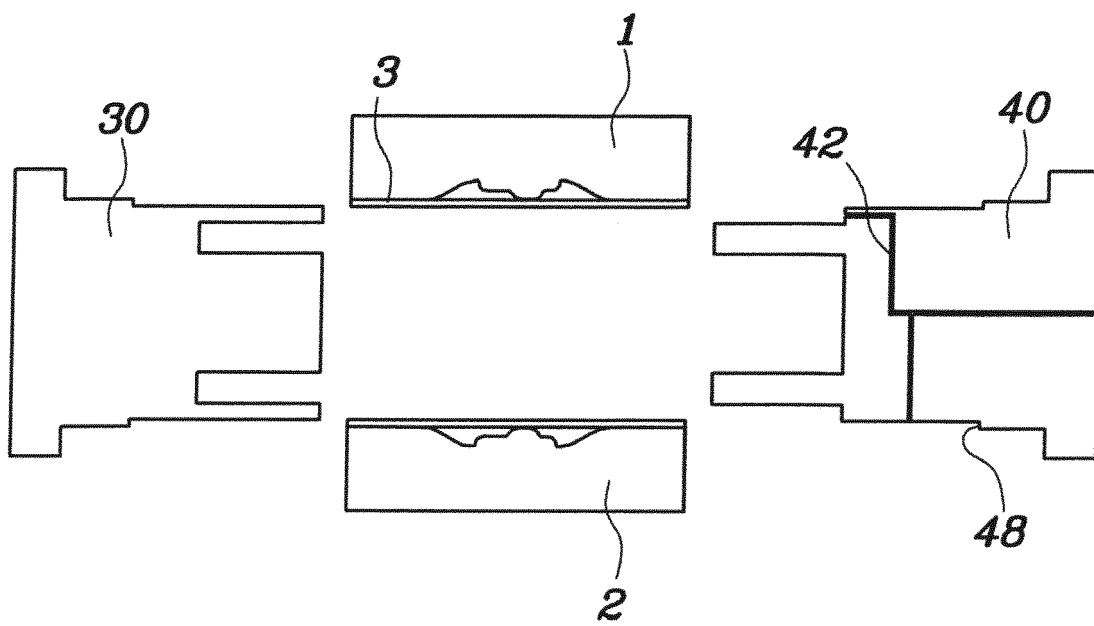


Fig. 4A

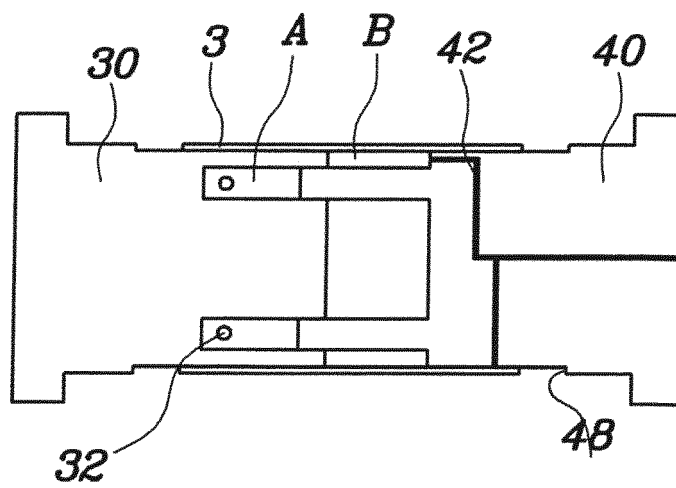


Fig. 4B

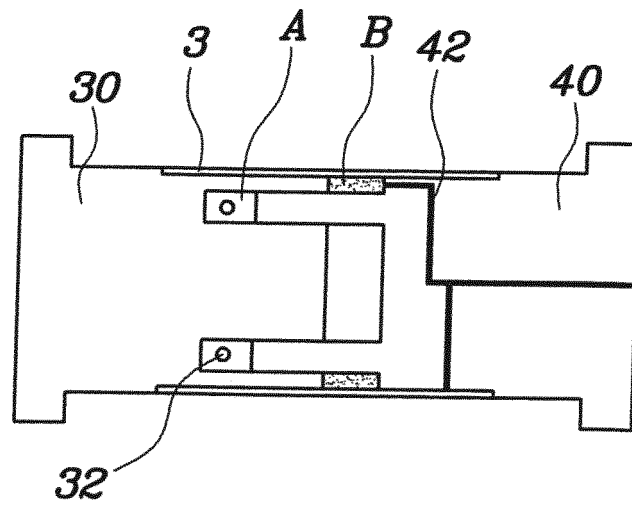


Fig. 4C

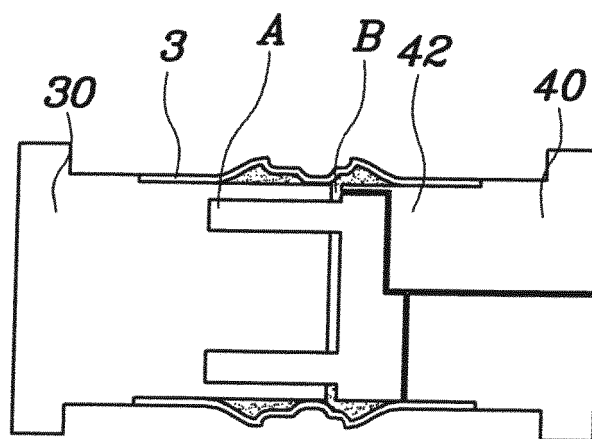


Fig. 4D

WHEEL_SINGLE

Time = 0.04

Contours of % Thickness Reduction- based on current z-strain

min=-64.0746, at elem# 56675

max=14.8174, at elem# 15341

Fringe Levels

1.482e+01

6.928e+00

-9.610e-01

-8.850e+00

-1.674e+01

-2.463e+01

-3.252e+01

-4.041e+01

-4.830e+01

-5.619e+01

-6.407e+01

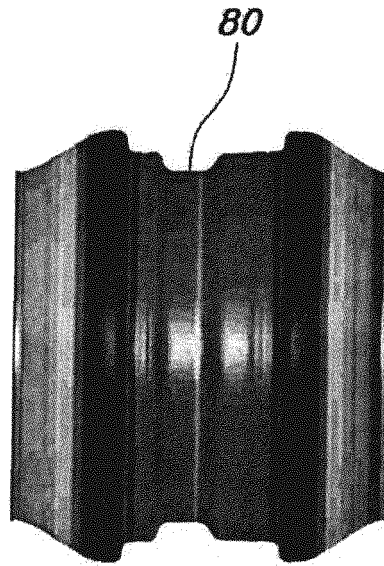


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2011/000486**A. CLASSIFICATION OF SUBJECT MATTER****B21D 26/033(2011.01)i, B21D 26/041(2011.01)i, B21D 26/045(2011.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B21D 26/033; B29C 43/10; B21D 26/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility models and applications for Utility models: IPC as above

Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & Keywords: hydroforming, large diameter, up and down unit mold, first excel punch, second excel punch, first pressing cylinder, second pressing cylinder, hydroforming control unit

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2005-262307 A (AISIN TAKAOKA LTD) 29 September 2005 See claim 3 and figures 1-3.	1-8
A	KR 10-0815724 B1 (POSCO) 20 March 2008 See claims 1, 4 and figures 2-4.	1-8
A	KR 10-2003-0034912 A (HYUNDAI MOTOR COMPANY) 09 May 2003 See claim 1 and figures 2-3.	1-8
A	JP 57-088919 X2 (HITACHI LTD) 03 June 1982 See all claims and figure 2.	1-8

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

17 AUGUST 2011 (17.08.2011)

Date of mailing of the international search report

18 AUGUST 2011 (18.08.2011)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/KR2011/000486

Patent document cited in search report	Publication date	Patent family member	Publication date
JP 2005-262307 A	29.09.2005	JP 2005-262307 A	29.09.2005
KR 10-0815724 B1	20.03.2008	NONE	
KR 10-2003-0034912 A	09.05.2003	NONE	
JP 57-088919 X2	03.06.1982	JP 1547074 C JP 57-088919 A	28.02.1990 03.06.1982

Form PCT/ISA/210 (patent family annex) (July 2009)