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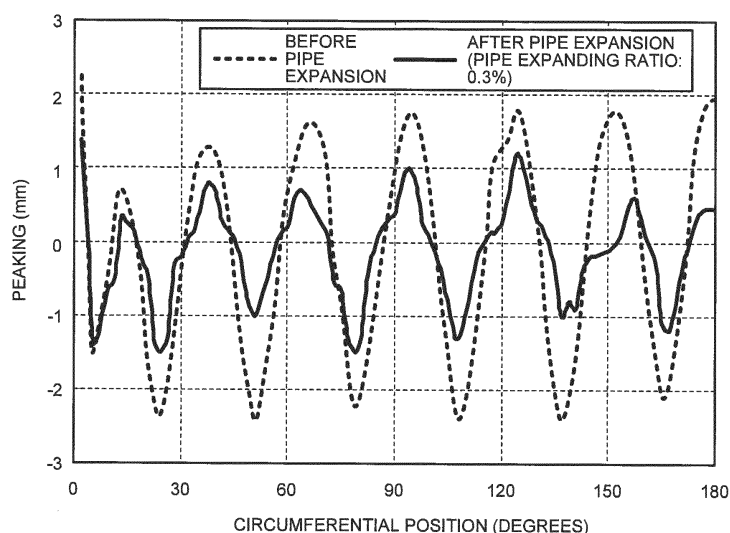
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(54) **METHOD FOR PRODUCING STEEL PIPE**

(57) A method for manufacturing a steel pipe includes a first pipe expanding step of expanding a steel pipe within a range of a pipe expanding ratio having a lower limit at a pipe expanding ratio at which a predetermined roundness is obtained and an upper limit at a maximum value of a pipe expanding ratio at which an equipment load of a pipe expanding machine falls in an allow-

able range when the steel pipe is expanded, and a second pipe expanding step of expanding the steel pipe after the first pipe expanding step at a pipe expanding ratio at which the pipe diameter of the steel pipe reaches a target value. This improves the roundness of the steel pipe without increasing the equipment load of the pipe expanding machine.

FIG.3



Description

No. S61-147930

Field

Summary

[0001] The present invention relates to a method for manufacturing a steel pipe that includes a pipe expanding step of expanding a steel pipe from the inside using a pipe expanding machine.

5 Technical Problem

Background

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[0002] In general, a manufacturing process for UOE steel pipes includes a step of applying beveling to edges in a width direction of a thick steel plate served as a raw material; a forming step of bending the width-direction edges of the thick steel plate using a pressing machine, and thereafter forming the thick steel plate into a cylindrical shape by forming the thick steel plate sequentially into a U-shape and an O-shape so that the width-direction edges of the thick steel plate face each other; a tack welding step of restraining the cylindrical thick steel plate, abutting the facing width-direction edges of the thick steel plate against each other, and tack welding the edges together; a permanent welding step of seam-welding the inner and outer surfaces of the butted portion of the thick steel plate using a submerged arc welding method; and a pipe expanding step of forming a steel pipe to have predetermined levels of roundness, straightness, and outside diameter by expanding the steel pipe from the inside using a pipe expanding machine.

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[0005] In the pipe expanding step, a steel pipe having a cross-sectional shape closer to a perfect circle can be manufactured by increasing a ratio of a difference in pipe diameter between before and after the pipe expansion to the pipe diameter before the pipe expansion (hereinafter called a pipe expanding ratio). However, increasing the pipe expanding ratio requires an increase in expanding force. In addition, with recent increases in thickness and strength of steel pipes, a larger force has become necessary to expand the pipes even at nearly the same pipe expanding ratio as conventional rates. Hence, there have been cases in which a conventional pipe expanding machine cannot ensure a large pipe expanding ratio necessary for improving the roundness. From such a background, it has been desired to provide a technology that can expand steel pipes to desired roundness without increasing the expanding force.

[0006] The present invention has been achieved to solve the above problems and an object of the present invention is to provide a method for manufacturing a steel pipe that can improve the roundness of the steel pipe without increasing the equipment load of the pipe expanding machine.

