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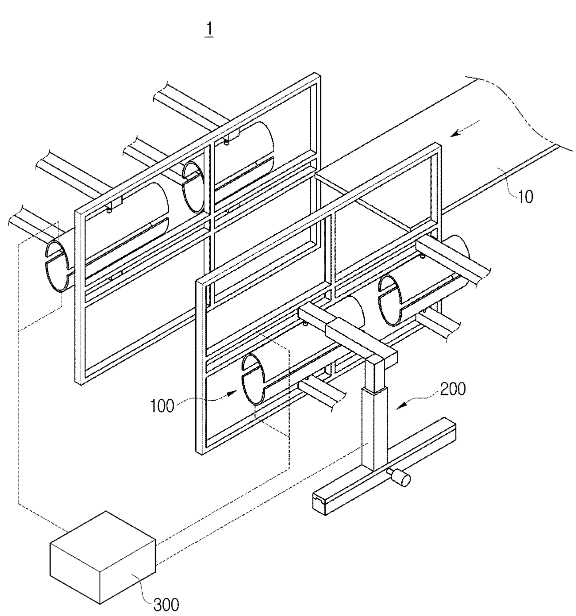
(54) **LOCAL HEAT TREATMENT SYSTEM AND COLD FORMING METHOD USING SAME**

(57) The present disclosure relates to a local heat treatment system and a cold forming method using the same. The local heat treatment system includes a heating device configured to locally heat only a plastic deformation occurrence portion of a blank material to a predetermined temperature, a moving device configured to move the heating device to a position of a local heating region of the blank material, and a controller configured to control the heating device and the moving device.

FIG. 1



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Description

[Technical Field]

[0001] The present disclosure relates to a local heat treatment system and a cold forming method using the same, and more particularly, to a local heat treatment system and a cold forming method using the same capable of improving the formability of an ultra-high tensile steel sheet and minimizing the springback phenomenon.

[Background Art]

[0002] In general, weight reduction of automobiles is effective for improving automobile fuel economy, and thus, the use of a high-tensile steel sheet, which is a material having a high specific strength, is increasing in recent years. The strength of such a high-tensile steel sheet is improving, and in recent years, an ultra-high tensile steel sheet having a tensile strength of 1 GPa or more has also been developed.

[0003] Because the ultra-high tensile steel sheet has a high strength, press molding of the ultra-high tensile steel sheet is not easy, so that it is easy to cause seizing due to increased molding load and increased mold wear, and the springback at which the molded shape returns is large, and thus the shape fixability is deteriorated. In addition, the ultra-high tensile steel sheet has a low ductility and tends to crack when a tensile stress is applied during molding.

[0004] Therefore, in order to improve the formability of the ultra-high tensile steel sheet, which is a difficult-to-form material, and to reduce the springback phenomenon, methods of improving formability by heating the entire molding material have been developed. As an example, a method of improving formability by heating the entire material, such as a warm forming process, has been applied. However, this method of heating the entire difficult-to-form material may cause unnecessary energy loss by heating even a region where molding is not performed.

[0005] Due to the above-described problem, a method of molding by locally heating only a part requiring plastic deformation through a laser or near-infrared heating device has been proposed and used. However, because this method is to warm a material after heating the material in a warm forming process, the productivity due to the heating time decreases, and during material handling, the local heating part cools quickly, making it difficult to maintain a constant quality.

[0006] Accordingly, there is a growing demand for a method and apparatus that does not heat the material in the molding process and thus does not decrease productivity, and performs cold forming rather than warm forming in order to secure a certain quality.

[Disclosure]

[Technical Problem]

[0007] The present disclosure is directed to providing a local heat treatment system and a cold forming method using the same capable of improving formability by locally heating a part to be plastically deformed through an external heat source and then cooling the part to adjust physical properties.

[0008] The present disclosure is directed to providing a local heat treatment system and a cold forming method using the same capable of improving productivity as well as reducing springback by cold forming a material whose physical properties are adjusted.

[Technical Solution]

[0009] An aspect of the present disclosure provides a local heat treatment system including a heating device configured to locally heat only a plastic deformation occurrence portion of a blank material to a predetermined temperature, a moving device configured to move the heating device to a position of a local heating region of the blank material, and a controller configured to control the heating device and the moving device.

[0010] The heating device may include a housing coupled to the moving device, a heat source coupled to the housing to emit near-infrared rays, and a reflector provided in the housing to condense light into the local heating region by reflecting the near-infrared rays generated by the heat source.

[0011] The moving device may include a rotating joint coupled to the heating device, and a plurality of moving members coupled to the rotating joint to move the heating device in three axes (x, y, and z) directions.

[0012] The plurality of moving members may include a first moving member coupled to the rotating joint to move the heating device in a direction in which the blank material is disposed, a second moving member coupled to the first moving member to move the first moving member in a vertical direction, and a third moving member coupled to the second moving member to move the second moving member in a horizontal direction.

[0013] The moving device and the heating device may be provided as one sub-assembly, a plurality of the sub-assemblies may be provided to locally heat the blank material on one side and the other side of the blank material, respectively, and the sub-assemblies may be independently controlled by the controller.

[0014] The controller may control the moving device and the heating device by setting a local heating position, a heating temperature, and a heating time in consideration of a strain and stress depending on a shape to be molded in a forming process of the blank material.

[0015] Another aspect of the present disclosure provides a cold forming method using the local heat treatment system according to any one of claims 1 to 6, which includes (a) operating the moving device so that the heating device is located in the local heating region, which is the plastic deformation occurrence portion, when the blank material is introduced into the local heat treatment system, (b) locally adjusting the physical properties of the blank material by heating and then cooling the plastic deformation occurrence portion of the blank material through the heating device to a predetermined temperature when the heating device is located in the local heating region, and (c) performing cold forming after moving the blank material whose physical properties is adjusted to a mold.

