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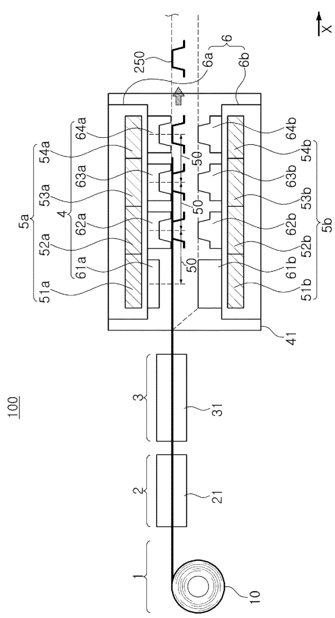
(54) METHOD AND APPARATUS MANUFACTURING HOT PRESS FORMED PARTS FOR MULTI-STEP PROCESS

(57) Provided are a method and apparatus for manufacturing hot press formed parts for a multi-step process, the method comprising: a heating step for heating a strip material; a transferring step for transferring the heated strip material to a processing apparatus having mounted on a press a plurality of molds comprising a notching mold and/or a blanking mold, a forming mold, and a trimming mold; a notching step, for obtaining a notched material connected to the strip by means of a web portion by cutting a part of the material by means of the notching mold, and/or a blanking step for obtaining a blanked material separated from the strip by cutting a part of the material by means of the blanking mold; a forming step of transferring and positioning the material which has gone through the notching step and/or the blanking step near the forming mold, and then forming the material by means of the forming mold; and a trimming step for removing, by means of the trimming mold, an outer edge portion of the material which is unnecessary for a final product shape.

[FIG. 1]



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Description

[Technical Field]

[0001] The present disclosure relates to a method and apparatus for manufacturing a hot press formed member for a multistage process having one or more improved properties of productivity and formability.

[Background Art]

[0002] In accordance with demand for weight reduction and improvements in the safety of vehicles, high-strength steel using a hot press forming method has been actively applied. In general, in the hot press forming method, a blank having a shape designed to form a part is prepared, heated to a high temperature, and then put into a mold mounted on a press. Thereafter, a pressing slide is lowered to bottom dead center to form a blank, and a formed part is rapidly cooled in the mold by holding the pressing slide at bottom dead center for a predetermined amount of time. As such, after sufficiently cooling the formed part, a part is manufactured by a process of lifting the slide and removing a product. In addition, in general, the part manufactured as described above goes through a procedure of being manufactured into a final part shape by additionally performing a process of cutting some unnecessary edge portions or internal hole portions from the final part shape. The process of cutting the product after forming is performed by laser trimming or mechanical trimming using a trimming mold/press because the formed product has high strength.
[0003] The general hot press forming described above has a limitation in that a final part should be manufactured by single forming. Therefore, there is a disadvantage in that it is not possible to manufacture a part shape that is difficult to be manufactured using single forming. In order to solve this problem, a method of utilizing indirect hot press forming in which a part is formed into an intermediate shape at room temperature and the preformed part is heated and then manufactured into a final part shape through hot press forming has been also partially applied. However, such indirect hot press forming has a disadvantage in that various additional production costs are required for an additional process of forming a part into an intermediate shape and a special heating furnace capable of heating the formed part.
[0004] On the other hand, in general cold press forming, it is a common approach to form a final part through a forming process with several steps. As such a cold press forming method, a method of forming a part by dividing a process into several processes using several presses and molds or forming a part by putting a multistage mold into one press has been used. Meanwhile, as a method of forming a part by putting a multistage mold into one press, a transfer type forming method in which blanks separated from each other are put into a mold and formed in multiple steps or a progressive type forming method in which a material in the form of a strip that is continuously connected is supplied and formed in multiple steps has been generally used.
[0005] However, unlike the cold press forming, it is not easy to apply a forming method contains several steps to the hot press forming because the hot press forming has a special restriction that high strength should be secured through rapid cooling of a high-temperature material.
[0006] (Patent Document 1) Korean Patent Laid-Open Publication No. 2006-0054479

[Disclosure]

[Technical Problem]

[0007] An aspect of the present disclosure is to provide a method and apparatus for manufacturing a hot press formed member for a multistage process having one or more improved properties of productivity and formability.
[0008] Another aspect of the present disclosure is to provide a formed member having excellent strength characteristics while having a complex shape that has not been obtained in a hot press forming method with a single process according to the related art.
[0009] An object of the present disclosure is not limited to the above description. Those skilled in the art to which the present disclosure pertains will have no difficulties in understanding additional objects of the present disclosure from the general contents of the specification of the present disclosure.

[Technical Solution]

[0010] According to an aspect of the present disclosure, a method for manufacturing a hot press formed member in a multistage process includes:

a heating step of heating a strip material;
a transfer step of transferring the heated strip material to a processing apparatus in which a plurality of molds

including one or more molds of a notching mold and a blanking mold; a forming mold; and a trimming mold; are mounted on one press;

one or more steps of a notching step of obtaining a notched material connected to the strip by a web portion by cutting a part of the material using the notching mold and a blanking step of obtaining a blank material separated from the strip by cutting a part of the material using the blanking mold;

a forming step of transferring the material subjected to one or more steps of the notching step and the blanking step and positioning the material in the vicinity of the forming mold, and then forming the material using the forming mold; and

a trimming step of removing an unnecessary outer edge portion of the material from a final product shape using the trimming mold.

[0011] According to another aspect of the present disclosure, an apparatus for manufacturing a hot press formed member for a multistage process includes:

a supply unit for continuously supplying a strip material;

a heating unit for heating the strip material;

a processing unit including a processing apparatus in which a plurality of molds including one or more molds of a notching mold and a blanking mold, a forming mold, and a trimming mold are mounted on one press; and

a transfer unit for transferring the strip material heated in the heating unit to the processing unit.

[0012] According to still another aspect of the present disclosure,

there is provided a hot press formed member manufactured by the method for manufacturing a hot press formed member for a multistage process,

wherein the hot press formed member has an under-cut shape, and a tensile strength of the hot press formed member is 1,300 MPa or more.

[Advantageous Effects]

[0013] As set forth above, according to an aspect of the present disclosure, the strip material may be stably heated and supplied with a fast cycle time, such that it is possible to provide a method and apparatus for manufacturing a hot press formed member for a multistage process having improved productivity.

[0014] Further, according to another aspect of the present disclosure, the strip material is formed by a multistage process, such that it is possible to relatively easily provide a complicated shape in comparison to hot press forming with a single process.

[0015] Further, according to still another aspect of the present disclosure, it is possible to provide a formed member having excellent strength characteristics while having a complex shape that has not been obtained in a hot press forming method with a single process according to the related art.

[0016] The various and beneficial advantages and effects of the present disclosure are not limited to the above description, and may be more easily understood in the description of specific exemplary embodiments in the present disclosure.

[Description of Drawings]

[0017]

FIG. 1 illustrates an exemplary hot press forming apparatus for a multistage process of the present disclosure.

FIG. 2A illustrates a result of a temperature distribution during resistance heating for a material having a uniform width, and FIG. 2B illustrates a result of a temperature distribution during resistance heating for a material having a non-uniform width.

FIG. 3 is a graph showing an operating method of an exemplary mechanical press of the present disclosure in a relationship of a stroke to a crank angle.

FIG. 4 is a graph showing a temperature change of a material over time in a case in which a common progressive method is applied in an exemplary notching step of the present disclosure.

FIG. 5 is a graph showing a temperature change of a material over time in a case in which a notching upper mold and a notching lower mold are brought into contact with a strip material only in a cutting process in an exemplary notching step of the present disclosure.

FIGS. 6 through 8 are graphs showing a temperature change of a material over time according to Examples 14 to

16, respectively.

FIG. 9 illustrates a change in thickness reduction rate in a case in which an exemplary forming process of the present disclosure is performed in a single process.

FIG. 10 illustrates a change in thickness reduction rate in a case in which an exemplary forming process of the present disclosure is performed by being divided into two steps.

FIG. 11 illustrates an exemplary hot press forming method for a multistage process of the present disclosure.

FIG. 12 illustrates a change of a material during performance of an exemplary multistage process of the present disclosure.

FIG. 13 illustrates an exemplary notching or blanking method of the present disclosure.

FIG. 14 illustrates an exemplary notching or blanking method using a push bar of the present disclosure.

FIGS. 15 through 17 illustrate a method of increasing contact time of an exemplary mold of the present disclosure.

FIG. 18 illustrates a structure of an exemplary hot press formed member of the present disclosure, in which FIG. 18A illustrates a perspective view of the formed member, and FIG. 18B illustrates a side view of the formed member.

[Best Mode for Invention]

[0018] In hot press forming, it is difficult to apply a forming method that has undergone several steps because high strength should be secured by rapidly cooling a high-temperature material. Accordingly, in recent years, there has been studied a method of applying a process of heating a blank using a galvanized steel material for hot press forming, putting the blank into a mold for several steps mounted on a mechanical servo press, and then applying a process of rapidly cooling the blank to a relatively low temperature, a process of piercing the blank, and a process of finally trimming the blank. However, in this method, it is essential to secure a sufficient performance of a heating furnace to supply the blank heated at a rate required by the press.

[0019] For example, a case in which the press is operated at a rate of 15 SPM (15 strokes per minute) means that there is a need for a heating furnace that may supply the heated blank every 4 seconds. Since a cycle time of common hot press forming is also on the order of 16 seconds, it may be considered that the operation is performed fairly quickly. It may be seen from this that there is a need for a performance of a heating furnace that may supply the heated blank every 16 seconds.

[0020] However, when the cycle time is 4 seconds, it is required to supply the blank heated at a rate 4 times faster than that in the case in which the cycle time is 16 seconds as described above. When the material stays in the heating furnace for a required time, the material is heated to a desired temperature, which means that 4 times as many blanks should be put into the heating furnace in order to heat the blank at a rate 4 times faster. Therefore, it may be presumed that a length of the heating furnace should be arithmetically longer by 4 times . For example, a length of the common heating furnace is about 30 m, and as described above, in order to heat the blank at a rate 4 times faster, the length of the heating furnace should be at a level of 120 m, or four heating furnaces having a length of 30 m should be installed in parallel.

[0021] However, an increase in length of the heating furnace becomes a big obstacle in terms of space and cost. Therefore, a facility capable of rapidly heating the blank may be used instead of using the heating furnace in a general atmosphere described above.

[0022] As a result of an earnest examination, the present inventors have found that it is not technically easy to rapidly and uniformly heat a blank having a shape. Accordingly, the present inventors have continued studies and have invented a hot press forming apparatus and method for a multistage process that implement a stable supply of a high-temperature material at a high rate capable of responding to a short cycle time and also implement improvement of formability.

[0023] In addition, the general hot press forming includes a process of performing cooling while holding the press at a bottom dead center for a predetermined time after forming and maintaining the mold in a closed state. However, in the case of the multistage process, since processes of several steps should be sequentially performed, cooling is not performed only in one mold, but is performed in a multistage mold. Therefore, in the hot press forming method for a multistage process of the present disclosure, it is required to design a process considering the effect of various process factors such as a press rate and the number of processes on cooling. Accordingly, the present inventors have designed an optimal multistage process in consideration of various process factors.

[Method for Manufacturing Hot Press Formed Member for Multistage Process]

[0024] An aspect of the present disclosure provides a method for manufacturing a hot press formed member for a multistage process, the method including:

a heating step of heating a strip material;

a transfer step of transferring the heated strip material to a processing apparatus in which a plurality of molds

including one or more molds of a notching mold and a blanking mold, a forming mold, and a trimming mold are mounted on one press;
one or more steps of a notching step of obtaining a notched material connected to the strip by a web portion by cutting a part of the material using the notching mold and a blanking step of obtaining a blank material separated from the strip by cutting a part of the material using the blanking mold;
a forming step of transferring the material subjected to one or more steps of the notching step and the blanking step and positioning the material in the vicinity of the forming mold, and then forming the material using the forming mold; and
a trimming step of removing an unnecessary outer edge portion of the material from a final product shape using the trimming mold.

[0025] According to an aspect of the present disclosure, the method may include the heating step of heating the strip material, and the strip material may be heated in a temperature range of 850 to 960°C. According to an aspect of the present disclosure, rapid heating may be applied as the heating method, and a heating rate may be in a range of 12 to 200°C/s. Meanwhile, a lower limit of the heating rate may be preferably 13°C/s, and the lower limit of the heating rate may be more preferably 30°C/s. In addition, an upper limit of the heating rate may be 100°C/s, and the upper limit of the heating rate may be more preferably 80°C/s. In addition, the heating temperature may be a value measured based on a temperature change based on any one point on a surface of the strip material.

[0026] According to an aspect of the present disclosure, as the rapid heating method, various methods such as induction heating, resistance heating, and infrared heating may be used. A strip material having a uniform width is heated using the rapid heating method described above, such that it is possible to secure a more uniform temperature distribution in comparison to a method of heating a blank material having a shape according to the related art, which ensures a stable supply of the heated strip material with a fast cycle time.

[0027] On the other hand, in the method of heating the blank material according to the related art, since it is difficult to perform uniform heating, an atmospheric heating furnace is mostly used. However, in order to supply the heated blank with a short cycle time of a multistage process, there is a problem in that the length of the heating furnace is excessively increased. Accordingly, in the present disclosure, it has been found that the problem described above can be solved by applying a rapid heating method to the strip material itself having a uniform width.

[0028] For example, in a case in which the cycle time is 4 seconds (in this case, a pitch amount designed in the multistage process to be described below is based on 500 mm), when a method of rapidly heating the blank to a final temperature in only 16 seconds is used, the length of the strip material involved in the heating process is calculated at a level of 2 m. Therefore, it is expected that a heating space may be remarkably reduced in comparison to a parallel arrangement method of four heating furnaces having a length of 120 m or 30 m in the method of heating the blank according to the related art described above as an example.