Solution to Problem

[0003] The UOE steel pipes for oil well pipes or line pipes are used by joining the pipe ends of the UOE steel pipes together using circumferential welding at a laying site. Hence, if the roundness of a UOE steel pipe is poor, the pipe ends of the UOE steel pipes cannot be abutted and joined together during the circumferential welding, and the steel pipe is likely to be deformed by pressure when the UOE steel pipe is laid in high-pressure ambience such as a deep sea. From such a background, technologies have been proposed that improve the roundness of the UOE steel pipe in the pipe expanding step (refer to Patent Literatures 1 to 5).

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[0007] A method for manufacturing a steel pipe according to the present invention includes: a first pipe expanding step of expanding a steel pipe within a range of a pipe expanding ratio having a lower limit at a pipe expanding ratio at which a predetermined roundness is obtained and an upper limit at a maximum value of a pipe expanding ratio at which an equipment load of a pipe expanding machine falls in an allowable range when the steel pipe is expanded; and a second pipe expanding step of expanding the steel pipe after the first pipe expanding step at a pipe expanding ratio at which a pipe diameter of the steel pipe reaches a target value.

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[0008] In the method for manufacturing a steel pipe according to the present invention, the range of the pipe expanding ratio at the first pipe expanding step is from 0.3% to less than 0.6%.

[0009] In the method for manufacturing a steel pipe according to the present invention, the wall thickness of the steel pipe is 25.4 mm or more.

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Advantageous Effects of Invention

Citation List

Patent Literature

[0004]

Literature 1: Japanese Laid-open Patent Publication No. 2010-167440

Literature 2: Japanese Laid-open Patent Publication No. H03-094936

Literature 3: Japanese Laid-open Patent Publication No. S59-183943

Literature 4: Japanese Laid-open Patent Publication No. H09-001234

Literature 5: Japanese Laid-open Patent Publication

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[0010] According to the present invention of the method for manufacturing a steel pipe, it can improve the roundness of the steel pipe without increasing the equipment load of the pipe expanding machine.

Brief Description of Drawings

[0011]

FIG. 1 is a schematic diagram illustrating a configuration of a pipe expanding machine used in a method for manufacturing a steel pipe as according to an embodiment of the present invention.

FIG. 2 is a schematic diagram illustrating a section of the steel pipe.

FIG. 3 is a diagram illustrating deviation of the pipe diameter in the circumferential position of the steel pipe before and after a pipe expansion process at a pipe expanding ratio of 0.3%.

FIGS. 4 are diagrams illustrating influence of the pipe expanding ratio of the first pipe expansion on the out-of-roundness after first expansion and second expansion. Description of Embodiments

[0012] The following describes a method for manufacturing a steel pipe as according to an embodiment of the present invention, with reference to the drawings.

[configuration of a pipe expanding machine]

[0013] First, with reference to FIGS. 1 and 2, a description will be made of a configuration of a pipe expanding machine used in the method for manufacturing a steel pipe according to the embodiment of the present invention. The configuration of the pipe expanding machine to be used in the present invention is not limited to the configuration illustrated in FIGS. 1 and 2.

[0014] As illustrated in FIG. 1, this pipe expanding machine 1 used in the method for manufacturing the steel pipe according to the embodiment of the present invention includes a cylindrical boom 2 with the leading end thereof inserted from one end of a steel pipe P and a pipe expanding head 4 that is provided at the leading end of the boom 2 and expands the steel pipe P when the diameter is expanded in the direction orthogonal to the axis. The pipe expanding head 4 includes a tapered outer circumferential surface 5 and a pipe expanding die 6.

[0015] The tapered outer circumferential surface 5 is provided at the leading end of the pull rod 3 which is mounted inside the boom 2 and is capable to move independently of the boom 2, and decreases in diameter from the leading end side toward the base end side of the boom 2. The pipe expanding dies 6 slide on the tapered outer circumferential surface 5, and includes a tapered inner circumferential surface 6a that decreases in diameter from the leading end side toward the base end side of the boom 2 and a die outer circumferential surface 6b that faces the inner circumferential surface of the steel pipe P. As illustrated in FIG. 2, a plurality of such pipe expanding dies 6 are provided along the circumferential direction of the tapered outer circumferential surface 5.

[Method for expanding the steel pipe]

[0016] Next, a description will be made of a method for expanding the steel pipe P using the pipe expanding machine 1.