[0016] In process (a), the controller of the local heat treatment system may control the moving device and the heating device by setting a local heating position, a heating temperature, and a heating time in consideration of a strain and stress depending on a shape to be molded in a forming process of the blank material.

[Advantageous Effects]

[0017] A local heat treatment system according to an embodiment of the present disclosure and a cold forming method using the same can improve formability of a material by selectively heating the material locally using an external heat source and then cooling the material to adjust physical properties thereof.

[0018] Further, by locally heating only a part to be plastically deformed so that the physical properties are adjusted, a molding load can be reduced, so that the wear of the mold can be minimized during cold forming and springback phenomenon can be minimized after the cold forming.

[0019] Further, compared to conventional hot forming, productivity and quality can be improved, as well as energy cost can be reduced.

[0020] Further, as artificial intelligence (AI) and sensing technology are combined, the process can be easily and quickly performed when the material is locally heated, thereby improving productivity, and the local heat treatment system can be conveniently applied even when the material has a complex molding shape

[Description of Drawings]

[0021]

FIG. 1 is a view schematically illustrating a local heat treatment system according to an embodiment of the present disclosure.

FIG. 2 is a view showing a state in which the local heat treatment system according to an embodiment of the present disclosure is in operation.

FIG. 3 is a perspective view showing in detail a moving device of the local heat treatment system shown in FIG. 2.

FIG. 4 is a view showing a heating device provided in the local heat treatment system according to an embodiment of the present disclosure.

FIG. 5 is a view showing irradiation of a heat source depending on a shape of a reflector provided in the heating device shown in FIG. 4.

FIG. 6 is a view taken to compare a state of V-bending molding of a material whose physical properties are adjusted by the local heat treatment system according to an embodiment of the present disclosure and a state of V-bending molding of a conventional material.

FIG. 7 is a view taken to compare a material whose physical properties are adjusted by the local heat treatment system according to an embodiment of the present disclosure and a conventional material that is asymmetrically molded.

FIG. 8 is a view taken to compare an actual part whose physical properties are adjusted by the local heat treatment system according to an embodiment of the present disclosure and a conventional actual part that is molded.

[Mode of the Disclosure]

[0022] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the accompanying drawings. The following embodiments are provided to fully convey the spirit of the present disclosure to a person having ordinary skill in the art to which the present disclosure belongs. The present disclosure is not limited to the embodiments shown herein but may be embodied in other forms. The drawings are not intended to limit the scope of the present disclosure in any way, and the size of components may be exaggerated for clarity of illustration.

[0023] FIG. 1 is a view schematically illustrating a local heat treatment system according to an embodiment of the present disclosure, FIG. 2 is a view showing a state in which the local heat treatment system according to an embodiment of the present disclosure is in operation, FIG. 3 is a perspective view showing in detail a moving device of the local heat treatment system shown in FIG. 2, FIG. 4 is a view showing a heating device provided in the local heat treatment system according to an embodiment of the present disclosure, and FIG. 5 is a view showing irradiation of a heat source depending on a shape of a reflector provided in the heating device shown in FIG. 4.

[0024] Referring to FIGS. 1 to 5, a local heat treatment system 1 according to an embodiment of the present disclosure includes a heating device 100 to heat only a part in which plastic deformation of a blank material 10 is generated, a moving device 200 to move the heating device 100 to a position of a local heating region of the blank material 10, and a controller 300 to control the heating device 100 and the moving device 200.

[0025] The blank material 10 is a difficult-to-form material having a tensile strength of 1 GPa or more, which is an ultra-high tensile steel material that is cut to have a predetermined length in order to form a product through cold forming according to the present disclosure. Because a region in which an actual plastic deformation is generated in a process of producing the blank material 10 as a product is local, formability of the blank material 10 may be improved by applying heat only to a region in which plastic deformation is generated using a separate external heat source. That is, in order to improve the formability of the material, it is important to focus a location where heat is applied to only a local region in which the plastic deformation of the blank material 10 is generated.

[0026] When bending molding of the blank material 10 is performed, it is more efficient that a near-infrared heat source is used as an external heat source than in other processes. In addition, because most of the bending molding is linear, it is appropriate to use a linear heat source.

[0027] Therefore, in the present disclosure, the heating device 100 is used as an external heat source, and a temperature of a local region in which plastic deformation is generated is increased by using a linear near-infrared heater, so that the bending properties of a difficult-to-form material may be improved, thereby molding the material into a precise shape.

[0028] More specifically, as shown in FIG. 4, the heating device 100 includes a heat source 110 and a reflector 120. The heat source 110 may be provided as a lamp that generates near-infrared rays.

[0029] The heat source 110 is an electromagnetic wave having a wavelength of 700 to 1300 nm and is generated outside of a visible red light. Because 90% or more of the heat source 110 is radiant heat, the efficiency of the heat source 110 may be high (85% to 90% efficiency). Because the heat source 110 is near-infrared rays and thus does not burn air, the heat source 110 which is non-toxic, smokeless, odorless, and noiseless may be used indoors. The heat source 110 is very convenient to use because it only takes about 0.1 seconds to reach a maximum output.

[0030] The reflector 120 serves to reflect near-infrared rays generated from the heat source and condense light into the local heating region. The reflector 120 may linearly adjust a region to which near-infrared rays are irradiated according to a shape. For example, FIG. 5A shows the reflector 120 formed in an elliptical shape, and FIG. 5B shows the reflector 120 formed in a parabolic shape. In the case of the elliptical reflector 120, near-infrared rays generated from the heat source 110 are reflected and condensed to one point to be linearly irradiated to the blank material 10. In the case of the parabolic reflector 120, near-infrared rays generated from the heat source 110 are parallelized to be irradiated onto a predetermined region of the blank material 10. That is, depending on a plastic deformation region of the blank material 10, the reflector 120 suitable for that region may be applied to be locally heated. In addition, reflectors of various shapes may be provided to be utilized according to respective characteristics thereof. Therefore, depending on the purpose, the shape of the reflector 120 may be modified and used.