[0029] That is, according to an aspect of the present disclosure, a ratio (L/S) of the total effective length (L) of the heating devices to the cycle time (S) may be in a range of 0.25 to 4, but is not particularly limited thereto. When the range described above is satisfied, it is possible to provide a hot press forming method that may implement a stable supply of a material with a fast cycle time and improvement of formability.

[0030] In this case, the total effective length (L) of the heating devices refers to a length of a part directly used for heating the material, and m is used for a unit thereof. As an example, in the case of the heating furnace, an effective length may refer to an internal length of the heating furnace, and in the case of the induction heating, an effective length may refer to a length of a radio frequency coil used for heating. That is, the effective length refers to the total effective length of all the heating devices even in a case of including one or more of series type heating and parallel type heating. Specifically, when four heating furnaces having a length of 30 m are arranged in parallel, the total effective length of the heating devices is 120 m [= 30 m $\times$ 4]. In addition, the cycle time described above refers to a time during which one cycle is performed in a multistage process, and seconds (sec) is used for a unit thereof.

[0031] Meanwhile, according to an aspect of the present disclosure, as the strip material, a plated steel sheet including a base steel sheet and a plating layer provided on the base steel sheet may be used. That is, when the rapid heating method is applied to the strip material, an aluminum plated steel sheet or an aluminum alloy plated steel sheet may be applied in order to achieve sufficient alloying of the plating layer and to prevent melting and volatilization of the plating layer.

[0032] According to an aspect of the present disclosure, the base steel sheet may have a composition containing, by wt%, 0.1 to 0.5% of C, 0.1 to 2% of Si, 0.5 to 3% of Mn, 0.01 to 0.5% of Cr, 0.001 to 1.0% of Al, 0.05% or less of P, 0.02% or less of S, 0.02% or less of N, 0.002 to 0.005% of B, and a balance of Fe and other unavoidable impurities, but the base steel sheet is not limited to this composition. In addition, the plating layer may be alloyed with a plating material produced by hot-dip plating so as to have a composition containing, by wt%, 5 to 11% of Si, 4.5% or less of Fe, and a balance of Al and other unavoidable impurities, but the plating layer is not limited to this composition. That is, as a non-limiting example of the present disclosure, an aluminum plated steel sheet or an aluminum alloy plated steel sheet satisfying the composition described above may be used.

[0033] According to an aspect of the present disclosure, as the strip material, an aluminum plated steel sheet or an aluminum alloy plated steel sheet having an Fe content of 5 wt% or more and preferably 5 to 60 wt% (more preferably, 30 to 60 wt%) in a surface portion of the plating layer may be used. In this case, the surface portion of the plating layer refers to a region within 2 pm from the surface of the plating layer. Meanwhile, a material in which an Fe content in the surface portion of the plating layer satisfies the range described above is used as the strip material, such that high-temperature heating may be performed in a state in which a sufficient alloying time is secured when rapid heating is applied.

[0034] According to an aspect of the present disclosure, the method may further include, before the heating step, a step of continuously supplying the prepared strip material to the heating unit. In the supply of the strip material, the material prepared in the form of a coil may be continuously supplied to the heating unit in the form of a strip material having a uniform width by an uncoiler. In this case, the strip material having a uniform width means that the width of the strip material measured in a direction perpendicular to a transfer direction of the material is uniform based on the surface of the strip material.

[0035] According to an aspect of the present disclosure, the "continuous supply" may mean that the strip material is supplied to the heating unit at a constant rate, except for a moment when the supply is temporarily stopped in consideration of a subsequent process.

[0036] According to an aspect of the present disclosure, the method includes the transfer step of transferring the heated strip material to the processing apparatus in which a plurality of molds including one or more molds of a notching mold and a blanking mold, a forming mold, and a trimming mold are mounted on one press.

[0037] According to an aspect of the present disclosure, the heated strip material may be continuously transferred to the processing apparatus. In this case, as for the meaning of the continuous transfer, the same description as that of the "continuous supply" as described above may be applied, except that the heated strip material is transferred to the processing apparatus.

[0038] According to an aspect of the present disclosure, it is preferable that the cooling of the heated strip material is minimized in the transfer step described above, and thus, the transfer step of the strip material may be performed in a thermal insulation chamber. That is, the strip material is transferred in the thermal insulation chamber described above, such that heat loss prevention and easy processability in the processing apparatus may be secured.

[0039] According to an aspect of the present disclosure, the thermal insulation chamber may be maintained within a temperature range of Ts - 200°C or higher and Ts + 50°C or lower based on a surface temperature (Ts) of the strip material supplied to the thermal insulation chamber. As such, when the temperature of the thermal insulation chamber is controlled to Ts - 200°C or higher, the cooling of the strip material may be minimized during the transfer, and easy processability in the processing apparatus may also be secured, and when the temperature of the thermal insulation chamber is controlled to Ts + 50°C or lower, it is possible to prevent an additional increase in temperature during the transfer. Meanwhile, in terms of further improving the easy processability and the effect of preventing the occurrence of the additional increase in temperature during the transfer described above, the temperature of the thermal insulation chamber may be preferably 900°C or higher and Ts + 50°C or lower, and may be more preferably in a range of 900 to 1,010°C.

[0040] In this case, the heating temperature range of the material generally used in the art may also be applied to the surface temperature (Ts) of the strip material supplied to the thermal insulation chamber, and thus the range is not particularly limited in the present specification. However, as a non-limiting example, the surface temperature (Ts) of the strip material may be in a range of 850 to 960°C.

[0041] Meanwhile, according to an aspect of the present disclosure, on the one press, one or more molds of the notching mold and the blanking mold and the forming mold may be mounted to be spaced apart from each other by a designed pitch amount in the transfer direction of the strip material. For example, in a case in which only the nothing mold (or only the blanking mold) is included, on the one press, the notching mold (or the blanking mold) is sequentially mounted in advance in the transfer direction of the strip material, and then the forming mold may be mounted to be spaced apart from the notching mold (or the blanking mold) by a designed pitch amount. Alternatively, in a case in which both the notching mold and the blanking mold are included, on the one press, the notching mold, the blanking mold, and the forming mold may be sequentially mounted in the transfer direction of the strip material, and in this case, two molds adjacent to each other in the transfer direction may be spaced apart from each other by a designed pitch amount.

[0042] In addition, according to an aspect of the present disclosure, on the one press, the forming mold and the trimming mold may be mounted to be spaced apart from each other by a designed pitch amount in the transfer direction of the strip material. That is, on the one press, the notching mold (and/or the blanking mold) and the forming mold may be sequentially mounted in the transfer direction of the strip material in the same manner as described above, and the trimming mold may be mounted to be spaced apart from the forming mold by a designed pitch amount.

[0043] Alternatively, as described below, in a case in which one or more steps of a piercing step and a flanging step are further included, on the one press, a piercing mold (and/or a flanging mold) may be further mounted between the forming mold and the trimming mold in the transfer direction of the material. For example, in a case in which a piercing step is further included, on the one press, the notching mold (and/or the blanking mold), the forming mold, the piercing mold, and the trimming mold may be sequentially mounted in the transfer direction of the material.

[0044] In addition, according to an aspect of the present disclosure, in addition to the piercing step and the flanging step described above, an additional processing step commonly applicable in the art may be further included according to the object of the present disclosure. Accordingly, an additional processing mold may be mounted on the one press according to the purpose to correspond to the additional process step described above.

[0045] In this case, according to an aspect of the present disclosure, in the one press, two molds adjacent to each other in the transfer direction of the strip material may be arranged to be spaced apart from each other by a designed pitch amount. For example, in a case in which the piercing step is further included, on the one press, the piercing mold may be mounted to be spaced apart from the forming mold by a designed pitch amount, and the trimming mold may be mounted to be spaced apart from the piercing mold by a designed pitch amount.

[0046] Alternatively, according to an aspect of the present disclosure, as described below, in a case in which one or more of one or more steps of the notching step and the blanking step; the forming step; one or more steps of the piercing step and the flanging step (however, the piercing step and the flanging step may be omitted); and the trimming step are performed in a multistage process divided into two or more steps, a plurality of molds provided for the step performed by being divided into a multistage process may be mounted on one press to be spaced apart from each other by a designed pitch amount in the transfer direction of the strip material. In this case, on the one press, the first mold in the step performed in a multistage process may be mounted to be spaced apart from the mold in the previous step by a designed pitch amount in the transfer direction of the strip material. In addition, the last mold in the step performed in a multistage process may be mounted to be spaced apart from the mold in the immediately following step by a designed pitch amount in the transfer direction of the strip material.

[0047] For example, in a case in which the forming step is performed in a multistage process with two steps, in one press, a primary forming mold and a secondary forming mold may be mounted to be spaced apart from each other by a designed pitch amount in the transfer direction of the strip material. In this case, the primary forming mold may be mounted on one press to be spaced apart from the notching mold (in the case of including the notching step) in the previous step by a designed pitch amount in the transfer direction of the strip material. In addition, the secondary forming mold that is the last mold in the forming step performed in a multistage process may be mounted on one press to be spaced apart from the piercing mold (in the case of including the piercing step) used in the immediately following step by a designed pitch amount in the transfer direction of the strip material.

[0048] According to an aspect of the present disclosure, as for the plurality of molds, pitch amounts designed between two molds adjacent to each other in the transfer direction of the strip material may be the same as each other. Meanwhile, FIG. 1 illustrates a transfer direction X of the strip material, and illustrates pitch amounts 50 designed between two molds adjacent to each other in the transfer direction X. The designed pitch amount may refer to a distance between the molds measured based on the center of each mold (a point that is 1/2 of the length of one mold in the transfer direction of the material).

[0049] According to an aspect of the present disclosure, all of the plurality of molds mounted on one press may be moved in conjunction with a pressing motion by the one press. That is, an upper mold and a lower mold for each mold mounted on the one press may be combined in conjunction with the pressing motion by the one press described above. That is, when a pressing slide is lowered and stays at a pressing bottom dead center, a combination of each mold mounted on the press may be performed.

[0050] Therefore, as described above, the pitch amounts designed for two molds adjacent to each other in the transfer direction of the material are controlled to be the same, such that when the processing of the material is performed by a progressive method corresponding to an example of the present disclosure, the transfer of the material between the molds may be controlled consistently. Through this, it is possible to secure improvement in productivity and processability and to easily perform a multistage process.

[0051] That is, according to an aspect of the present disclosure, after each closing of a press upper plate (pressing slide) and a press lower plate (press bolster) according to the pressing motion of the one press is performed once, the material may be transferred in the transfer direction of the material by a designed pitch amount.

[0052] According to an aspect of the present disclosure, the method may include one or more steps of the notching step of obtaining a notched material connected to the strip by a web portion by cutting a part of the material using the notching mold and the blanking step of obtaining a blank material separated from the strip by cutting a part of the material using the blanking mold.

[0053] In the notching step or the blanking step, the upper mold and the lower mold of each mold are combined, such that the material may be processed into a desired shape by preliminarily removing an unnecessary portion from the material. In this case, the material processed into a desired shape obtained through the notching step may be a notched material connected to the strip by the web portion. In addition, the material processed into a desired shape obtained through the blanking step may be a blank material separated from the strip.

[0054] According to an aspect of the present disclosure, a heated mold may be used in one or more steps of the notching step and the blanking step, and although not particularly limited, an initial temperature of one or more molds of the notching mold and the blanking mold may be 50°C or higher. Meanwhile, the higher the temperature of the mold, the better the effect of suppressing cooling, and thus, an upper limit of the initial temperature of the mold is not particularly limited. However, the upper limit of the initial temperature of the mold may be preferably equal to or lower than the heating temperature of the strip material. That is, a heated notching mold may be used in the notching step and/or a heated blanking mold may be used in the blanking step. In general, in the notching step and the blanking step, it is essential that the upper mold and the lower mold of the mold are brought into contact with each other in order to process the material. Therefore, the heated mold is used in the notching step and the blanking step, such that it is possible to prevent the strip material heated to a high temperature from coming into contact with a cold mold, and thus, it is possible to suppress rapid cooling of the material and to secure easy formability in a subsequent process.

[0055] According to an aspect of the present disclosure, in order to suppress cooling of the strip material, one or more initial temperatures of the notching mold and the blanking mold may be 400°C or higher and more preferably 500°C or higher. The initial temperature of the mold refers to an initial temperature of the mold at a point in time when the material is put into the mold. Meanwhile, the higher the temperature of the mold, the better the effect of suppressing cooling, and thus, an upper limit of the initial temperature of the mold is not particularly limited. However, the upper limit of the initial temperature of the mold may be preferably equal to or lower than the heating temperature of the strip material. As described above, the initial temperature of the mold is controlled to be 400°C or higher, such that it is possible to secure easy formability in the forming step, which is a subsequent process. In addition, the initial temperature of each of the notching and blanking molds is controlled to be equal to or lower than the heating temperature of the strip material, such that it is possible to prevent an additional increase in temperature due to contact during notching and blanking.

[0056] According to an aspect of the present disclosure, a surface temperature of the material immediately after one or more steps of the notching step and the blanking step may be controlled to 700°C or higher and may be more preferably controlled to 712°C or higher. Meanwhile, an upper limit of the surface temperature is not particularly limited, but may be preferably equal to or lower than the heating temperature of the strip material. In this case, the surface temperature of the material is a value measured based on when the contact between the mold and the material is finished immediately after one or more steps of the notching step and the blanking step. Meanwhile, the surface temperature of the material satisfies the range described above, such that excellent formability and prevention of an additional increase in temperature may be simultaneously achieved in a subsequent process.