[0017] To expand the steel pipe P using the pipe expanding machine 1, first, by moving the steel pipe P using an pipe positioning equipment, which is not illustrated, the pipe expanding dies 6 are positioned in a pipe expansion start position, and the pull rod 3 is moved back from the pipe expansion start position, whereby the first pipe expansion process is performed. This displaces each of the pipe expanding dies 6 sliding on the tapered outer circumferential surface 5 in the radial direction by way of a wedge action, and expands the steel pipe P. The undulation in the cross-sectional shape of the steel pipe P becomes small, and the cross-sectional shape of the steel pipe P becomes close to a perfect circular shape. Next, the pull rod 3 is moved forward to the pipe expansion start position, and after the pipe expanding dies 6 are returned inward in the direction orthogonal to the axis by a release mechanism, which is not illustrated, the steel pipe P is further moved in an amount corresponding to a pitch (length in the axial direction) of the pipe expanding dies 6. The pipe expanding dies 6 are positioned in a new expansion position, and then, the operation described above is repeated. This can enable the first pipe expansion process over the entire length of the steel pipe P in increments of the pitch of the pipe expanding dies 6.

[0018] In the first pipe expansion process, the lower limit value of a pipe expanding ratio is set to a value at which predetermined roundness is obtained, and the upper limit value of the pipe expanding ratio is set to an expanding force is less than the equipment load of the pipe expanding machine 1.

[0019] FIG. 3 is a diagram illustrating deviation of the pipe diameter in the circumferential position of the steel pipe before and after the pipe expansion process at a pipe expanding ratio of 0.3%. The steel pipe used for measuring the circumferential position dependence has an outside diameter of 762 mm. The vertical axis of FIG. 3 represents peaking (deviation of the pipe diameter from an average pipe diameter in a certain circumferential position). A positive peaking value means that the pipe diameter in that circumferential position is larger than the average pipe diameter. The horizontal axis of FIG. 3 represents the circumferential position in which the pipe diameter of the steel pipe is measured, and indicates at what angle the pipe diameter is measured, assuming a circumferential position corresponding to a seam-welded portion as 0 degree. As illustrated in FIG. 3, it was found that the peaking that has been at a maximum of 2.5 mm before the pipe expansion process is reduced to 1.5 mm or less by performing the pipe expansion process at the pipe expanding ratio of 0.3%, and thus the roundness is improved.

[0020] From what has been described above, the lower

limit value of the pipe expanding ratio is preferably set to 0.3% in the first pipe expansion process. This is because, as illustrated in FIG. 3, the roundness is greatly improved by performing the pipe expansion process at the pipe expanding ratio of 0.3%, and the pipe expansion at a predetermined pipe expanding ratio can be performed with a smaller applied load in a second pipe expansion process to be described later. The roundness (out-of-roundness) after the first pipe expansion is preferably set to 1.0% or less in percentage terms when expressed as a ratio to the outside diameter of the steel pipe. If, however, the pipe expanding ratio set in the first pipe expansion process is too large, a pipe expanding ratio necessary to ensure sufficient roundness cannot be obtained in the second pipe expansion process to be described later, and hence the upper limit value of the pipe expanding ratio in the first pipe expansion process is preferably set to less than 0.6% and more preferably set to less than 0.5%.

[0021] Then, the second pipe expansion process is performed, by moving the steel pipe P using an pipe positioning equipment, which is not illustrated, and the pipe expanding dies 6 are positioned again in the pipe expansion start position and moving back again the pull rod 3 from the pipe expansion start position. The pull rod 3 is then moved forward to the pipe expansion start position, and after the pipe expanding dies 6 are returned inward in the direction orthogonal to the axis by a release mechanism, which is not illustrated, the steel pipe P is further moved by an amount corresponding to a pitch (length in the axial direction) of the pipe expanding dies 6. The pipe expanding dies 6 are positioned in a new expansion position, and then, the operation described above is repeated. This can perform the second pipe expansion process on the steel pipe P over the entire length thereof in increments of the pitch of the pipe expanding dies 6. The second pipe expansion process corresponds to a second pipe expanding step according to the present invention.