[0031] As described above, because the heating device 100 using near-infrared rays uses only the heat source 110 and the reflector 120, the blank material 10 may be locally heated from one direction.

[0032] The heating device 100 may further include a housing 130. The housing 130 serves to protect the heat source 110 and the reflector 120 from external impacts and prevent energy loss through heat insulation. The housing 130 is provided such that the heat source 110 and the reflector 120 are coupled, and a part of the housing 130 has an open shape so that near-infrared rays generated from the heat source 110 are irradiated in one direction through the reflector 120. In addition, the housing 130 may be coupled to the moving device 200, which will be described later.

[0033] The moving device 200 serves to move the heating device 100 to a surface of a region of the blank material 10 to be plastically deformed, by being combined with the heating device 100. The moving device 200 includes a rotating joint 213 coupled to the heating device 100 and a plurality of moving members 210, 220, and 230 to move the heating device 100 in three axial directions.

[0034] The rotating joint 213 is coupled to the housing 130 of the heating device 100 to adjust an angle of the heating device 100. That is, the rotating joint 213 serves to adjust the angle of the heating device 100 so that near-infrared rays may be smoothly condensed on the surface of the local heating region of the blank material 10. The structure of the rotating joint 213 is a generally well-known technique, and thus a detailed description thereof will be omitted.

[0035] The plurality of moving members 210, 220, and 230 is composed of the first moving member 210, the second moving member 220, and the third moving member 230 in order to move the heating device 100 in three axial directions, that is, in x, y, and z-axis directions. For example, as shown in FIG. 3, the third moving member 230 may be provided to move in the x-axis direction, the second moving member 220 may be provided to move in the y-axis direction, and the first moving member 210 may be provided to move in the z-axis direction.

[0036] The first moving member 210 is coupled to the rotating joint 213 to move the heating device 100 in a direction in which the blank material 10 is disposed, that is, in the z-axis direction. The first moving member 210 may be provided with a hydraulic or pneumatic cylinder to move in one direction.

[0037] The second moving member 220 is coupled with the first moving member 210 to move the first moving member 210 in a vertical direction, that is, in the y-axis direction. Because the first moving member 210 is coupled to the heating device 100, the heating device 100 is moved together when the first moving member 210 moves. The second moving member 220 may be provided with a hydraulic or pneumatic cylinder to move in one direction.

[0038] The third moving member 230 is coupled with the second moving member 220 to move the second moving member 220 in a horizontal direction, that is, in the x-axis direction. Because the second moving member 220 coupled to the first moving member 210, the first moving member 210 is moved together when the second moving member 220 moves. The third moving member 230 may have a coupling structure of rack and pinion gears that receive a rotational force of a motor 232 and convert the rotational force into a linear motion.

[0039] The present embodiment illustrates that the first and second moving members 210 and 220 have a cylinder structure and the third moving member 230 has a gear coupling structure that converts a rotational motion into a linear motion, but the present disclosure Is not limited thereto, and the moving members may have various structures as long as the heating device 100 may be moved in three axial directions.

[0040] The local heat treatment system 1 according to an embodiment of the present disclosure may be configured such that the moving device 200 and the heating device 100 form one sub-assembly, and a plurality of the sub-assemblies may be provided to locally heat the blank material 10 at required positions on one side and the other side of the blank material 10, respectively. The plurality of sub-assemblies may be independently controlled by the controller 300.

[0041] The controller 300 may control independently the plurality of sub-assemblies as described above, respectively, as well as control the heating device 100 and the moving device 200, respectively. The controller 300 may be combined with artificial intelligence (AI) and sensing technology to more efficiently control each of the sub-assemblies. For example, the controller 300 may measure a strain and stress during the molding process, which are the molding characteristics of an object to be molded before the blank material 10 is locally heated and may optimize a local heating position, a heating temperature, a heating time, and the like in consideration of a molding shape, a process time, and the like. That is, the controller 300 may control the moving device 200 and the heating device 100 by setting the local heating position, the heating temperature, and the heating time based on measurement data obtained by measuring the object to be molded. Accordingly, when the blank material 10 is located in the local heat treatment system 1, the moving device 200 is operated to quickly and easily move the heating device 100 to an optimized point, and the heating device 100 heats the heating position by time and at a constant temperature. Therefore, the local heat treatment system 1 may be conveniently applied even when the object to be molded has a complex molding shape, and at the same time may be applied to various shapes.

[0042] Hereinafter, a method of cold forming the blank material 10 using the local heat treatment system 1 as described above will be described with reference to FIGS. 1 to 5.

[0043] The cold forming method of the present disclosure largely includes a process of locally heating and then cooling a plastic deformation generating part of the blank material 10 through the local heat treatment system 1, and a process of positioning the locally heated blank material 10 into a mold and then molding the blank material 10.

[0044] Specifically, as shown in FIG. 1, when the blank material 10 is introduced into the local heat treatment system 1, the moving device 200 is operated such that the heating device 100 is located in a local heating region, which is a region in which plastic deformation is generated. That is, as shown in FIG. 2, when the heating device 100 is located in the local heating region, the plastic deformation generating part of the blank material 10 is heated to a predetermined temperature through the heating device 100. The locally heated blank material 10 goes through a cooling process so that physical properties of the material are adjusted and then is provided for a cold forming process. That is, by adjusting the physical properties of the blank material 10 in advance prior to the cold forming process, a forming process time may be shortened compared to a conventional process of performing warm forming after heating a material in a warm forming process.

[0045] The heating device 100 and the moving device 200 may be controlled by the controller 300 to locally heat the blank material 10. The controller 300 independently controls the plurality of heating devices 100 and moving devices 200, respectively. The controller 300 may control the moving device 200 and the heating device 100 by setting a local heating position, a heating temperature, and a heating time in consideration of the strain and stress depending on a shape to be molded during the molding process of the blank material 10.