[0057] Meanwhile, as illustrated in FIGS. 11 through 13, in a case of a general progressive method, a strip material 200 transferred to a processing apparatus 41 is generally maintained at a transfer height level 110a of the material and is then lowered according to a movement of an upper mold 61a in a contact state with the notching upper mold 61a as contact with the notching upper mold 61a occurs. As such, the strip material 200 is lowered in the contact state with the notching upper mold 61a and is then notched by cutting a part of the strip material 200 as the strip material also comes into contact with a notching lower mold 61b in the vicinity of a bottom dead center of the slide 110b. Subsequently, the notched material is lifted again up to the original transfer height level while coming into contact with the notching upper mold 61a.

[0058] Referring to FIG. 4 illustrating an exemplary experimental result reflecting such matters, it may be confirmed that the temperature of the material is rapidly decreased in a section where the contact of the notching upper mold is started. Accordingly, the present inventors have further found that when the strip material comes into contact with the mold only at a point in time when the strip material is cut, the time during which the strip material comes into contact with the upper mold of the mold may be minimized to reduce cooling. In addition, although not additionally illustrated in the drawing, in the same manner as in the notching step described above, even in the blanking step, cooling may be reduced by minimizing the time during which the material comes into contact with the upper mold of the blanking mold.

[0059] That is, according to an aspect of the present disclosure, in the notching step and the blanking step, the strip material put into the processing apparatus may be controlled so that the strip material is lowered to the pressing bottom dead center from the transfer height level of the material in a non-contact state with the upper mold of the mold, and then comes into contact with the upper mold (or an upper mold surface) and the lower mold (or a lower mold surface) of the mold only in the cutting process.

[0060] For example, in a case in which the notching step or the blanking step is included, in the notching step (or the blanking step), the strip material put into the processing apparatus may be controlled so that the strip material is lowered to the pressing bottom dead center from the transfer height level of the material in a non-contact state with the notching upper mold (or the blanking upper mold), and then comes into contact with the notching upper mold and the notching lower mold (or the blanking upper mold and the blanking lower mold) only in the cutting process.

[0061] Alternatively, in a case in which both the notching step and the blanking step are included, the notching step is performed in the same manner as described above, and then the blanking step may be performed in the same manner as described above except that it is premised on a notched material.

[0062] In addition, according to an aspect of the present disclosure, in the notching step (or the blanking step), when the strip material is lifted after the cutting process, as in the lowering described above, the strip material may be separated from the notching (or blanking) lower mold in a non-contact state with the notching (or blanking) upper mold and then the strip material may be lifted to the transfer height level of the strip material. As such, in the notching step (or the blanking step), the notching (or blanking) upper mold and the notching (or blanking) lower mold are controlled so that they come into contact with the strip material only at a point of cutting of the strip material, such that excessive cooling in the notching step (or the blanking step) may be suppressed, thereby securing easy formability in the subsequent forming step.

[0063] Meanwhile, in FIG. 1 illustrating an exemplary hot press forming apparatus for a multistage process of the present disclosure, among the notching mold and the blanking mold, in a case in which only the notching mold is included, the notching upper mold 61a and the notching lower mold 61b are illustrated, and in a case in which only the blanking mold is included, the blanking upper mold 61a and the blanking lower mold 61b are illustrated. However, a drawing illustrating a case in which both the notching mold and the blanking mold are included is omitted.

[0064] In the notching step and the blanking step described above, various methods may be used as a method in which the strip material comes into contact with the upper mold and the lower mold of the mold only in the cutting process. For example, as illustrated in FIG. 14, as a structure protruding from a surface of the notching upper mold (or the blanking upper mold) in contact with the strip material, a push bar 11 operated by a spring may be provided. In this case, the push bar may be positioned on the surface of the notching upper mold (or the blanking upper mold) in contact with the strip material so as to correspond to the portion to be removed from the material in a subsequent process.

[0065] That is, according to an aspect of the present disclosure, the push bar 11 may allow the notching upper mold (or the blanking upper mold) to be lowered and lifted while pressing the material 200 to be in contact with the portion to be removed from the material 200 in a subsequent process. Through this, when the press is lowered and lifted, the press may be controlled so as not to be in contact with the strip material in a region other than the region where the push bar is provided on the surface of the notching upper mold (or the blanking upper mold) in contact with the strip material. As an example, the portion to be removed from the strip material in a subsequent process may correspond to a guide bar, a guide pin, or the like that guides the strip for transferring the strip.

[0066] Meanwhile, according to an aspect of the present disclosure, the present inventors have further found that, during the pressing motion of the processing apparatus, as the time for the material to stay in the vicinity of the pressing bottom dead center (that is, the holding time in the vicinity of the pressing bottom dead center) is increased, the closing time of the upper mold and the lower mold of the mold is increased, and accordingly, the cooling rate of the material may be increased.

[0067] FIG. 3 illustrates a stroke of the slide according to a crank angle for an operating method of an exemplary mechanical pressing motion of the present disclosure. FIG. 3A corresponds to a general crank motion method, and FIG. 3B corresponds to other motion methods such as link, knuckle, and servo motion methods. It may be confirmed that there is a difference in the holding time of the slide in the vicinity of the bottom dead center according to the difference in the method described above, and in the case of the motion method of FIG. 3B, a percentage of a holding time in the vicinity of the bottom dead center is higher than that of the motion method of FIG. 3A.

[0068] Therefore, according to an aspect of the present disclosure, the pressing motion of the processing apparatus may be performed by any one method selected from the group consisting of a link motion method, a knuckle motion method, and a servo motion method, but is not particularly limited thereto.

[0069] Alternatively, according to an aspect of the present disclosure, in the pressing motion of the processing apparatus, a percentage of a holding time in the vicinity of the bottom dead center in one stroke may be 4 to 30% and more preferably 10 to 30%. In this case, the percentage of the holding time in the vicinity of the bottom dead center refers to a percentage of the time the press to stay to a point corresponding to 1 mm from the pressing bottom dead center in an upward direction.

[0070] According to an aspect of the present disclosure, when the percentage of the holding time is 4% or more, a minimum mold contact time for cooling is secured, such that an increase in the number of processes for securing physical properties may be prevented. In addition, through this, it is possible to prevent an increase in extraction time of the final part so as to secure a critical cooling rate, such that desired physical properties may be easily secured. In addition, when the percentage of the holding time is 30% or less, an unnecessary holding time in the vicinity of the bottom dead center is reduced, such that it is possible to secure a stable process by sufficiently securing the processing time for the up-and-down motion of the pressing slide and the transfer of the strip.

[0071] According to an aspect of the present disclosure, one or more steps of the notching step and the blanking step may be performed in a single process, and may be performed in a multistage process by being divided into two or more steps.

[0072] In addition, according to an aspect of the present disclosure, the method may include the forming step of transferring the material subjected to one or more steps of the notching step and the blanking step and positioning the material in the vicinity of the forming mold, and then forming the material using the forming mold (that is, by combining the upper mold and the lower mold of the forming mold).

[0073] According to an aspect of the present disclosure, the forming step may be performed in a single process, or may be performed in a multistage process by being divided into two or more steps.

[0074] According to an aspect of the present disclosure, although not particularly limited, in the forming step described above, the forming step may be performed in a multistage process with two or more steps to form an under-cut shape (the same contents to be described below are applied to the under-cut shape).

[0075] According to an aspect of the present disclosure, in a case in which the forming step described above is performed in a multistage process with two or more steps, a forming direction of the material in one forming step and a forming direction of the material in the other forming step may be different from each other. For example, a forming direction of the material in a primary forming step and a forming direction of the material in an additional forming step of forming an under-cut shape after the primary forming step may be different from each other. In this case, the fact that the forming directions are different from each other means that the forming directions are not parallel to each other.

[0076] As a non-limiting example of the present disclosure, in the primary forming step, a burring portion may be first formed in a vertical forming direction based on the surface of the material, and then bending processing may be performed on the material in the forming step after the primary forming step (for example, the secondary forming step) . In this case, the bending processing is performed to form an angle of 90° or less with the forming direction described above, such that the forming direction in the primary forming step and the forming directions in the second and subsequent forming steps may be different from each other.

[0077] In this case, according to an aspect of the present disclosure, after the bending processing is performed only once, the burring portion may not be cooled by additional mold contact. Therefore, when the burring portion is formed in the forming step, the process may be designed to perform the bending processing after cooling is sufficiently performed.

[0078] That is, according to an aspect of the present disclosure, in the primary forming step, processing may be performed on the material to form a formed portion such as a burring portion, and bending processing may be performed on the material in a forming step after the primary forming step, thereby forming a bent portion (that is, a portion formed by connecting a flat portion and a side portion) to be described below on the material.

[0079] Meanwhile, as another non-limiting example of the present disclosure, the material may be formed in the primary forming step based on the plane of the material using the forming mold so that the material includes a flat portion (A) having a first plane direction (S) and a side portion (B) having a second plane direction (P) different from the first plane direction. Subsequently, in the forming step after the primary forming step (for example, the secondary forming step), the material may be formed by applying pressure to the side portion to include a portion in which an angle (D) formed by the first plane direction (S) and the second plane direction (P) is within 90° or less.

[0080] According to an aspect of the present disclosure, the method includes the forming step performed in a process with two or more steps in which the forming directions are different from each other as described above, such that it is possible to provide a hot press formed member having an under-cut shape to be described below.

[0081] That is, the method includes the forming step performed in a multistage process with two or more steps according to an aspect of the present disclosure, such that it is possible to easily form an under-cut shape that has not been formed by the prior art in which the forming step is performed in a single process. Therefore, according to the present disclosure, a formed member having an overall tensile strength of 1,300 MPa or more may be easily manufactured by applying a hot press forming method even when the formed member has the under-cut shape described above as a final product.

[0082] According to an aspect of the present disclosure, in a case in which the notching step or the blanking step is included, when the material is transferred from the notching mold or the blanking mold to the vicinity of the forming mold, the notched material (or the blank material) may be transferred by a designed pitch amount to correspond to the designed pitch amount between the notching mold (or the blanking mold) and the forming mold, thereby positioning the notched material in the vicinity of the forming mold. In this case, the vicinity of the forming mold may refer to a space in which forming is performed between the forming upper mold and the forming lower mold.

[0083] According to an aspect of the present disclosure, the method may further include, after the forming step, one or more steps of a piercing step of removing an unnecessary portion such as a hole portion from the formed material and a flanging step of forming a flange portion in the formed material. That is, one or more steps of the piercing step and the flanging step may be performed between the forming step described above and a trimming step to be described below.

[0084] That is, according to an aspect of the present disclosure, in the piercing step, the formed material may be transferred and positioned in the vicinity of the piercing mold, and then an unnecessary portion such as a hole portion may be removed from the formed material using the piercing mold (that is, by combining an upper mold and a lower mold of the piercing mold) . In this case, the vicinity of the piercing mold may refer to a space in which piercing is performed between the piercing upper mold and the piercing lower mold.

[0085] In addition, in the flanging step, the formed material (alternatively, as a case of including both the piercing step and the flanging step, when the piercing step and the flanging step are sequentially performed, the formed material refers to a "pierced material") may be transferred and positioned in the vicinity of the flanging mold, and then the formed material may be processed to form a flange portion in the pierced material using the flanging mold (that is, by combining the upper mold and the lower mold of the flanging mold). In this case, the vicinity of the flanging mold may refer to a space in which flanging is performed between the flanging upper mold and the flanging lower mold.

[0086] Meanwhile, according to an aspect of the present disclosure, in a case in which both the piercing step and the flanging step described above are included, the order of the piercing step and the flanging step is not particularly limited. That is, the piercing step and the flanging step only need to be performed between the forming step and the trimming step, and piercing and flanging may be formed sequentially, or piercing-flanging may be performed.

[0087] According to an aspect of the present disclosure, when the material is transferred from the vicinity of the forming mold to the vicinity of the piercing mold (or the flanging mold), the formed material may be transferred by a designed pitch amount to correspond to the designed pitch amount between the forming mold and the piercing mold (or the flanging mold), thereby positioning the formed material in the vicinity of the piercing mold (or the flanging mold). Meanwhile, as a case including both the piercing step and the flanging step, even when the material is transferred from the piercing mold to the flanging mold, the material may be transferred in the same manner as described above.

[0088] According to an aspect of the present disclosure, one or more steps of the piercing step and the flanging step may be performed in a single process, and may be performed in a multistage process by being divided into two or more steps. Alternatively, one or more steps of the piercing step and the flanging step may be omitted, if necessary.

[0089] In addition, according to an aspect of the present disclosure, the method may include the trimming step of removing an unnecessary outer edge portion of the material from a final product shape using the trimming mold. A material having a desired final product shape may be obtained by such a trimming step.

[0090] According to an aspect of the present disclosure, in the trimming step, the formed material (here, in a case of further including one or more steps of the piercing step and the flanging step described above, the formed material refers to a material subjected to one or more steps of the piercing step and the flanging step) may be transferred and positioned in the vicinity of the trimming mold, and then an unnecessary outer edge portion is removed from the material using the trimming mold, thereby manufacturing a material having a final product shape. In this case, the trimming step may be performed on the material transferred to the vicinity of the trimming mold (a space in which trimming is performed between the trimming upper mold and the trimming lower mold) by combining the upper mold and the lower mold of the trimming mold.

[0091] According to an aspect of the present disclosure, when the material is transferred from the forming step to the trimming step, the material may be transferred from the mold in the pre-transfer step (previous step) to the vicinity of the mold in the post-transfer step (subsequent step) by a designed pitch amount to correspond to a designed pitch amount for two molds adjacent to each other.

[0092] According to an aspect of the present disclosure, the trimming step may be performed in a single process, or may be performed in a multistage process by being divided into two or more steps.