[0022] In the second pipe expansion process, the pipe expanding ratio is set to a value at which the pipe diameter of the steel pipe P reaches a target value. In general, the equipment load when a steel pipe P is expanded to the same pipe expanding ratio is larger for a steel pipe with poor roundness than for a steel pipe with good roundness. In this method for expanding the pipe, however, the roundness of the steel pipe has been improved by the first pipe expansion process, so that the equipment load in the second pipe expansion process is reduced. Because the roundness of the steel pipe has been improved by the first pipe expansion process, the sum of the pipe expanding ratios of the first and the second expanding processes is larger than a pipe expanding ratio in the case of performing the expanding process only once with the same equipment load. As a result, the roundness is improved as well.

Embodiment

[0023] Next, advantageous effects of the present invention will be described by way of example. An influence of the pipe expanding ratio on the roundness (out-of-roundness) when UOE steel pipes of Grade X65 according to the American Petroleum Institute (API) standard having an outside diameter of 914.4 mm were manufactured was investigated in cases in which wall thicknesses of the steel pipes were 19.0 mm, 25.4 mm, and 31.8 mm. The pipe expansion was basically performed twice, and the pipe expanding ratio obtained from outside diameters of the steel pipe at the time when the second pipe expansion ended and the steel pipe before the first pipe expansion was performed was set constant at 1.0%. The pipe expanding ratio of the first pipe expansion was varied from 0.2% to 1.0%, and the influence of the pipe expanding ratio of the first pipe expansion on the out-of-roundness was investigated.

[0024] FIGS. 4A to 4C illustrate the results of the investigation. FIG. 4A corresponds to the case in which the wall thickness of the steel pipe is 19.0 mm, FIG. 4B to the case in which the wall thickness of the steel pipe is 25.4 mm, and FIG. 4C to the case in which the wall thickness of the steel pipe is 31.8 mm. In FIGS. 4A to 4C, open circles indicate the out-of-roundness after the first pipe expansion, and solid circles indicate the out-of-roundness after the second pipe expansion.

[0025] In the case of FIG. 4A in which the wall thickness is 19.0 mm, the value of the out-of-roundness after the first pipe expansion decreases and becomes better as the pipe expanding ratio of the first pipe expansion increases from 0.2%. In the case in which the pipe expanding ratio of the first pipe expansion was 1.0% and the second pipe expansion was not performed, the out-of-roundness was 3.0 mm. The out-of-roundness after the second pipe expansion is mostly smaller and better than that in the case in which the pipe expansion is performed once. The out-of-roundness after the second pipe expansion decreases and becomes better as the pipe expanding ratio of the first pipe expansion increases from 0.2%. This is considered to be because of the following reason. If the pipe expanding ratio of the first pipe expansion is small, that is, for example, less than 0.3%, the second pipe expansion is performed in a state in which the roundness has not been improved very much, so that the roundness improving effect by performing the pipe expansion in two steps is not obtained; in contrast, the roundness improving effect by performing the pipe expansion in two steps is obtained by preferably obtaining the pipe expanding ratio of the first pipe expansion of 0.3% or more.

[0026] When the pipe expanding ratio of the first pipe expansion is 0.3%, the out-of-roundness after the first pipe expansion is 9.0 mm, which corresponds to approximately 1.0% (= 9.0 mm/914.4 mm) when expressed as a ratio to 914.4 mm, which is the outside diameter of the steel pipe. Hence, the out-of-roundness after the first pipe

expansion is found to be preferably 1.0% or less in percentage terms. After the pipe expanding ratio of the first pipe expansion has exceeded 0.4%, the out-of-roundness after the second pipe expansion turns to increase, and gradually worsens. When the pipe expanding ratio of the first pipe expansion is 0.6% or more, the difference is small between the case in which the pipe expansion has been performed once and the case in which the pipe expansion has been performed twice. This is considered to be because an excessively large pipe expanding ratio of the first pipe expansion does not allow the pipe expanding ratio of the second pipe expansion to be sufficiently obtained, and is hardly effective for eventual improvement in the roundness. The out-of-roundness after the second pipe expansion was able to be eventually reduced to a minimum of 2.9 mm by performing the second pipe expansion and obtaining a total pipe expanding ratio of 1.0%. This is substantially the same as the out-of-roundness of 3.0 mm obtained in the case in which the pipe expansion was performed in one step. Hence, it has been found that dividing the pipe expansion into two steps is effective for ensuring good roundness. Thus, the pipe expanding ratio of the first pipe expansion is preferably from 0.3% to less than 0.6%, and more preferably from 0.3% to less than 0.5%.