[0046] For example, the controller 300 may be combined with artificial intelligence (AI) and sensing technology to more efficiently control the moving device 200 and the heating device 100. That is, the controller 300 may measure a strain and stress during the molding process, which are the molding characteristics of an object to be molded before the blank material 10 is locally heated and may optimize a local heating position, a heating temperature, a heating time, and the like in consideration of a molding shape, a process time, and the like. Accordingly, the controller 300 may control the moving device 200 and the heating device 100 by setting the local heating position, the heating temperature, and the heating time based on measurement data obtained by measuring the object to be molded. Therefore, when the blank material 10 is located in the local heat treatment system 1, the moving device 200 is operated to quickly and easily move the heating device 100 to an optimized point, and the heating device 100 heats the heating position by time and at a constant temperature.

[0047] The blank material 10 introduced into the local heat treatment system 1 may be fixed at a predetermined position through a separate holder (not shown). That is, the blank material 10 may be supported by the holder so as not to interfere with a part heated through the heating device 100.

[0048] The blank material 10 locally heated through the local heat treatment system 1 is provided in a state in which the physical properties of the material are adjusted by being cooled.

[0049] Thereafter, the blank material 10 whose physical properties are adjusted is molded to have a required shape through cold forming.

[0050] Hereinafter, the present disclosure will be described in more detail through embodiments 1 to 6 and comparative examples 1 to 3.

Embodiment 1

[0051] A blank material is prepared as an ultra-high tensile steel having a tensile strength of 1.5 GPa, and a part to be plastically deformed is locally heated to 550 °C and then V-shaped bending molding is performed.

Embodiment 2

[0052] A blank material is prepared as an ultra-high tensile steel having a tensile strength of 1.5 GPa, and a part to be plastically deformed is locally heated to 850°C and then V-shaped bending molding is performed.

Embodiment 3

[0053] A blank material is prepared as an ultra-high tensile steel having a tensile strength of 1.5 GPa, and a part to be plastically deformed is locally heated to 950°C and then V-shaped bending molding is performed.

Embodiment 4

[0054] A blank material is prepared as an ultra-high tensile steel having a tensile strength of 1.2 GPa, and a part to be plastically deformed is locally heated to 400°C and then asymmetric molding is performed.

Embodiment 5

[0055] A blank material is prepared as an ultra-high tensile steel having a tensile strength of 1.2 GPa, and a part to be plastically deformed is locally heated to 800°C and then asymmetric molding is performed.

Embodiment 6

[0056] A blank material is prepared as an ultra-high tensile steel having a tensile strength of 1.5 GPa, and a part to be plastically deformed is locally heated to 800°C and then molding of an actual part is performed.

Comparative example 1

[0057] A blank material is prepared as an ultra-high tensile steel having a tensile strength of 1.5 GPa, and V-shaped bending molding is performed without local heating.

Comparative example 2

[0058] A blank material is prepared as an ultra-high tensile steel having a tensile strength of 1.2 GPa, and asymmetric molding is performed without local heating.

Comparative example 3

[0059] A blank material is prepared as an ultra-high tensile steel having a tensile strength of 1.5 GPa, and molding of an actual part is performed without local heating.

[Table 1]

Type of Steel	Embodiments/ Comparative Examples	Molding Methods	Local Heating	Molding Results
1.5 GPa ultra-high tensile steel	Embodiment 1	V-shaped bending molding	550°C	No cracks
	Embodiment 2	V-shaped bending molding	850°C	No cracks
	Embodiment 3	V-shaped bending molding	950°C	No cracks
1.2 GPa ultra-high tensile steel	Embodiment 4	Asymmetric molding	400°C	Springback 15°
	Embodiment 5	Asymmetric molding	800°C	Springback 7°
1.5 GPa ultra-high tensile steel	Embodiment 6	Molding of an actual part	800°C	No cracks
1.5 GPa ultra-high tensile steel	Comparative Example 1	V-shaped bending molding	-	Crack occurrence
1.2 GPa ultra-high tensile steel	Comparative Example 2	Asymmetric molding	-	Springback 25°
1.5 GPa ultra-high tensile steel	Comparative Example 3	Molding of an actual part	-	Crack occurrence

[0060] As may be seen from the molding results in [Table 1], no cracks occurred as a result of molding after performing local heating, and the springback phenomenon was significantly reduced. Results according to the experiments of these embodiments and comparative examples are shown in FIGS. 6 to 8.

[0061] FIG. 6 is a view taken to compare a state of V-bending molding of a material whose physical properties are adjusted by the local heat treatment system according to an embodiment of the present disclosure and a state of V-bending molding of a conventional material.

[0062] FIG. 6A shows a state in which V-bending molding is performed through Comparative example 1, and FIG. 6B shows a state in which V-bending molding is performed through Embodiments 1 to 3. That is, as shown in the drawing, in the case of Comparative example 1, it may be confirmed that a crack occurred in the plastically deformed part. In contrast, in the case of Embodiments 1 to 3 of the present disclosure, because the physical properties were adjusted by locally heating a part to be plastically deformed, the part was smoothly molded without cracking.

[0063] FIG. 7 is a view taken to compare a material whose physical properties are adjusted by the local heat treatment system according to an embodiment of the present disclosure and a conventional material that is asymmetrically molded.

[0064] FIG. 7A shows a state in which asymmetric molding is performed through Comparative example 2, and FIG. 7B shows a state in which asymmetric molding is performed through Embodiment 4. That is, as shown in the drawing, in the case of Comparative example 2, it may be confirmed that a 25° springback phenomenon occurred after asymmetric molding. In contrast, in the case of Embodiment 5 of the present disclosure, because the physical properties were adjusted by locally heating a part to be plastically deformed, no cracking occurred, and a 7° springback phenomenon occurred. That is, it may be seen that the springback is significantly reduced compared to the prior art.

[0065] FIG. 8 is a view taken to compare an actual part whose physical properties are adjusted by the local heat treatment system according to an embodiment of the present disclosure and a conventional actual part that is molded.