[0093] According to an aspect of the present disclosure, one or more of one or more steps of the notching step and the blanking step; the forming step; and the trimming step (in a case of further including one or more steps of the piercing step and the flanging step described above, including the step described above) may be performed in a multistage process by being divided into two or more steps. As such, each process is performed in a multistage process, such that formability may be further improved in comparison to a case of performing each process in a single process, and a thickness reduction rate in each process may be reduced, which may further improve the effect of preventing occurrence of cracks in the final product.

[0094] According to an aspect of the present disclosure, the method may further include a step of cooling a product having the trimmed final shape to room temperature.

[0095] In addition, according to an aspect of the present disclosure, one or more of one or more steps of the notching step and the blanking step; the forming step; and the trimming step (in a case of further including one or more steps of the piercing step and the flanging step described above, including the step described above) may further include a step of cooling the mold. For example, in a case in which the forming step is performed in a multistage process by being divided into two or more steps, the secondary forming step may further include a step of cooling the secondary forming mold.

[0096] Meanwhile, in a common hot press forming method, forming is completed in one process, and the material is rapidly cooled to secure strength while the material is held in the mold for a predetermined time immediately after the forming. On the other hand, in the technique of the present disclosure, cooling is performed through several processes such as notching, blanking, forming, piercing, flanging, and/or trimming.

[0097] Therefore, according to an aspect of the present disclosure, as a result of an earnest examination on the availability of the physical properties of the material through the multistage process described above, the present inventors have further found that the cooling rate of the material that may determine the availability of the physical properties of the material may be influenced by SPM, which is a press rate, the number of processes until the final product is taken out, the holding time to stay in the vicinity of the bottom dead center to close the upper mold and the lower mold in one process, the relational expression of the slide stroke, and the like.

[0098] That is, according to an aspect of the present disclosure, the multistage process may be performed with the number of processes equal to or greater than a minimum number of processes calculated by the following Relational Expression 1. Through this, a product having desired physical properties may be obtained.

[Relational Expression 1]

$$N = \mathrm{ROUNDUP}\ \{T/[(60/SPM) \times (f/100)]\}$$

[0099] (In Relational Expression 1, N represents a minimum required number of processes from the forming step except for the notching step and the blanking step,

SPM represents the number of strokes per minute (SPM) of the press,
f represents a percentage (%) of a holding time in the vicinity of the bottom dead center in one stroke,
T represents a value calculated from the following Relational Expression 2 when $0.8 \leq t < 1.5$, and represents a value calculated from the following Relational Expression 3 when $1.5 \leq t$, and
ROUNDUP represents a value obtained by rounding up the number below the decimal point of the calculated value within {}.)

[Relational Expression 2]

$$T = t$$

[Relational Expression 3]

$$T = 5 \times t - 6$$

[0100] (In Relational Expressions 2 and 3, t is a thickness of the material, and a unit thereof is mm.)
[0101] In addition, according to an aspect of the present disclosure, f may satisfy the following Relational Expression 4 when $0.8 \leq t < 1.5$ is satisfied, and may satisfy the following Relational Expression 5 when $1.5 \leq t$ is satisfied.

[Relational Expression 4]

$$0.8 \times t + 2.6 \leq f$$

[Relational Expression 5]

$$4.4 \times t - 2.8 \leq f$$

[0102] (In Relational Expressions 4 and 5, t is a thickness of the material, and a unit thereof is mm.)
[0103] According to an aspect of the present disclosure, as the thickness of the material is increased, cooling is not easily performed, and thus the contact time with the mold needs to be longer. Therefore, as the thickness of the material is increased, a pressing motion having a large holding percentage at the bottom dead center may be selected.
[0104] Alternatively, according to an aspect of the present disclosure, the contact time with the mold may be approached by increasing the number of processes, but as an air-cooling time is increased due to too many processes in a state of little contact with the mold in one process, the room for occurrence of other phases increases. Therefore, most preferably, it is required to increase the percentage of the holding time for the pressing slide to stay in the vicinity of the bottom dead center in one process. In addition, the contact time with the mold affects not only the percentage of the holding time for the slide to stay in the vicinity of the bottom dead center, but also the duration of one process, that is, the pressing motion rate (SPM) .
[0105] Therefore, according to an aspect of the present disclosure, a final product having desired strength may be obtained by performing a multistage process in which the number of processes is equal to or greater than the minimum required number of processes calculated from Relational Expression 1, and securing a minimum f value according to the thickness of the material represented in Relational Expressions 4 and 5.
[0106] According to an aspect of the present disclosure, in the notching step and the blanking step, it is required to suppress cooling of the material, while in the multistage process after the notching step and the blanking step (that is, from the forming step), it is required to promote cooling so as to secure a temperature below an Ms temperature in the final product. Therefore, it is required to increase the contact time with the mold for rapid cooling, and to this end, the

following method may be used.

[0107] In a common progressive method, the position of the strip material is lifted in conjunction with lifting of the press upper mold, and the strip material waits for transfer to the subsequent step. However, in this case, the formed product (or the material) is cooled in contact with the upper mold and the lower mold of the mold only while the pressing slide stays in the vicinity of the bottom dead center, and as the pressing slide is lifted, the formed product is also lifted and separated from the upper mold and the lower mold of the mold, and thus the formed product is cooled only to a level of air-cooling.

[0108] Therefore, as a result of earnestly examining a preferred exemplary embodiment of the multistage process by the present inventors, it is found that since the strip material is not transferred during lifting of the slide upper plate (pressing slide), as illustrated in FIGS. 15 through 17, the pressing slide may be lifted from the pressing bottom dead center to a predetermined height, and the material (or the formed product) may stay in the vicinity of the pressing bottom dead center before the transfer step of the strip material. It was further found that faster cooling could be secured in a case of applying a method of allowing the material to stay in the vicinity of the pressing bottom dead center during lifting of the pressing slide and lifting the material immediately before the point of the transfer step of the strip by utilizing the position information of the pressing slide.

[0109] FIGS. 15 through 17 illustrate the pressing motion of the exemplary processing apparatus 41 of the present disclosure. That is, according to an aspect of the present disclosure, as illustrated in FIG. 15, when the material is put into the processing apparatus 41, a pressing slide 6a is lowered to a pressing bottom dead center 120b to process the material. Next, as illustrated in FIG. 16, the material stays in the vicinity of the pressing bottom dead center 120b during lifting of the pressing slide 6a. Finally, as illustrated in FIG. 17, when the pressing slide is lifted and reaches a point 120a that does not interfere with the transfer of the material, a method of lifting the material positioned in the vicinity of the pressing bottom dead center 120b may be applied by utilizing the position information of the pressing slide.

[0110] According to an aspect of the present disclosure, the method of lifting the material described above is illustrated in FIG. 17. Specifically, when the pressing slide 6a is lifted and then reaches the point 120a that does not interfere with the transfer of the material, the material may be lifted from the vicinity of the pressing bottom dead center to the transfer point 120a by a material position control unit 600 in the form of a cylinder that controls the material to be separated from lower molds 61b, 62b, 63b, and 64b of a mold used in each step.

[0111] In this case, according to an aspect of the present disclosure, the material position control unit 600 may be provided on the surface on which the mold on the press lower plate (that is, the press bolster) is provided. More specifically, the material position control units 600 may be provided at both ends of one mold (that is, any one of the lower molds 61b, 62b, 63b, and 64b) in the transfer direction of the material. Alternatively, as illustrated in FIG. 17, one material position control unit 600 may be provided between two molds adjacent to each other.

[0112] In addition, according to an aspect of the present disclosure, in a case in which the forming step is performed in a multistage process with two or more steps, in order to prevent occurrence of cracks due to excessive cooling of a portion to be formed, the forming step may further include a step of heating one or more forming molds of additional forming molds other than the primary forming mold used in the primary forming step.

[0113] Alternatively, according to an aspect of the present disclosure, one or more steps of the piercing step and the flanging step, and/or the trimming step may further include a step of heating one or more molds in each step in order to prevent occurrence of cracks due to excessive cooling of the processed portion.

[0114] A three-dimensional structure of the material after passing through the multistage process according to the exemplary progressive method of the present disclosure is illustrated in FIG. 12A. Specifically, a notched material 210 after passing through the notching step as a first process has a shape connected to the strip by a web portion 300. Subsequently, a formed material 220 after passing through the forming step as a second process forms a three-dimensional structure. In this case, a side view of the three-dimensional structure is illustrated in FIG. 12B. In addition, a shape of a pierced material 230 after passing through the piercing step as a third process is illustrated, and an unnecessary hole portion is removed from the material. In addition, a trimmed material 240 after passing through the trimming step as a fourth process is illustrated, and an unnecessary outer edge portion 400 is removed by performing the trimming step. By performing all the processes described above, a final product (250 in FIG. 11) taken out from the processing apparatus may be obtained.

[0115] In addition, although not particularly illustrated in the drawing, in a case of including the blanking step of obtaining a blank material separated from a strip according to a transfer method to be described below, the material may be processed in the same manner, except that a blank separated from the strip is formed so as not to include the strip web portion as illustrated in FIG. 12, and then a subsequent process is performed. In this case, the shape of the material may be formed in the same manner as in the case of using a common method in the art.

[0116] Meanwhile, according to an aspect of the present disclosure, in the case of the progressive method, the material is transferred by forming a material guide portion in the web portion 300 and operating the material guide portion. The strip web portion 300 is a portion that is not actually formed and is removed from the final product shape in the trimming step. Therefore, the web portion 300 may be heated at a low temperature in the processing process or may be cooled faster than the portion of the material to be processed in the notching step so as to promote smooth transfer of the material.

[0117] That is, according to an aspect of the present disclosure, in the notching step, the cooling of the web portion of the material may be performed faster than the cooling of the formed portion of the material.

[0118] Alternatively, according to an aspect of the present disclosure, in the notching step, the web portion of the material may be controlled to a temperature lower than that of the formed portion of the material of the product. As such, in order to control the web potion of the material to a lower temperature than other portions, in the notching mold, only a part of the mold corresponding to the web portion of the material may be controlled to a temperature lower than those of other portions.

[0119] In addition, in the hot press forming method for a multistage process according to an aspect of the present disclosure, it is required to achieve uniform heating by rapidly heating the strip material and to minimize a decrease in temperature by minimizing the contact time with the mold in one or more steps of the notching step and the blanking step for a high-temperature strip material. On the other hand, in the forming step, the piercing step, the flanging step, the trimming step, and the like (here, one or more steps of the piercing step and the flanging step may be omitted) after the one or more steps of the notching step and the blanking step, it is required to secure fast cooling by maximizing the contact time of the material with the mold. As such, in a case in which the hot press forming method is performed to the final step by the progressive method, one or more steps of the notching step and the blanking step, the forming step, the piercing step, the flanging step, and the trimming step all proceed to the same transfer point, and thus conflicting requirements make it difficult to achieve different goals.

[0120] Therefore, as a result of an earnest examination, the present inventors have further found that there are many advantages to using the progressive method in the heating step, the notching step, and the blanking step in order to satisfy the conflicting requirements described above in each step, and the contact with the mold may be controlled for a longer period of time using the transfer method in the forming step, the piercing step, the flanging step, and the trimming step.

[0121] According to an aspect of the present disclosure, it is confirmed that physical properties are secured more advantageously by applying a complex method in which the heating step, the notching step, and the blanking step are performed by the progressive method and the forming step, the piercing step, the flanging step, and the trimming step are performed by the transfer method.

[0122] That is, according to an aspect of the present disclosure, the hot press forming method for a multistage process may include the blanking step of obtaining a blank material separated from the strip by cutting a part of the heated strip material put into the processing apparatus, and it is possible to apply a transfer method using a tongs-shaped (or, a gripper-shaped) transfer unit when the material is transferred from the mold in the pre-transfer step (previous step) to the vicinity of the mold in the post-transfer step (subsequent step) based on two molds adjacent to each other in the transfer direction of the material in one press.

[0123] For example, when the material is transferred from the blanking step to the forming step, and when the material is transferred from the forming step to the subsequent step (the piercing step, the flanging step, or the trimming step), the material positioned in the vicinity of the mold in the previous step may be transferred to the vicinity of the mold in the subsequent step using the tongs-shaped (or, the gripper-shaped) transfer unit.

[Apparatus for Manufacturing Hot Press Formed Member for Multistage Process]

[0124] Another aspect of the present disclosure provides an apparatus for manufacturing a hot press formed member for a multistage process, the apparatus including:

a supply unit for continuously supplying a strip material;
a heating unit for heating the strip material;
a processing unit including a processing apparatus in which a plurality of molds including one or more molds of a notching mold and a blanking mold, a forming mold, and a trimming mold are mounted on one press; and
a transfer unit for transferring the strip material heated in the heating unit to the processing unit.

[0125] Meanwhile, the description of the method for manufacturing a hot press formed member for a multistage process described above may be similarly applicable to the apparatus for manufacturing a hot press formed member for a multistage process.

[0126] Specifically, an exemplary structure of the apparatus for manufacturing a hot press formed member for a multistage process of the present disclosure is illustrated in FIG. 1, and an apparatus 100 for manufacturing a hot press formed member for a multistage process includes a supply unit 1, a heating unit 2, a transfer unit 3, and a processing unit 4.

[0127] According to an aspect of the present disclosure, the supply unit 1 continuously supplies a strip material 200. In this case, the supply unit 1 may continuously supply a material 10 provided in the form of a coil to the heating unit 2 in the form of a strip material having a uniform width by an uncoiler.

[0128] According to an aspect of the present disclosure, the heating unit 2 may heat the strip material supplied from the supply unit described above using a heating device 21. In this case, the rapid heating method described above may be applied, and for example, various heating devices such as an induction heating device, a resistance heating device, and an infrared heating device may be used.

[0129] According to an aspect of the present disclosure, the transfer unit 3 may transfer the strip material 200 heated in the heating unit 2 to the processing unit 4. In this case, the transfer of the strip material 200 may be performed in a thermal insulation chamber 31. Meanwhile, the same description described above may apply to the thermal insulation chamber.