[0027] The case of FIG. 4B in which the wall thickness is 25.4 mm failed to obtain the pipe expanding ratio of the first pipe expansion of 0.9% or more because doing so would exceed the maximum equipment limit. Hence, in the case in which the pipe expansion was performed only once, the out-of-roundness was able to be reduced down to a minimum of 3.9 mm, which was achieved when the pipe expanding ratio of the first pipe expansion was 0.8%. However, a total pipe expanding ratio of 1.0% was obtained by obtaining a pipe expanding ratio of the first pipe expansion of 0.8% or less and performing the second pipe expansion, so that the out-of-roundness after the second pipe expansion was able to be reduced to a minimum of 2.9 mm. This is a better value than the out-of-roundness of 3.9 mm obtained in the case in which the pipe expansion was performed in one step. Hence, it has been found that dividing the pipe expansion into two steps is effective for ensuring good roundness. Other results are almost the same as those in the case of FIG. 4A, and it has been found that the pipe expanding ratio of the first pipe expansion is preferably from 0.3% to less than 0.6%, and more preferably from 0.3% to less than 0.5%.

[0028] The case of FIG. 4C in which the wall thickness is 31.8 mm failed to expand the pipe at a pipe expanding ratio of the first pipe expansion of 0.8% or more because doing so would exceed the maximum equipment limit. Hence, in the case in which the pipe expansion was performed only once, the out-of-roundness was able to be reduced down to a minimum of 4.0 mm, which was achieved when the pipe expanding ratio of the first pipe expansion was 0.7%. It was impossible to obtain a pipe expanding ratio of the first pipe expansion of 0.2% and

perform the second pipe expansion at a pipe expanding ratio of 0.8% because, in this case, the second pipe expansion would exceed the maximum equipment limit. Dividing the pipe expansion into two steps, however, led to reduction in the out-of-roundness after the second pipe expansion to a minimum of 2.9 mm. This is a better value than the out-of-roundness of 4.0 mm obtained in the case in which the pipe expansion was performed in one step, so that it has been found that dividing the pipe expansion into two steps is effective for ensuring good roundness. Other results are almost the same as those in the case of FIG. 4A, and it has been found that the pipe expanding ratio of the first pipe expansion is preferably from 0.3% to less than 0.6%, and more preferably from 0.3% to less than 0.5%.

[0029] From the results described above, it has been found that, in the case of manufacturing a thick-walled steel pipe having a wall thickness of, for example, 25.4 mm or more, dividing the pipe expansion into two steps can obtain better roundness than that in the case in which the pipe expansion is performed in only one step.

[0030] While the description has been made above of the embodiment to which the present invention made by the inventors is applied, the present invention is not limited by the description and the drawings constituting parts of the disclosure of the present invention by way of the present embodiment. For example, the technology of the present invention can also be applied in the pipe expanding step when, as the forming step of forming a thick steel plate into a cylindrical shape so that edges in the width direction of the thick steel plate face each other, a bending press method is used that presses down a thick steel plate placed on two linear dies arranged in parallel with a certain space therebetween with a punch at a portion of the thick steel plate above the space, instead of the method that performs U-forming and O-forming using the pressing machine. In other words, for example, other embodiments, examples, and operational techniques made, for example, by those skilled in the art based on the present embodiment are all included in the category of the present invention.

Industrial Applicability

[0031] According to the embodiment of the present invention, the roundness of a steel pipe can be improved without increasing the equipment load of the pipe expanding machine.

Reference Signs List

[0032]

- 1 pipe expanding machine
- 2 cylindrical boom
- 4 pipe expanding head
- 5 tapered outer circumferential surface
- 6 pipe expanding dies

- 6a tapered inner circumferential surface
 6b die outer circumferential surface
 P steel pipe

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Claims

1. A method for manufacturing a steel pipe, the method comprising:

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a first pipe expanding step of expanding a steel pipe within a range of a pipe expanding ratio having a lower limit at a pipe expanding ratio at which a predetermined roundness is obtained and an upper limit at a maximum value of a pipe expanding ratio at which an equipment load of a pipe expanding machine falls in an allowable range when the steel pipe is expanded; and a second pipe expanding step of expanding the steel pipe after the first pipe expanding step at a pipe expanding ratio at which a pipe diameter of the steel pipe reaches a target value.