[0066] FIG. 8A shows a state in which an actual part is molded through Comparative example 3, and FIG. 8B shows a state in which an actual part is molded through Embodiment 6. That is, as shown in the drawing, in the case of Comparative example 3, it may be confirmed that cracks and fractures occurred in the plastically deformed part. In contrast, in the case of Embodiment 6 of the present disclosure, because the physical properties were adjusted by locally heating a part to be plastically deformed, the part was molded without cracks and fractures.

[0067] It may be confirmed from FIG. 8B that the physical properties were adjusted by not wholly heating a portion where the actual part is plastically deformed, but by locally heating opposite ends, that is, portions where cracks and fractures occurred during plastic deformation of the existing real part, and then cooling the portions. This is determined by the data values obtained by measuring a strain and stress during the molding process in consideration of the molding characteristics of an object to be molded. Therefore, because all parts to be plastically deformed may be prevented from being unnecessarily locally heated, not only may the waste of energy be more effectively reduced, but also productivity may be improved. In addition, an optimized heating position may be set, and a heating time and a heating temperature may be provided. That is, the local heat treatment system 1 capable of improving formability and minimizing the springback phenomenon, and the cold forming method through the same may be provided, and a molded part with improved quality may be provided.

[0068] The foregoing has illustrated and described specific embodiments. However, it should be understood by those of skilled in the art that the disclosure is not limited to the above-described embodiments, and various changes and modifications may be made without departing from the technical idea of the disclosure described in the following claims.

Claims

1. A local heat treatment system comprising:

   a heating device configured to locally heat only a plastic deformation occurrence portion of a blank material to a predetermined temperature;
   a moving device configured to move the heating device to a position of a local heating region of the blank material; and
   a controller configured to control the heating device and the moving device.

2. The local heat treatment system according to claim 1, wherein
   the heating device comprises:

   a housing coupled to the moving device;
   a heat source coupled to the housing to emit near-infrared rays; and
   a reflector provided in the housing to condense light into the local heating region by reflecting the near-infrared rays generated by the heat source.

3. The local heat treatment system according to claim 1, wherein
   the moving device comprises:

   a rotating joint coupled to the heating device; and
   a plurality of moving members coupled to the rotating joint to move the heating device in three axes (x, y, and z) directions.

4. The local heat treatment system according to claim 3, wherein
   the plurality of moving members comprises:

   a first moving member coupled to the rotating joint to move the heating device in a direction in which the blank material is disposed;
   a second moving member coupled to the first moving member to move the first moving member in a vertical direction; and
   a third moving member coupled to the second moving member to move the second moving member in a horizontal direction.

5. The local heat treatment system according to claim 1, wherein
   the moving device and the heating device are provided as one sub-assembly,
   a plurality of the sub-assemblies is provided to locally heat the blank material on one side and the other side of the blank material, respectively, and
   the sub-assemblies are independently controlled by the controller.

6. The local heat treatment system according to claim 1, wherein
   the controller controls the moving device and the heating device by setting a local heating position, a heating temperature, and a heating time in consideration of a strain and stress depending on a shape to be molded in a forming process of the blank material.

7. A cold forming method using the local heat treatment system according to any one of claims 1 to 6, comprising:

(a) operating the moving device so that the heating device is located in the local heating region, which is the plastic deformation occurrence portion, when the blank material is introduced into the local heat treatment system;
(b) locally adjusting the physical properties of the blank material by heating and then cooling the plastic deformation occurrence portion of the blank material through the heating device to a predetermined temperature when the heating device is located in the local heating region; and
(c) performing cold forming after moving the blank material whose physical properties is adjusted to a mold.

8. The cold forming method according to claim 7, wherein
in process (a), the controller of the local heat treatment system controls the moving device and the heating device by setting a local heating position, a heating temperature, and a heating time in consideration of a strain and stress depending on a shape to be molded in a forming process of the blank material.