[0130] According to an aspect of the present disclosure, the processing unit 4 may include a processing apparatus 41 in which one or more molds 61a and 61b of a notching mold and a blanking mold, forming molds 62a and 62b, and trimming molds 64a and 64b are mounted on one press 6, 6a, or 6b. Meanwhile, in the forming method, as described above, one or more molds of a piercing mold and a flanging mold may be further mounted between the forming mold and the trimming mold.

[0131] According to an aspect of the present disclosure, the one press 6 may include a pressing slide corresponding to an upper plate 6a of the press and a press bolster corresponding to a lower plate 6b of the press. In this case, the lower plate 6b of the press may be provided to face the upper plate 6a of the press.

[0132] According to an aspect of the present disclosure, the processing apparatus 41 may further include additional temperature control unit 5a and 5b for the mold for controlling the temperature of each mold described above, and the temperature control unit for the mold may be provided between the mold and the press. That is, the temperature control unit for the mold may be provided on the press in contact with each mold.

[0133] According to an aspect of the present disclosure, in a case of using a heated mold as the notching mold and/or the blanking mold, the processing apparatus 41 may further include additional temperature control units 51a and 51b for the notching mold and/or the blanking mold for controlling the temperature of the mold. In this case, the temperature control units 51a and 51b may be provided between the molds 61a and 61b and the presses 6a and 6b.

[0134] In addition, according to an aspect of the present disclosure, a temperature control unit for each mold may be additionally provided between each mold and press in the same manner as described above (for example, temperature control units 52a and 52b for the forming molds, temperature control units 53a and 53b for the piercing molds or the flanging molds, and temperature control units 54a and 54b for the trimming molds, see FIG. 1B).

[0135] According to an aspect of the present disclosure, as described above, as a structure protruding from a surface of the notching upper mold or the blanking upper mold in contact with the strip material, a push bar 11 operated by a spring may be provided (see FIG. 14). Meanwhile, the same description described above may apply to the push bar.

[0136] According to an aspect of the present disclosure, as described above, a material position control unit 600 in the form of a cylinder may be provided on a surface on which the mold on the press lower plate (that is, the press bolster) is provided. The same description described above may apply to the material position control unit 600.

[0137] In addition, according to an aspect of the present disclosure, the processing apparatus may include blanking molds as a plurality of molds, and may further include a tongs-shaped (or, a gripper-shaped) transfer unit for transferring the material from the mold in a previous step to the vicinity of the mold in a subsequent step based on two molds adjacent to each other in a transfer direction of the material. In this case, the tongs-shaped (or, the gripper-shaped) transfer unit is an example of applying a transfer method, and the same description described above may be applied.

[0138] In addition, the same contents as those of the method for manufacturing a hot press formed member for a multistage process described above may be applied to the apparatus for manufacturing a hot press formed member for a multistage process according to an aspect of the present disclosure. Therefore, as an example, a processing apparatus that may perform a multistage process in which the number of processes is equal to or greater than the minimum required number of processes calculated from Relational Expression 1 may be used. For example, in the processing apparatus described above, the number of the plurality of molds mounted on one press may be equal to or greater than the minimum number of processes calculated from Relational Expression 1 described above. Alternatively, a processing apparatus satisfying Relational Expressions 4 and 5 described above may be used by utilizing the information on the thickness (corresponding to t in Relational Expressions 4 and 5) of the material put into the processing apparatus.

[Hot Press Formed Member]

[0139] Still another aspect of the present disclosure provides

a hot press formed member manufactured by the method for manufacturing a hot press formed member for a multistage process,
wherein the hot press formed member has an under-cut shape, and a tensile strength of the hot press formed member is 1,300 MPa or more.

[0140] According to an aspect of the present disclosure, the under-cut shape has the same meaning as the term used in the art. Accordingly, the under-cut shape may include various shapes commonly interpreted in the art. For example, since a convex or concave portion is included in a side portion or a burring portion or the like is formed in the side portion, a formed shape of a hot press formed member may include a shape that may not form a formed product or may not be taken out by only a vertical movement of the mold.

[0141] As a non-limiting example of the present disclosure, various shapes of the hot press formed member are illustrated in FIG. 18. The hot press formed member according to an aspect of the present disclosure may include a flat portion (A) having a first plane direction (S) and a side portion (B) having a second plane direction (P) different from the first plane direction. In this case, the hot press formed member may have one or more flat portions and/or one or more side portions. Meanwhile, in the hot press formed member, any one of the flat portions (A) and any one of the side portions (B) may be connected to each other, and since the flat portion (A) and the side portion (B) described above have plane directions different from each other, the flat portion (A) and the side portion (B) are connected to each other to provide a bent portion.

[0142] For example, in a case in which the hot press formed member has a hat shape as illustrated in FIG. 18, a first side portion and a second side portion may be connected to each of both ends of one flat portion (that is, the first side portion may be connected to one end of both ends of one flat portion, and the second side portion may be connected to the other end). In addition, a first flat portion may be additionally connected to the end of the first side portion other than the end connected to the flat portion, and a second flat portion may be additionally connected to the end of the second side portion other than the end connected to the flat portion (however, the hot press formed member may further include, but is not limited to, additional flat portions and/or side portions). Therefore, as a non-limiting example of the present disclosure, the hot press formed member may be composed of three flat portions (A) and two side portions (B) as illustrated in FIG. 18.

[0143] Meanwhile, as a non-limiting example of the present disclosure, as illustrated in the side view of the formed member of FIG. 18B, the under-cut shape may include a portion where an angle (D) of a narrow side formed by the first plane direction (S) of one flat portion (A) and the second plane direction (P) of one side portion (B) is within 90°.

[0144] Alternatively, as another non-limiting example of the present disclosure, as illustrated in the perspective view of the formed member of FIG. 18A, the under-cut shape may include an additional formed portion (C) (for example, including a burring portion or the like) in one or more of any one of the flat portions (A) and any one of the side portions (B). In this case, the formed member may include a bent portion formed by connecting any one of the flat portions (A) and any one of the side portions (B) . Accordingly, the formed portion (C) may be provided on a plane of the side portion in the second plane direction.

[0145] According to an aspect of the present disclosure, in a case in which the forming step described above is performed in a multistage process with two or more steps, the under-cut shape may be formed by a manufacturing method in which a forming direction of the material in one forming step and a forming direction of the material in the other forming step are different from each other. Specifically, the under-cut shape may mean that two or more portions having forming directions different from each other are included, and in this case, the same description described above may apply to the forming direction.

[0146] For example, as described above, in a case in which a burring portion is formed in the primary forming step and then bending processing is performed in the secondary forming step, since the forming directions in the primary forming step and the secondary forming step are different from each other, it is possible to form an under-cut shape that may not be formed when the forming step is performed in a single process.

[0147] Alternatively, as another example, the material may be processed in the primary forming step to include a flat portion and a side portion, and then pressure may be applied to the material in a direction perpendicular to a plane of the side portion in the secondary forming step, thereby forming an under-cut shape in which an angle formed by the flat portion and the side portion is within 90°.

[0148] Meanwhile, according to an aspect of the present disclosure, the hot press formed member may have an overall tensile strength of 1,300 MPa or more even when it has an under-cut shape, and an upper limit of the tensile strength may not be particularly limited because the higher the strength characteristic, the better the characteristic. However, as a non-limiting example, the upper limit of the tensile strength may be 2,000 MPa.

[Mode for Invention]

(Examples)

[0149] Hereinafter, the present disclosure will be described in more detail with reference to Examples. However, it should be noted that the following Examples are provided to describe the present disclosure by way of illustration, but are not intended to limit the scope of the present disclosure. This is because the scope of the present disclosure is determined by contents disclosed in the claims and contents reasonably inferred therefrom.

(Experimental Example 1)

[0150] A strip material having a uniform width and a blank material having a non-uniform width were prepared, and resistance heating was performed for each material at a heating rate of 50°C/s. At this time, an alloy plated steel sheet having an Fe content of 30 wt% in a surface portion of a plating layer (within 2 μm from the surface of the plating layer) was used as a material, the alloy plated steel sheet obtained by alloying a plated steel sheet formed by immersing, in a plating bath Al-Si9%-Fe3%, a base steel sheet having a composition containing, by wt%, 0.22% of C, 0.3% of Si, 1.2% of Mn, 0.2% of Cr, 0.03% of Al, 0.01% of P, 0.001% of S, 0.003% of N, 0.003% of B, and a balance of Fe and other unavoidable impurities.

[0151] A temperature distribution result at the time of the resistance heating of the strip material having a uniform width is illustrated in FIG. 2A as Example 1, and a temperature distribution result at the time of the resistance heating of the strip material having a non-uniform width is illustrated in FIG. 2B as Comparative Example 1.

[0152] As can be seen by comparing the temperature distribution results of FIG. 2, in Comparative Example 1, as illustrated in FIG. 2B, a larger temperature difference occurred in a narrow region and a wide region of the material in comparison to FIG. 2A. Therefore, in the case of Example 1 using the strip material having a uniform width in FIG. 2A, it was confirmed that more uniform heating was easily performed by applying rapid heating in comparison to Comparative Example 1 using the blank having a non-uniform width.

(Experimental Example 2)

[0153] The prepared strip material having a thickness of 1.4 mm was rapidly heated to 920°C at a heating rate of 50°C/s using a resistance heating method with an effective length of a heating device having 2 m and a cycle time of 4 seconds. In this case, the same alloy plated steel sheet used in Experimental Example 1 was used as the strip material. Subsequently, the heated strip material was passed through a heating chamber at 900°C and then transferred to a processing apparatus. The transferred strip material was operated at 15 SPM using a pressing motion by a crank motion method of FIG. 3A. The case in which nothing was performed using a notching mold in a cold state having an initial temperature of 25°C was used as Example 2, and the case in which notching was performed using a notching mold in a heated state having an initial temperature of 500°C was used as Example 3. A graph of the temperature change of the material over time in the notching step of each of Examples 2 and 3 is illustrated in FIG. 4.

[0154] In the case of Example 2, cooling of the material was significantly quickly performed from when a notching upper mold was lowered and came into contact with the material by using the notching mold in a cold state. On the other hand, in the case of Example 3, excessive cooling was suppressed when the notching upper mold was lowered and then came into contact with the material using the heated notching mold having an initial mold temperature of 50°C or higher. That is, in Example 3, excessive cooling was suppressed in comparison to Example 2, such that after completion of the notching step, the temperature of the material was controlled to 700°C or higher. Therefore, it was confirmed that the elongation of the material subjected to the notching step of 50% or more was secured, which was a level sufficient to perform the forming process in a subsequent process, and thus formability in the subsequent process was more excellent.

(Experimental Example 3)

[0155] A strip material was processed in the same manner as that of Experimental Example 2 described above, except that a strip material having a thickness of 1 mm was used and the initial temperature of the notching mold was changed as shown in Table 1. At this time, a surface temperature of the material was measured based on the point at which contact of the notching mold with the material was finished in the notching step. The result thereof is shown in Table 1.

[0156] Meanwhile, in order to confirm the effect of availability of additional forming according to the temperature of the notching mold, an elongation of the material obtained after the notching step was measured to evaluate availability of additional forming based on the following criteria.

×: Elongation of less than 50%
◦: Elongation of 50% or more

[0157] At this time, in Comparative Example 2, when the blank itself, not the strip material, was rapidly heated, a surface temperature of the material was measured. The result thereof is shown in Table 1. Availability of additional forming was measured in the same manner as described above.

[0158] In addition, the uniformity of the temperature of the material was measured in the same manner as that of Experimental Example 1 described above, and evaluation was performed according to the following criteria.

×: Case in which the temperature difference generated in the material was 50°C or higher
◦: Case in which the temperature difference generated in the material was lower than 50°C

[Table 1]

No.	Initial temperature of notching mold	Surface temperature of material	Uniformity of temperature	Availability of additional forming
Comparative Example 2	500°C	550 to 720°C	×	×
Example 4	25°C	608°C	○	×
Example 5	50°C	612°C	○	×
Example 6	200°C	656°C	○	×
Example 7	300°C	682°C	○	×
Example 8	400°C	712°C	○	○
Example 9	500°C	742°C	○	○
Example 10	600°C	772°C	○	○
Example 11	700°C	801°C	○	○

[0159] As shown in Table 1, in Comparative Example 2, a high surface temperature of the material was secured by heating the blank itself, but due to the non-uniform temperature distribution caused by the shape of the blank material having a non-uniform width, after the blanking step, a portion of the material having a temperature that was too low was formed, resulting in unavailability of additional forming.

[0160] On the other hand, in the cases of Examples 4 to 11 in which the strip material was rapidly heated, it was confirmed that the temperature uniformity of the material was superior to that in Comparative Example 2.

[0161] Meanwhile, in Examples 8 to 11 in which the initial temperature of the notching mold was 400°C or higher, since the temperature of the material after notching was higher than those in Comparative Examples 4 to 7 in which the initial temperature of the notching mold was lower than 400°C, a desired level of an elongation was secured, and thus additional forming was possible.

(Experimental Example 4)

[0162] A strip material was notched in the same manner as that of Experimental Example 2, except that the operation was performed using a pressing motion by a link method of FIG. 3B, a push bar was provided on a surface of the notching upper mold in contact with the strip material so that the notching upper mold and the notching lower mold were in contact with the strip material only in the cutting process in the notching step, and the push bar was controlled to be operated by a spring. At this time, the case in which the initial temperature of the notching mold was 25°C was used as Example 12, and the case in which the initial temperature of the notching mold was 500°C was used as Example 13. A graph of the temperature change of the material over time in the notching step is illustrated in FIG. 5.