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2. The method for manufacturing a steel pipe according to claim 1, wherein the range of the pipe expanding ratio at the first pipe expanding step is from 0.3% to less than 0.6%.

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3. The method for manufacturing a steel pipe according to claim 1 or 2, wherein the wall thickness of the steel pipe is 25.4 mm or more.

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FIG.1

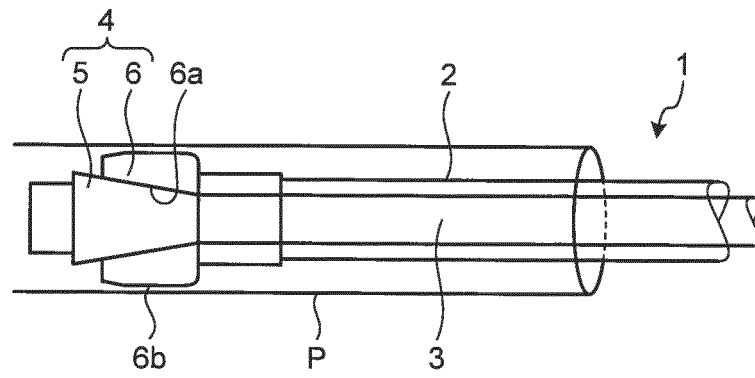


FIG.2

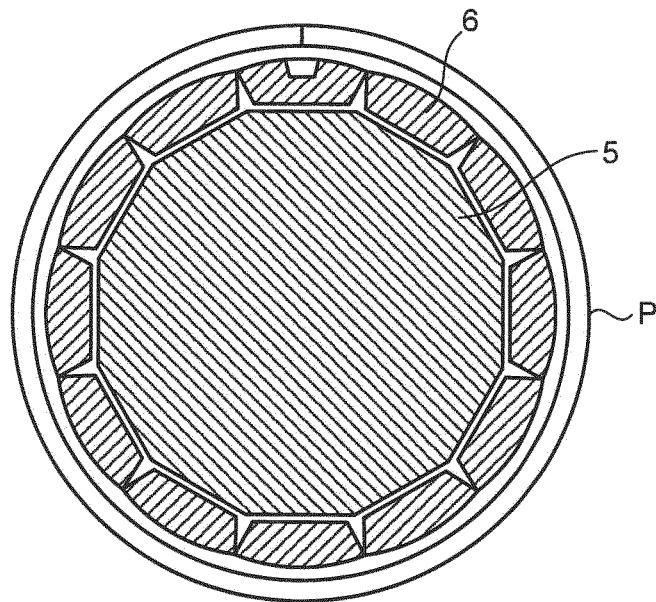


FIG.3

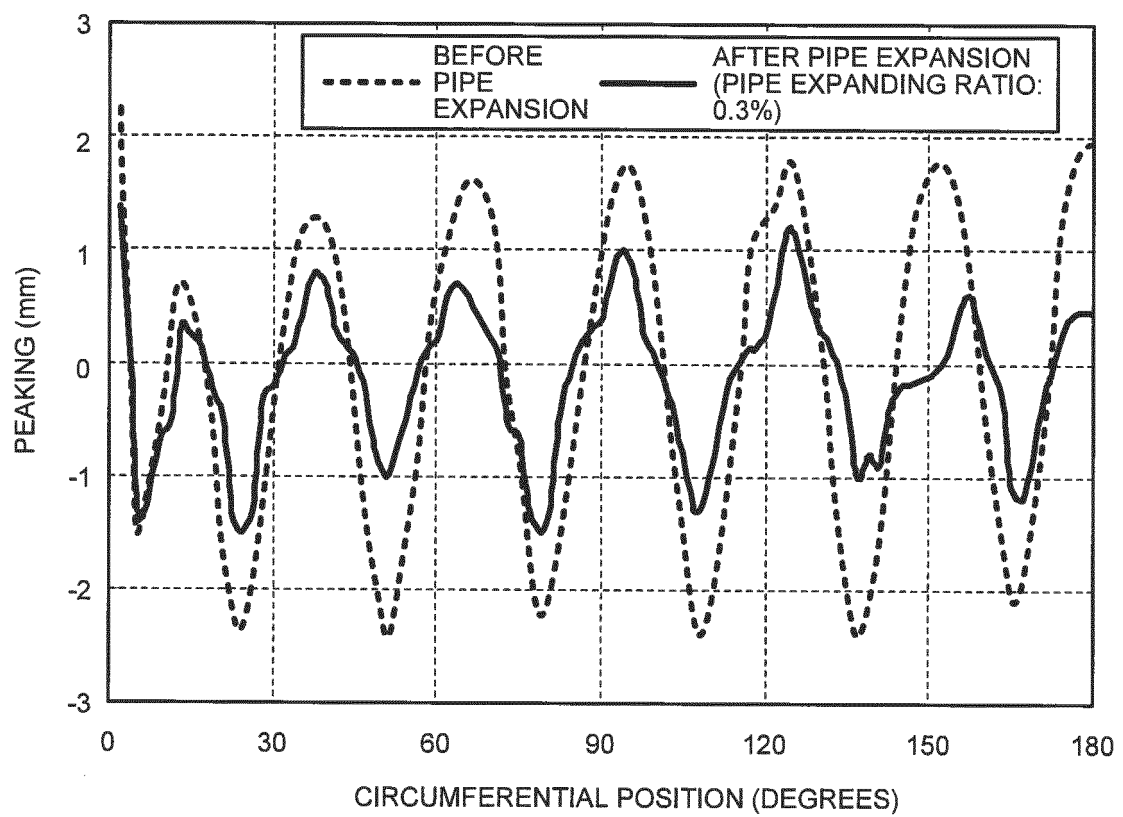