FIG. 1

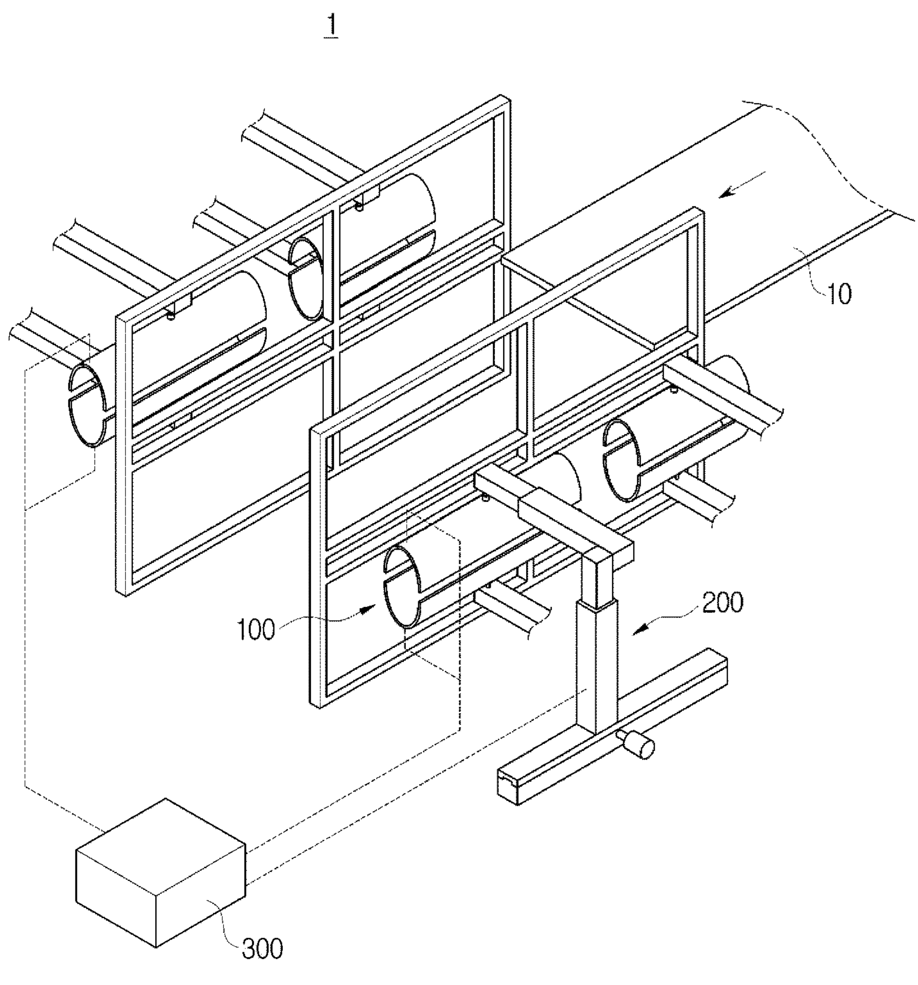


FIG. 2

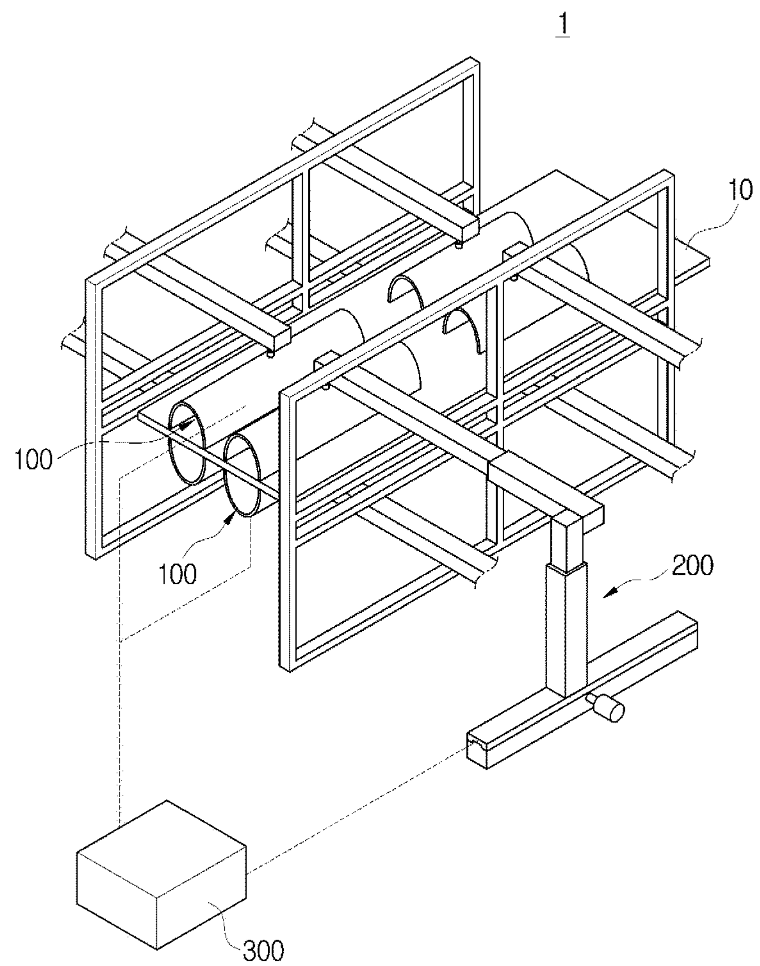


FIG. 3

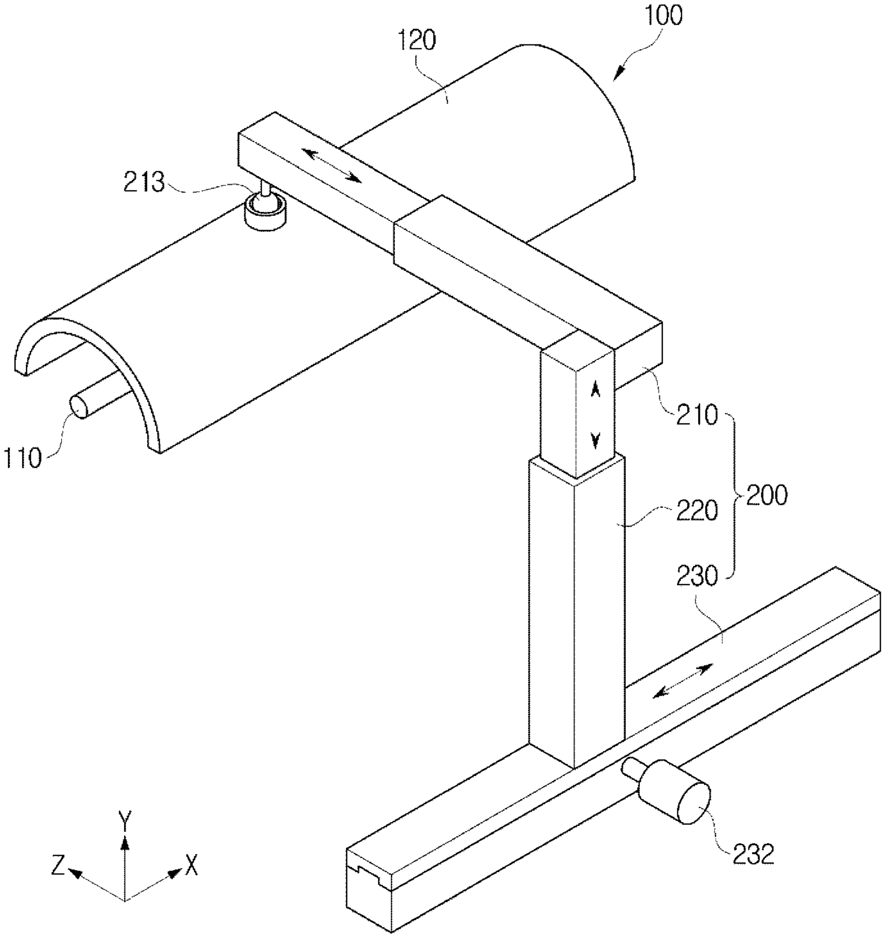


FIG. 4

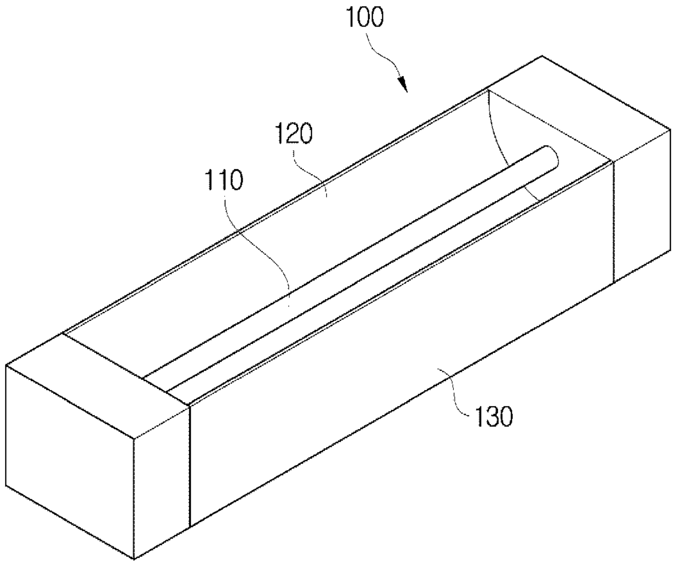
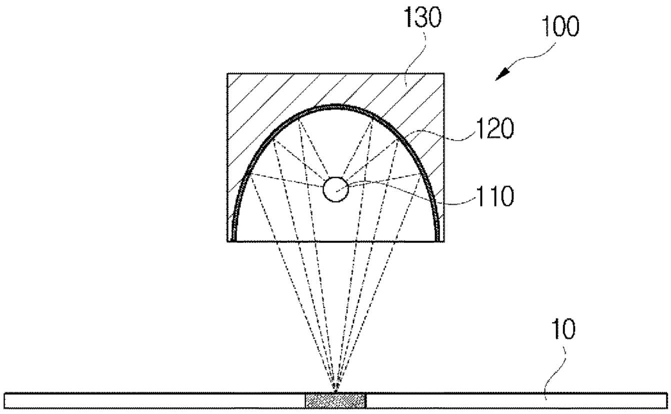