[0163] Meanwhile, it was conformed from the comparison of FIGS. 4 and 5 that in Examples 12 and 13, the cooling of the material was significantly reduced as the contact time with the notching upper mold was decreased in comparison to Examples 2 and 3. As such, when the press was lowered and lifted, the notching upper mold was lowered and lifted without contact with the strip material, and the notching upper and lower molds were brought into contact with the strip material only in the cutting process, such that the surface temperature of the material after the notching step was controlled to be higher. It was confirmed from this that a high elongation of 50% or more of the material was secured, and more excellent formability was confirmed in the subsequent process.

(Experimental Example 5)

[0164] A steel sheet having the same composition as used in Experimental Example 1 described above as the prepared strip material having a thickness of 1.4 mm was rapidly heated to 920°C at a heating rate of 50°C/s using a resistance heating method. Subsequently, the heated strip material was transferred to a processing apparatus in a thermal insulation chamber at 900°C. The transferred strip material was operated at 15 SPM using the motion method shown in Table 2 and the pressing motion satisfying a holding percentage in the vicinity of the bottom dead center in one stroke, and a notching step, a forming step, a piercing step, and a trimming step of the HAT-shaped product were performed. At this time, in the notching step, the notching mold having an initial temperature satisfying Table 2 was used, and the notching upper mold and the notching lower mold were controlled to be in contact with the strip material only in the cutting process using a push bar.

[0165] The formability, whether or not a martensite (Ms) phase was secured, and the strength characteristic of Examples 14 to 16 satisfying the experimental conditions of Table 2 were evaluated. The results are shown in Table 2.

[0166] In this case, the formability was evaluated on the same criteria as those of Experimental Example 3 described above. As for the strength characteristic of the product, a fraction of 99% or more of the martensite phase in the final product was secured based on the forming and cooling analysis method considering the phase transformation of the material, and thus the tensile strength was 1,300 MPa or more was indicated as "◦", and the case in which a fraction of the martensite phase secured in the final product was 90% or less was indicated as "×".

[Table 2]

No.	Initial temperature of notching mold	Motion method of pressing motion	Holding percentage in vicinity of bottom dead center in one stroke	Formability	Strength characteristic of product
Comparative Example 3	-	FIG. 3(A)	3.20	×	×
Example 14	25°C	FIG. 3(A)	3.2%	○	×
Example 15	500°C	FIG. 3(A)	3.2%	○	×
Example 16	500°C	FIG. 3(B)	10%	○	○

[0167] The temperature changes of the material over time during the multistage process of Examples 14 to 16 shown in Table 2 are illustrated in FIGS. 6 through 8, respectively. In this case, as for the temperature change of the material, a temperature change on the surface of the final product is illustrated based on the point that is the circled portion in each of FIGS. 6 through 8.

[0168] In the case of Comparative Example 3 in which the multistage process was performed in the same conditions as those in Examples 14 to 16 except for applying the method of rapidly heating the blank material according to the related art, due to the non-uniform temperature distribution caused by the shape of the blank material having a non-uniform width, a portion of the material having a temperature that was too low was formed, resulting in unavailability of additional forming.

[0169] Meanwhile, in the case of Example 14, it was confirmed that the formability was superior to that in Comparative Example 3. However, as illustrated in FIG. 6, the cooling rate was low because the contact time with the mold was rather short, and thus 99% or more of sufficient martensite was not secured.

[0170] On the other hand, in the case of Example 15, as illustrated in FIG. 7, a decrease in temperature in a section of 0 to 4 seconds corresponding to the notching step was rather reduced, and the formability was superior to that in Example 14. However, the contact time with the mold and the formed product was rather short, and thus 99% or more of sufficient martensite was not secured.

[0171] In addition, in the case of Example 16, as illustrated in FIG. 8, since a decrease in temperature in the notching step was low, the formability was excellent and the strength characteristic of the product was also more excellent.

[0172] Specifically, in Example 16, since a percentage of a holding time for the upper mold and the lower mold of the mold to stay at the pressing bottom dead center in a closed state was higher than those in Examples 14 and 15, a fast cooling rate of the material in the whole process was secured. Therefore, after the multistage process was performed for 16 seconds in total, the temperature of the material was secured below the Ms temperature of 400°C, and thus a critical cooling rate was secured, such that a martensite phase was sufficiently secured after the multistage process. As a result, a product having a desired predetermined strength characteristic was obtained.

(Experimental Example 6)

[0173] When the notched material manufactured by the method of Experimental Example 2 was manufactured, the case in which the notching step was performed in a single process as illustrated in FIG. 9A was used as Example 17. A thickness reduction rate at this time is illustrated in FIG. 9B. Similarly, the case in which the notching step was performed by being divided into a two-step process as illustrated in FIG. 10A was used as Example 18. A thickness reduction rate at this time is illustrated in FIG. 10B.

[0174] It was confirmed that in the case of Example 18, since the notching step was performed by being divided into two steps, a thickness reduction rate in the final product was further reduced, and therefore, the effect of preventing occurrence of cracks was more excellent, in comparison to Example 17 in which the notching step was performed in a single process.

(Experimental Example 7)

[0175] The evaluation results of the pressing motion rate (SPM) and the percentage of the holding time for the slide to stay in the vicinity of the bottom dead center in one process, whether or not the material taken out is secured below the Ms temperature according to the change in the minimum required number of processes from the forming step excluding notching, whether or not a stable martensite phase is secured, and the physical properties of the product depending on several thicknesses of the materials having the same composition as in Experimental Example 2 described above are shown in Table 3.

[0176] In this case, the formability was evaluated based on the same criteria as those in Experimental Example 2 described above, as for whether or not a stable martensite phase was secured, based on the same criteria as those in Experimental Example 5 described above, the case in which 99% or more of the martensite phase was secured was indicated as "OK", and the case in which 90% or less of the martensite phase was secured was indicated as "NOK". In addition, the evaluation of the product strength corresponds to "OK" described above. The case in which the tensile strength was 1,300 MPa or more was indicated as "o", and the other cases were indicated as "×".

[Table 3]

Experimental Example	Material thickness [mm]	f	SPM	Number of processes	Whether or not to reach below Ms temperature when removing product	Evaluation of formability	Whether or not stable martensite phase is secured	Evaluation of product strength
Comparative Example 4	1	12.5	15	3	OK	×	NOK	×
Example 19	1	5	15	5	OK	○	NOK	×
Example 20	1	12.5	15	3	OK	○	OK	○
Example 21	1	5	10	3	OK	○	NOK	×
Example 22	1	7.5	10	3	OK	○	NOK	×
Example 23	1	7.5	15	4	OK	○	NOK	×
Example 24	1	9	15	4	OK	○	OK	○
Example 25	1	9	15	2	NOK	○	There is room for formation of phases other than martensite phase during time of air-cooling after removing product	×
Example 26	1.5	5	15	7	OK	○	NOK	×
Example 27	1.5	12.5	15	4	OK	○	OK	○
Example 28	1.5	12.5	15	2	NOK	○	There is room for formation of phases other than martensite phase during time	×
							of air-cooling after removing product	
Example 29	1.5	7.5	15	5	OK	○	NOK	×
Example 30	1.5	10	15	4	OK	○	OK	○
Example 31	1.5	12.5	30	6	OK	○	OK	○
Example 32	2	5	15	8	OK	○	NOK	×
Example 33	2	12.5	15	7	OK	○	NOK	×
Example 34	2	25	15	3	NOK	○	There is room for formation of phases other than martensite phase during time of air-cooling after removing product	×
Example 35	2	25	15	4	OK	○	OK	○
Example 36	2	17.5	10	4	OK	○	OK	○

[0177] As shown in Table 3, in the case of Comparative Example 4 in which a method of rapidly heating the blank material according to the related art was applied, despite the condition that the physical properties were secured as in Example 20 due to the temperature non-uniformity of the material caused in the heating step, the formability was not excellent due to the temperature non-uniformity of the material caused in the heating step, and the physical properties of the final product were not secured.

[0178] Meanwhile, in Examples 19, 21 to 23, 26, 29, 32, and 33, the formability was superior to that in Comparative Example 4, but the physical properties were not secured because other phases were formed due to the minimum f value that was smaller than the minimum f value required from the material thickness according to Relational Expressions 4 and 5 described above. In addition, in Examples 25, 28, and 34, the minimum f value satisfied the minimum f value required from the material thickness according to Relational Expressions 4 and 5 described above, but the minimum number of processes was smaller than the minimum number of processes (N) calculated from Relational Expression 1. For this reason, the temperature of the material did not reach a temperature below the Ms temperature at the time of tanking out the product, and there was room for formation of phases other than martensite in the air-cooling process after removing the product under the condition of having a temperature below the Ms temperature. Therefore, when Relational Expressions 4 and 5 described above were not satisfied or Relational Expression 1 was not satisfied, it was required to solve the problem by removing the product after performing more processes than the minimum required process (N) by a method such as adding a cooling process.

[0179] On the other hand, Examples 20, 24, 27, 30, 31, 35, and 36 are cases in which the minimum f value required from the material thickness according to Relational Expressions 4 and 5 described above was satisfied, and the multistage process is performed with more than the minimum number of processes (N) calculated from Relational Expression 1 described above. Accordingly, at the time of removing the product in the multistage process, the temperature below the Ms temperature was secured, and phases other than martensite were not formed, such that a product securing a sufficient martensite phase was obtained, and the physical properties of the final product were secured.

(Experimental Example 8)

[0180] A blanking step was performed in the same manner as that of Experimental Example 2 described above, except that in Examples 37 and 38, a blanking step of preparing a blank material separated from the strip was included instead of the notching step, and then forming, piercing, and trimming steps were performed. At this time, when transfer was performed between two or more molds adjacent to each other in the transfer direction of the material, a tongs-shaped (or, a gripper-shaped) transfer unit was used.

[0181] In the case of Example 37, the cooling of the material was performed significantly quickly because the blanking mold in a cold state having an initial temperature of 25°C was used, whereas in Example 38 in which the initial temperature was 500°C, when the blanking upper mold was lowered and came into contact with the material, excessive cooling was suppressed by using a heated blanking mold.

[0182] That is, it was confirmed that in Example 38, since excessive cooling was suppressed, the temperature of the blank material after completion of the blanking step was 700°C or higher, and a material having an elongation of 50% or more was secured, such that the formability in a subsequent process after the blanking step was more excellent in comparison to Example 37.

[Description of Reference Numerals]

[0183]

100: Apparatus for manufacturing hot press formed member for multistage process
1: Supply Unit
10: Material Provided In Form Of Coil
11: Push Bar
2: Heating Unit
21: Heating Device For Strip Material
3: Transfer Unit
31: Thermal Insulation Chamber
4: Processing Unit
41: Processing Apparatus
5a, 5b: Temperature Control Unit For Mold
50: Designed Pitch Amount
X: Transfer Direction Of Strip Material
51a, 51b: Temperature Control Unit For Notching Mold Or Blanking Mold

52a, 52b: Temperature Control Unit For Forming Mold
53a, 53b: Temperature Control Unit For Piercing Mold Or Flanging Mold
54a, 54b: Temperature Control Unit For Trimming Mold
6: Press
6a: Press Upper Plate (pressing Slide)
6b: Press Lower Plate (Press Bolster)
61a, 61b: Notching Mold Or Blanking Mold
62a, 62b: Forming Mold
63a, 63b: Piercing Mold Or Flanging Mold
64a, 64b: Trimming Mold
110a: Transfer Height Level Of Strip Material
110b: Vicinity Of Bottom Dead Center Of pressing Slide
120a: Point That Does Not Interfere With Transfer Of Material
120b: Vicinity Of pressing Bottom Dead Center
200: Material
210: Notched Material
220: Formed Material
230: Pierced Material
240: Trimmed Material
250: Final Product Taken Out
300: Web Portion
400: Unnecessary Outer Edge Portion
600: Material Position Control Unit
A: Flat Portion
B: Side Portion
C: Formed Portion (Burring Portion Or The Like)
S: First Plane Direction
P: Second Plane Direction
D: Angle Of Narrow Side Formed By First Plane Direction And Second Plane Direction

Claims

1. A method for manufacturing a hot press formed member for a multistage process, the method comprising:

a heating step of heating a strip material;
a transfer step of transferring the heated strip material to a processing apparatus in which a plurality of molds including one or more molds of a notching mold and a blanking mold; a forming mold; and a trimming mold; are mounted on one press;
one or more steps of a notching step of obtaining a notched material connected to the strip by a web portion by cutting a part of the material using the notching mold and a blanking step of obtaining a blank material separated from the strip by cutting a part of the material using the blanking mold;
a forming step of transferring the material subjected to one or more steps of the notching step and the blanking step and positioning the material in the vicinity of the forming mold, and then forming the material using the forming mold; and
a trimming step of removing an unnecessary outer edge portion of the material from a final product shape using the trimming mold.

2. The method for manufacturing a hot press formed member for a multistage process of claim 1, wherein in the transfer step, the heated strip material is transferred in a thermal insulation chamber, and the thermal insulation chamber is maintained within a temperature range of Ts - 200°C or higher and Ts + 50°C or lower based on a surface temperature (Ts) of the strip material supplied to the thermal insulation chamber.

3. The method for manufacturing a hot press formed member for a multistage process of claim 1, wherein in the one press, the molds are arranged to be spaced apart from each other by a designed pitch amount between two molds adjacent to each other in a transfer direction of the material, and
after each stroke is performed according to a pressing motion, the material is transferred by the designed pitch amount in the transfer direction of the material.

4. The method for manufacturing a hot press formed member for a multistage process of claim 1, wherein an initial temperature of the notching mold and an initial temperature of the blanking mold are 400°C or higher.

5. The method for manufacturing a hot press formed member for a multistage process of claim 1, wherein one or more of one or more steps of the notching step and the blanking step; the forming step; and the trimming step are performed in a multistage process by being divided into two or more steps.