FIG.4A

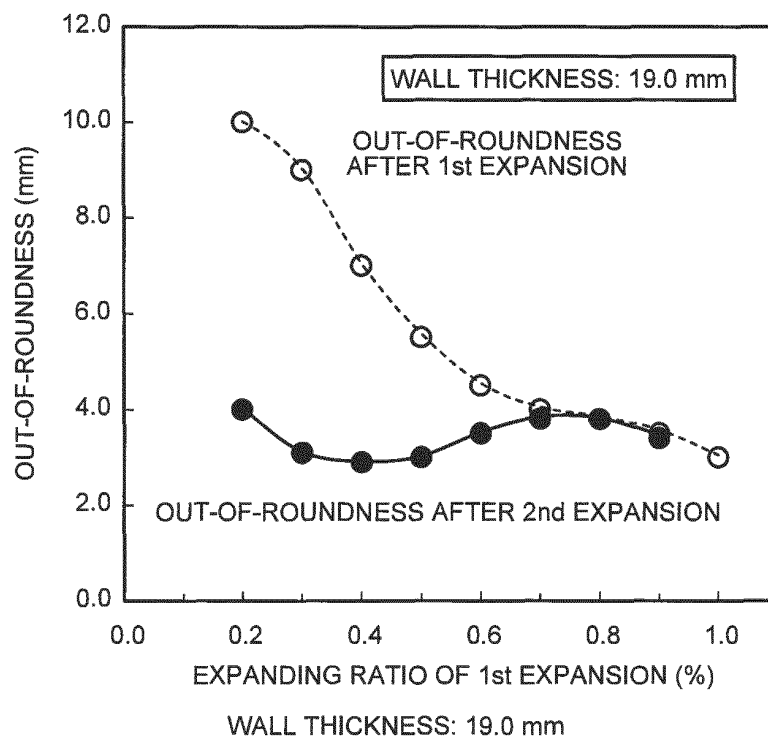


FIG.4B

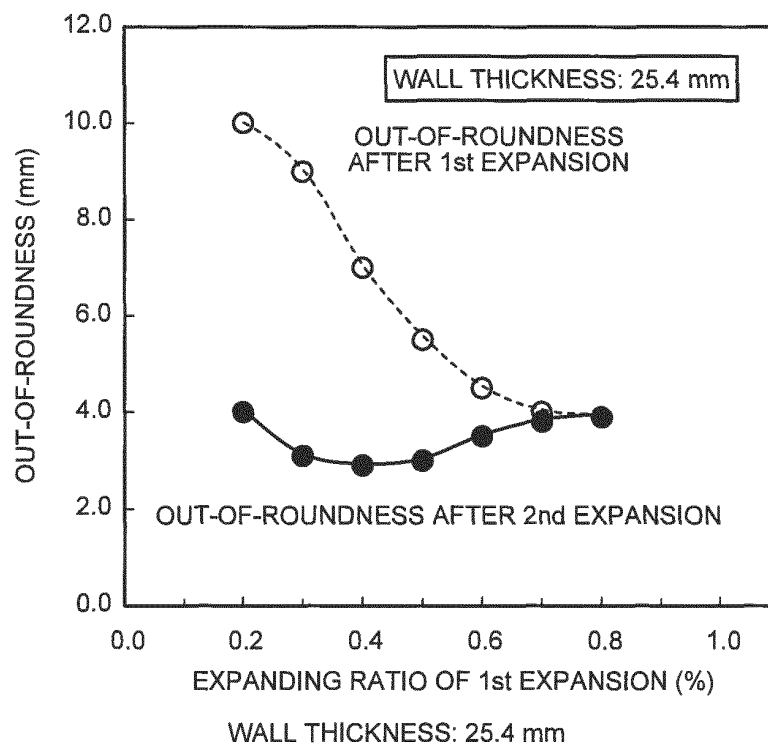
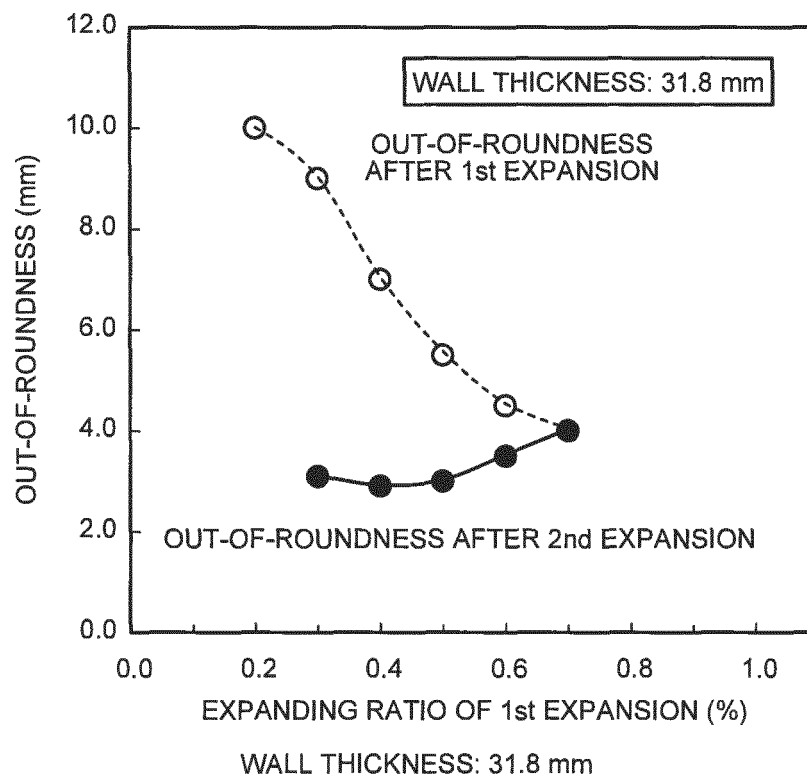


FIG.4C



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/062925

A. CLASSIFICATION OF SUBJECT MATTER

B21D3/14(2006.01)i, B21C37/08(2006.01)i, B21D39/20(2006.01)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)

B21D3/14, B21C37/08, B21D39/20

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014

Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 8-300069 A (NKK Corp.), 19 November 1996 (19.11.1996), paragraphs [0015] to [0017]; table 1 (Family: none)	1-3
A	JP 59-183943 A (Sumitomo Metal Industries, Ltd.), 19 October 1984 (19.10.1984), page 2, upper right column, line 3 to lower left column, line 7 (Family: none)	1-3

☐ 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
04 August, 2014 (04.08.14)Date of mailing of the international search report
12 August, 2014 (12.08.14)Name and mailing address of the ISA/
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Form PCT/ISA/210 (second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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- JP H03094936 B [0004]
- JP S59183943 B [0004]
- JP H09001234 B [0004]
- JP S61147930 B [0004]