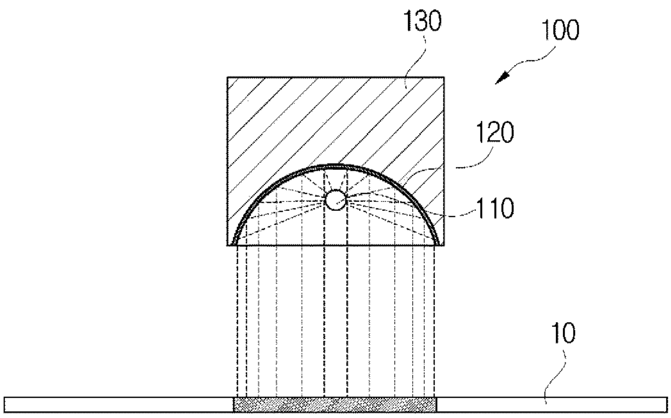


FIG. 5

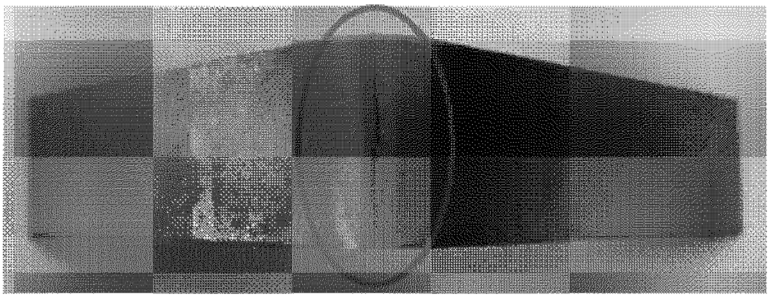


(a)

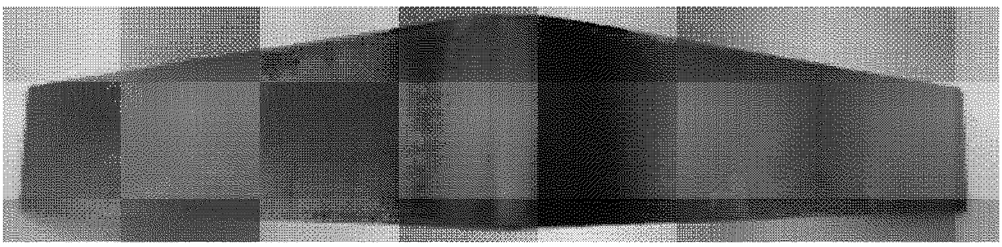


(b)

FIG. 6

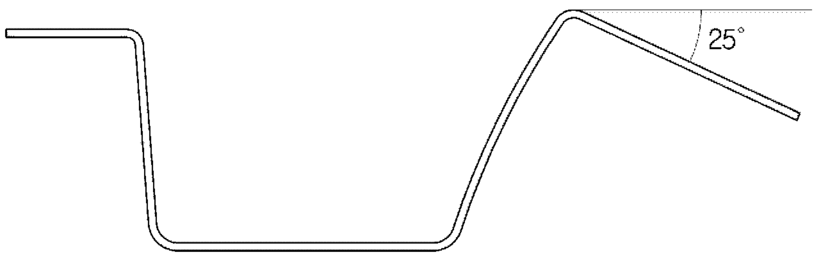


(a)