6. The method for manufacturing a hot press formed member for a multistage process of claim 1, wherein in the notching step and the blanking step, the strip material put into the processing apparatus is controlled so that the strip material is lowered to a pressing bottom dead center from a transfer height level of the strip material in a non-contact state with an upper mold of a mold, and then comes into contact with an upper mold surface and a lower mold surface of the mold only in a cutting process.

7. The method for manufacturing a hot press formed member for a multistage process of claim 1, wherein in a pressing motion of the processing apparatus, a percentage of a holding time in the vicinity of a bottom dead center in one stroke is 4 to 30%, and
the percentage of the holding time in the vicinity of the bottom dead center is a percentage of a time for the press to stay to a point corresponding to 1 mm from a pressing bottom dead center in an upward direction.

8. The method for manufacturing a hot press formed member for a multistage process of claim 1, further comprising, between the forming step and the trimming step, one or more steps of a piercing step of removing an unnecessary hole portion from a formed material and a flanging step of forming a flange portion in the formed material.

9. The method for manufacturing a hot press formed member for a multistage process of claim 1, wherein the multistage process is performed with the number of processes equal to or greater than a minimum number of processes calculated by the following Relational Expression 1:

[Relational Expression 1]

$$N = \mathrm{ROUNDUP}\{T/[(60/SPM) \times (f/100)]\}$$

in Relational Expression 1, N represents a minimum required number of processes from the forming step except for the notching step and the blanking step,
SPM represents the number of strokes per minute (SPM) of the press,
f represents a percentage (%) of a holding time in the vicinity of a bottom dead center in one stroke,
T represents a value calculated from the following Relational Expression 2 when $0.8 \leq t < 1.5$, and represents a value calculated from the following Relational Expression 3 when $1.5 \leq t$, and
ROUNDUP represents a value obtained by rounding up the number below the decimal point of the calculated value within { },

[Relational Expression 2]

$$T = t$$

[Relational Expression 3]

$$T = 5 \times t - 6$$

in Relational Expressions 2 and 3, t is a thickness of the material, and a unit thereof is mm.

10. The method for manufacturing a hot press formed member for a multistage process of claim 9, wherein f satisfies the following Relational Expression 4 when $0.8 \leq t < 1.5$ is satisfied, and satisfies the following Relational Expression 5 when $1.5 \leq t$ is satisfied:

[Relational Expression 4]

$$0.8 \times t + 2.6 \leq f$$

[Relational Expression 5]

$$4.4 \times t - 2.8 \leq f$$

in Relational Expressions 4 and 5, t is a thickness of the material, and a unit thereof is mm.

11. The method for manufacturing a hot press formed member for a multistage process of claim 1, wherein when the material is put into the processing apparatus, a pressing slide is lowered to a pressing bottom dead center to process the material, the material stays in the vicinity of the pressing bottom dead center during lifting of the pressing slide, and then, when the pressing slide reaches a point that does not interfere with the transfer of the material, the material positioned in the vicinity of the pressing bottom dead center is lifted utilizing position information of the pressing slide.

12. The method for manufacturing a hot press formed member for a multistage process of claim 1, wherein the method includes a blanking step of obtaining a blank material separated from the strip by cutting a part of the heated strip material put into the processing apparatus using the blanking mold, and
a tongs-shaped transfer unit is used when the material is transferred from a mold in a previous step to the vicinity of a mold in a subsequent step based on two molds adjacent to each other in a transfer direction of the material in the one press.

13. An apparatus for manufacturing a hot press formed member for a multistage process, the apparatus comprising:

a supply unit for continuously supplying a strip material;
a heating unit for heating the strip material;
a processing unit including a processing apparatus in which a plurality of molds including one or more molds of a notching mold and a blanking mold, a forming mold, and a trimming mold are mounted on one press; and
a transfer unit for transferring the strip material heated in the heating unit to the processing unit.

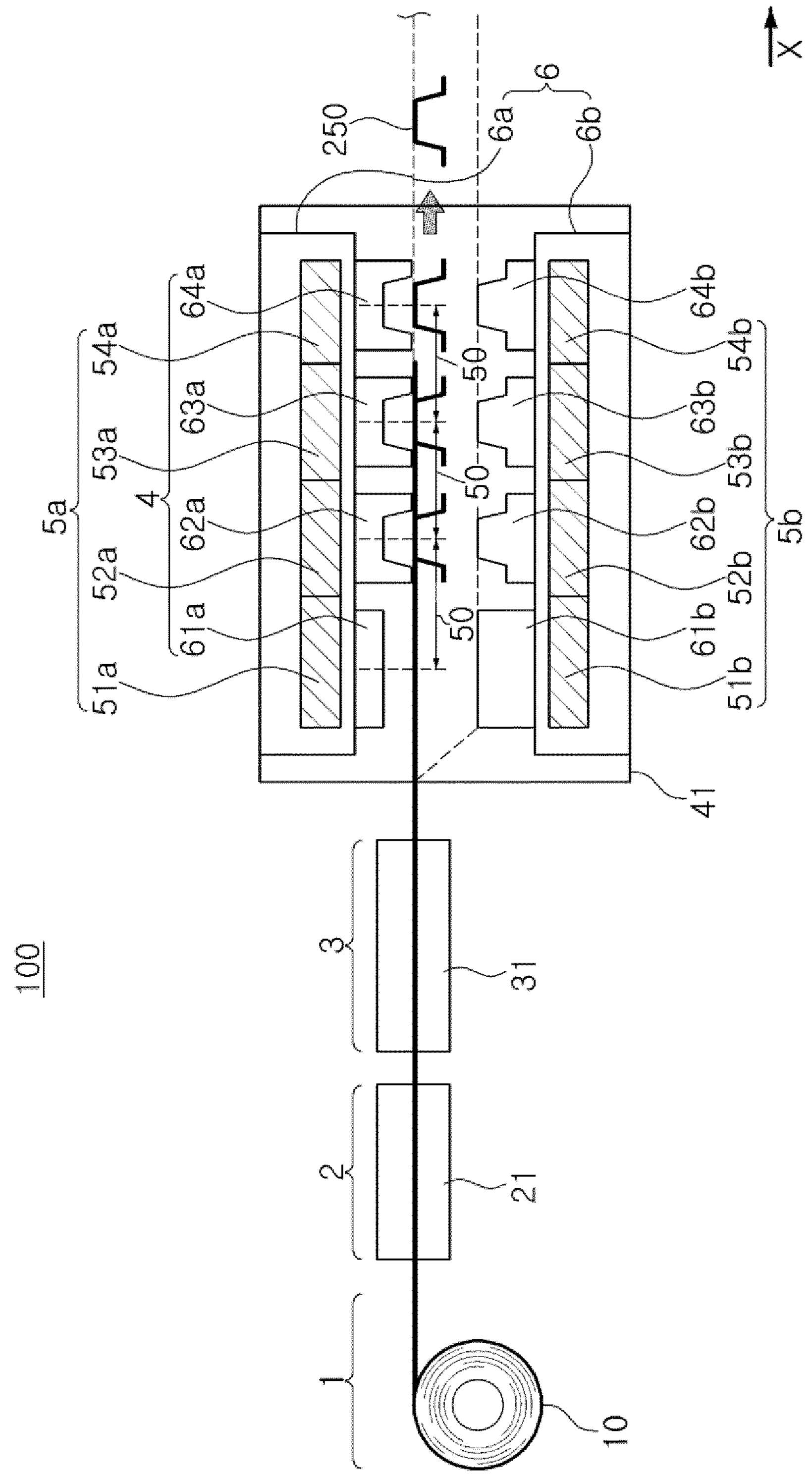
14. The apparatus for manufacturing a hot press formed member for a multistage process of claim 13, wherein the processing apparatus further includes a temperature control unit for controlling an initial temperature of one or more molds of the notching mold and the blanking mold to 400°C or higher, and
the temperature control unit is provided between the one or more molds of the notching mold and the blanking mold and the press.

15. The apparatus for manufacturing a hot press formed member for a multistage process of claim 13, wherein a push bar operated by a spring is provided as a structure protruding from a surface of an upper mold of one or more molds of the notching mold and the blanking mold in contact with the strip material.

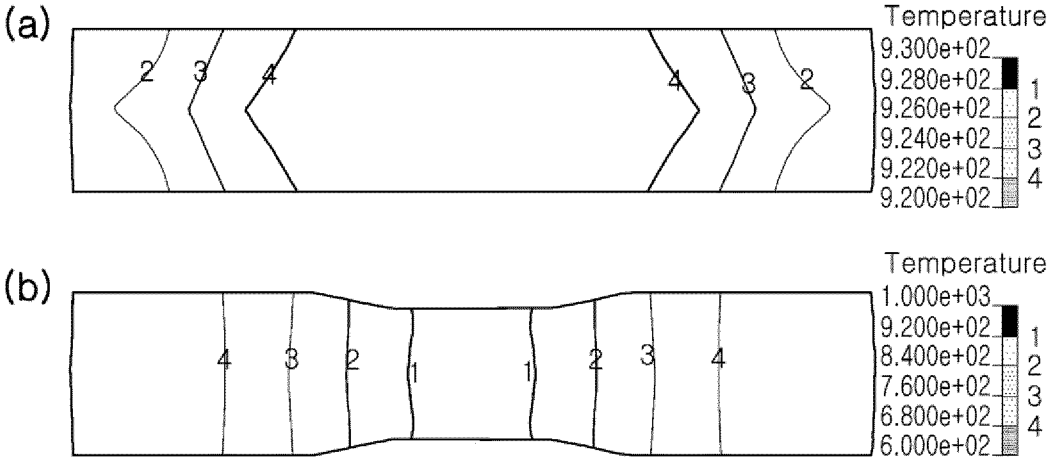
16. The apparatus for manufacturing a hot press formed member for a multistage process of claim 13, wherein the one press includes a pressing slide and a press bolster, and
a material position control unit in the form of a cylinder is provided on a surface on which the mold on the press bolster is provided.

17. A hot press formed member manufactured by the method for manufacturing a hot press formed member for a multistage process of claim 1, wherein the hot press formed member has an under-cut shape, and a tensile strength of the hot press formed member is 1,300 MPa or more.

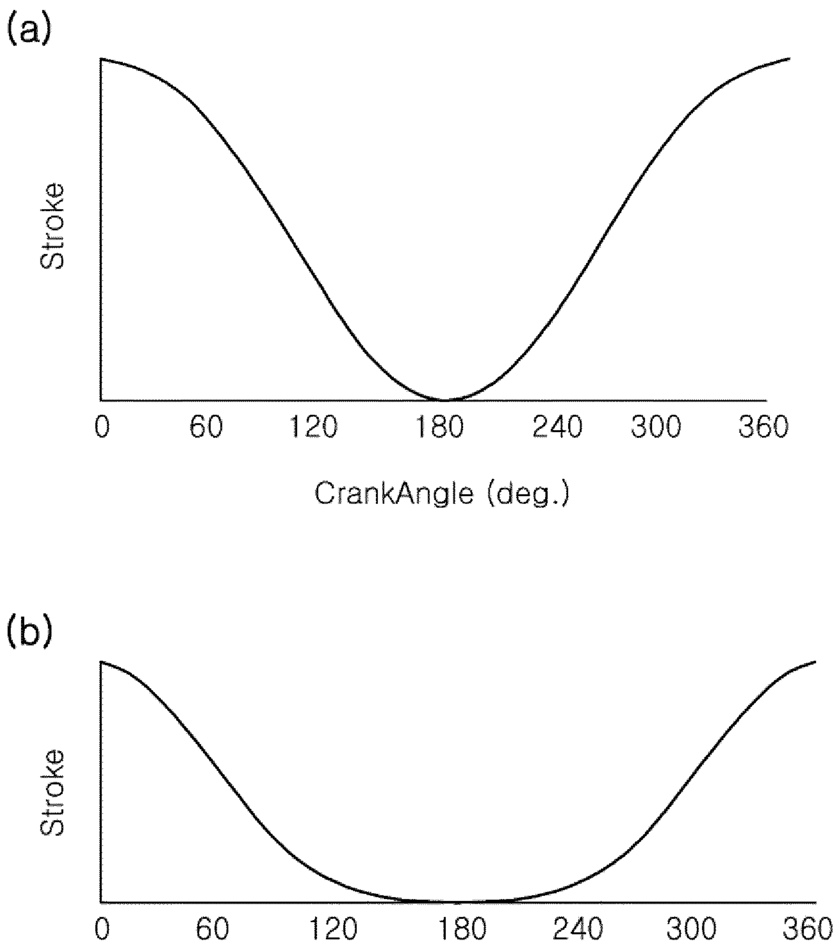
[FIG. 1]


100
1
10
2
21
3
31
41
4
5a
5b
6
6a
6b
50
250
X
51a
52a
53a
54a
61a
62a
63a
64a
51b
52b
53b
54b
61b
62b
63b
64b