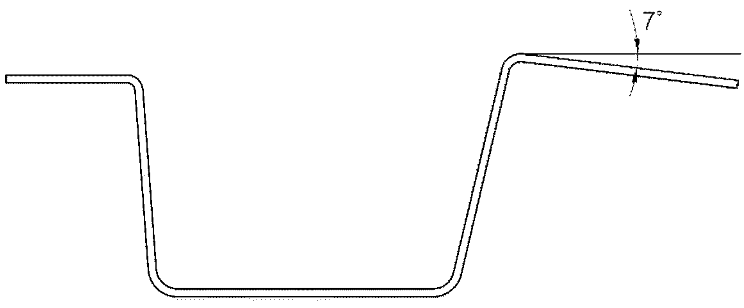


(b)

FIG. 7

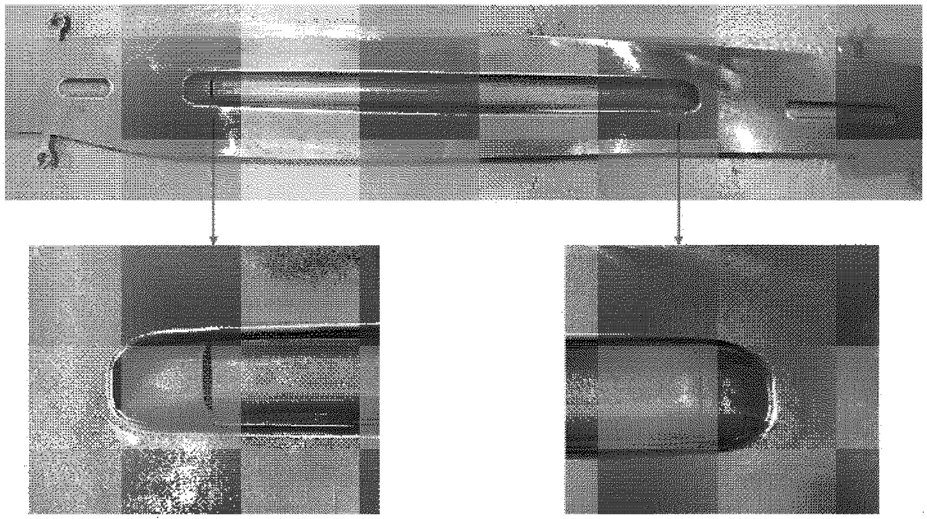


(a)

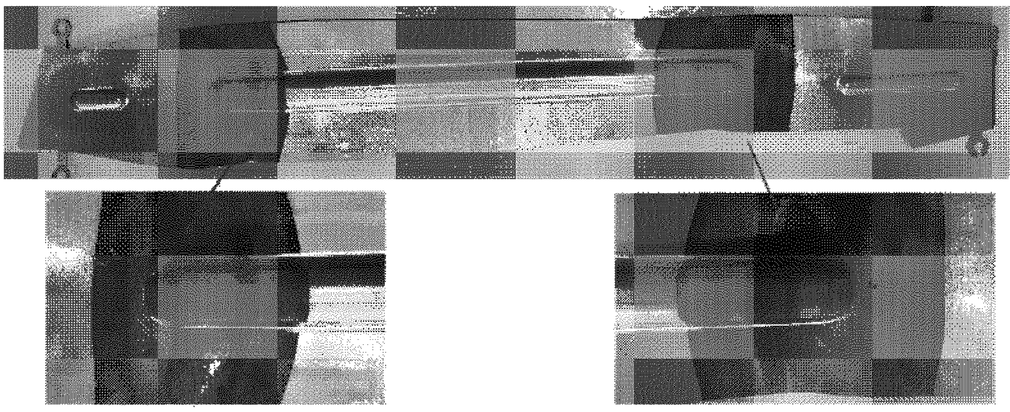


(b)

FIG. 8



(a)



(b)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2019/009979

A. CLASSIFICATION OF SUBJECT MATTER

C21D 1/34(2006.01)i, C21D 9/46(2006.01)i, C21D 11/00(2006.01)i, B21D 37/16(2006.01)i, B21J 1/06(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)

C21D 1/34; C21D 1/09; C21D 1/10; C21D 6/00; C21D 9/00; C21D 9/40; C21D 9/50; G06F 17/00; C21D 9/46; C21D 11/00; B21D 37/16; B21J 1/06

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: local heat treatment, cold forming, heating device, moving device, control device

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2017-141486 A (MITSUBISHI HEAVY IND., LTD.) 17 August 2017 See paragraphs [0019], [0027]-[0033] and figures 1-4.	1,6-8
A		2-5
A	KR 10-2012-0110963 A (POSCO) 10 October 2012 See paragraphs [0016]-[0021] and figures 1-2.	1-8
A	KR 10-1176068 B1 (HWANG, Hyun-tae et al.) 24 August 2012 See paragraphs [0027]-[0043] and figures 1-3.	1-8
A	US 2010-0084059 A1 (PFAFFMAN et al.) 08 April 2010 See paragraphs [0022]-[0023], claims 1-3 and figures 1-3.	1-8
A	JP 2011-225998 A (NETUREN CO., LTD.) 10 November 2011 See paragraphs [0022]-[0025] and figures 1-3.	1-8

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 DECEMBER 2019 (04.12.2019)	**04 DECEMBER 2019 (04.12.2019)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex Daejeon Building 4, 189, Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea Facsimile No. +82-42-481-8578	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2019/009979

Patent document cited in search report	Publication date	Patent family member	Publication date
JP 2017-141486 A	17/08/2017	None	
KR 10-2012-0110963 A	10/10/2012	KR 10-1359055 B1	07/02/2014
KR 10-1176068 B1	24/08/2012	KR 10-2011-0107019 A	30/09/2011
US 2010-0084059 A1	08/04/2010	US 8372222 B2	12/02/2013
JP 2011-225998 A	10/11/2011	JP 5565635 B2	06/08/2014

Form PCT/ISA/210 (patent family annex) (January 2015)