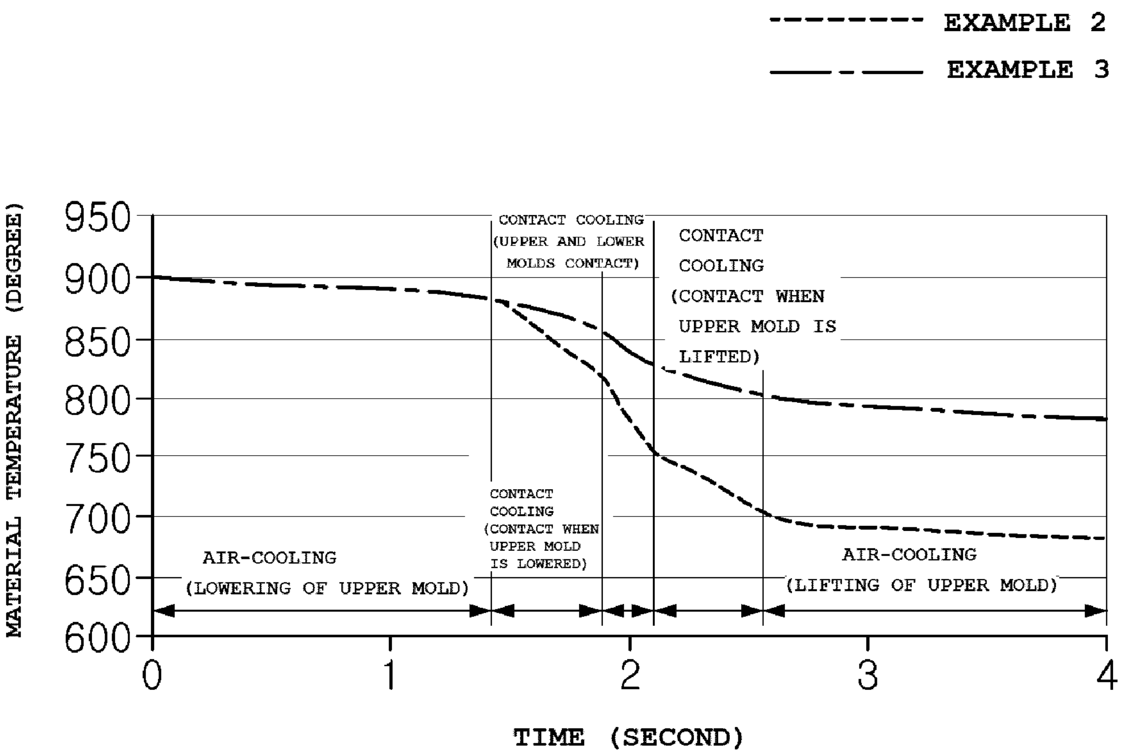
[FIG. 2]


(a)
Temperature
9.300e+02
9.280e+02
9.260e+02
9.240e+02
9.220e+02
9.200e+02
1
2
3
4
(b)
Temperature
1.000e+03
9.200e+02
8.400e+02
7.600e+02
6.800e+02
6.000e+02
1
2
3
4

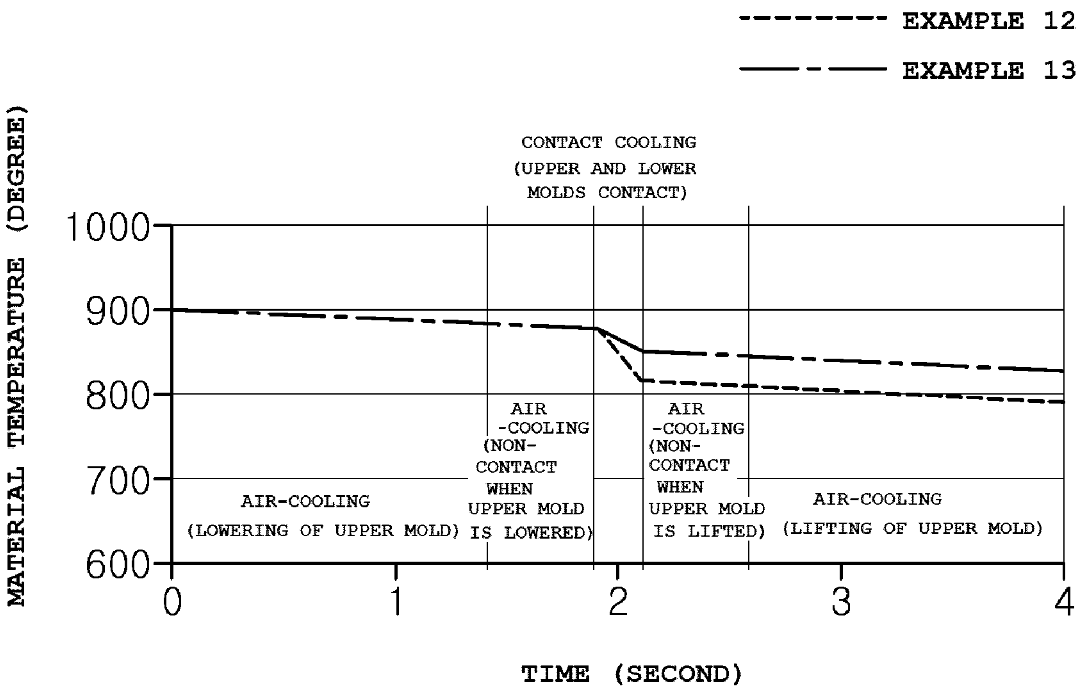
[FIG. 3]


(a)
Stroke
0
60
120
180
240
300
360
CrankAngle (deg.)
(b)
Stroke
0
60
120
180
240
300
360

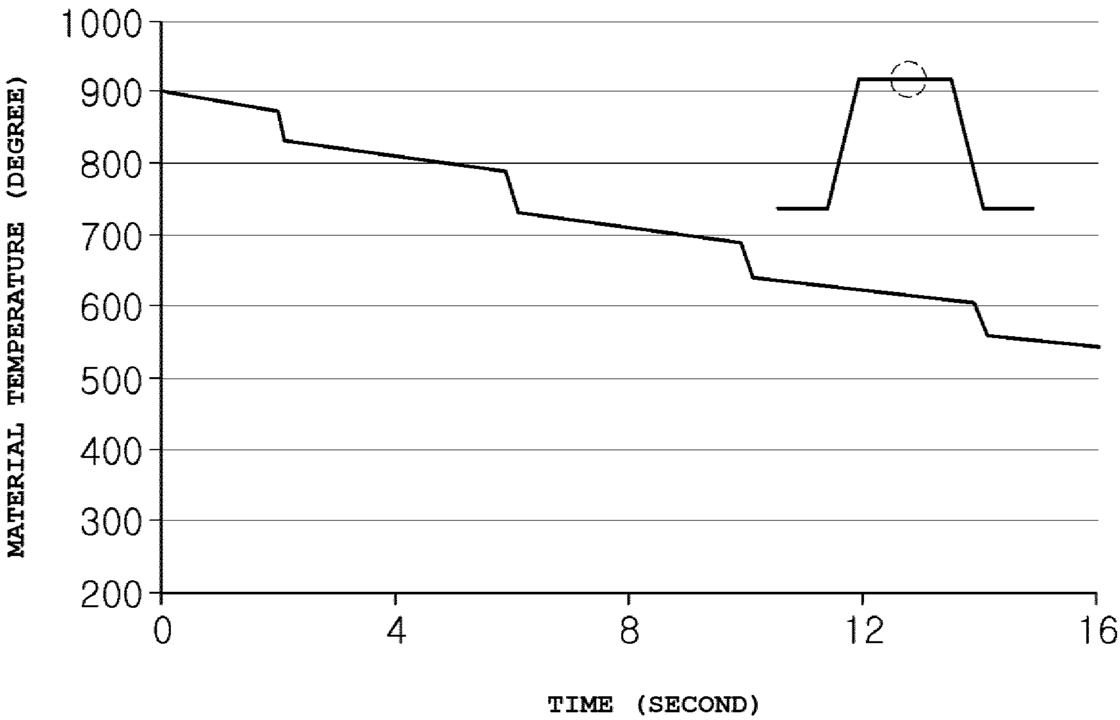
[FIG. 4]


EXAMPLE 2
EXAMPLE 3
MATERIAL TEMPERATURE (DEGREE)
950
900
850
800
750
700
650
600
CONTACT COOLING (UPPER AND LOWER MOLDS CONTACT)
CONTACT COOLING (CONTACT WHEN UPPER MOLD IS LIFTED)
CONTACT COOLING (CONTACT WHEN UPPER MOLD IS LOWERED)
AIR-COOLING (LOWERING OF UPPER MOLD)
AIR-COOLING (LIFTING OF UPPER MOLD)
0
1
2
3
4
TIME (SECOND)

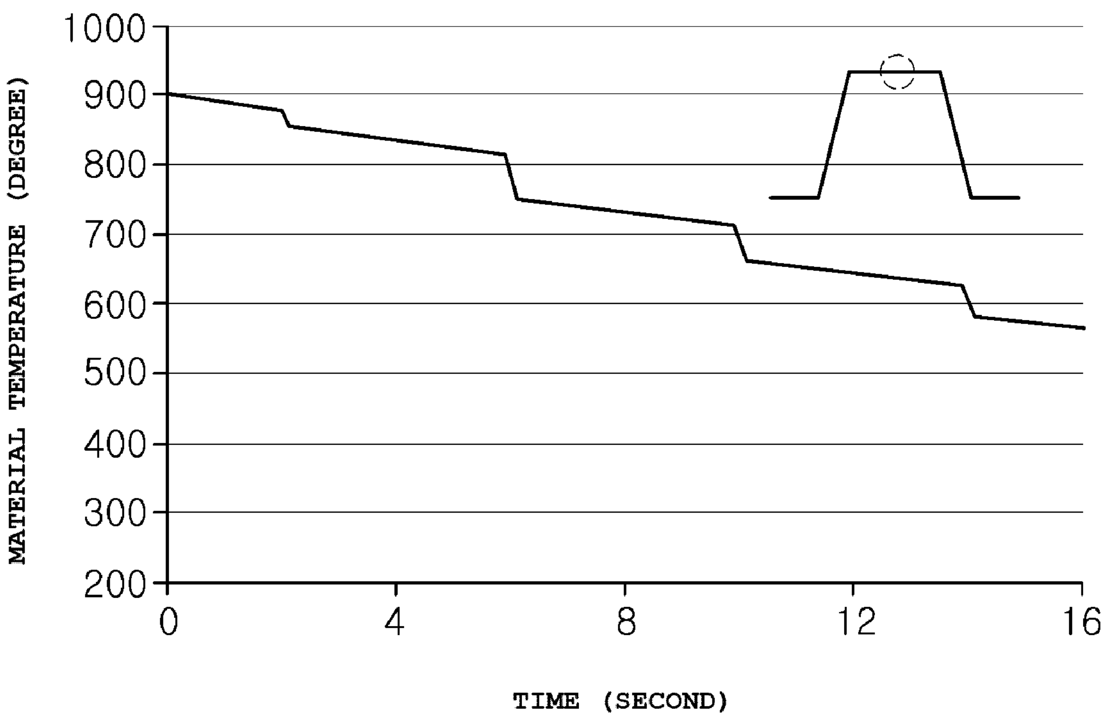
[FIG. 5]


EXAMPLE 12
EXAMPLE 13
CONTACT COOLING (UPPER AND LOWER MOLDS CONTACT)
MATERIAL TEMPERATURE (DEGREE)
1000
900
800
700
600
AIR -COOLING (NON-CONTACT WHEN UPPER MOLD IS LOWERED)
AIR -COOLING (NON-CONTACT WHEN UPPER MOLD IS LIFTED)
AIR-COOLING (LOWERING OF UPPER MOLD)
AIR-COOLING (LIFTING OF UPPER MOLD)
0
1
2
3
4
TIME (SECOND)

[FIG. 6]


MATERIAL TEMPERATURE (DEGREE)
1000
900
800
700
600
500
400
300
200
0
4
8
12
16
TIME (SECOND)

[FIG. 7]


MATERIAL TEMPERATURE (DEGREE)
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500
400
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200
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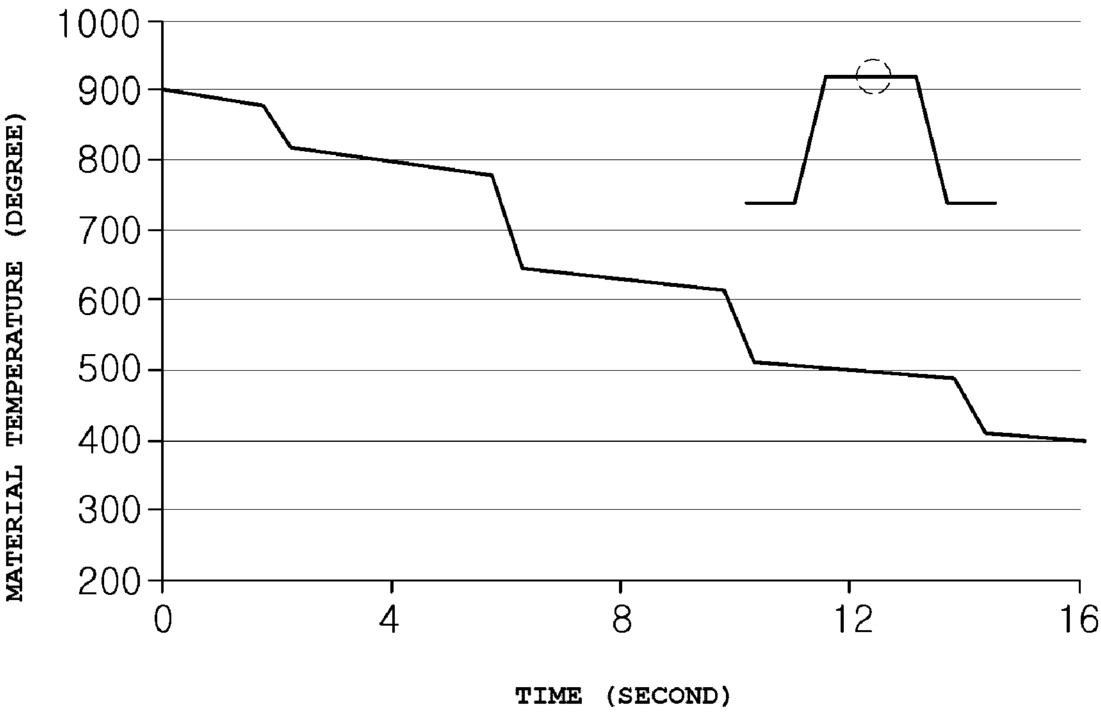
4
8
12
16
TIME (SECOND)

[FIG. 8]


1000
900
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600
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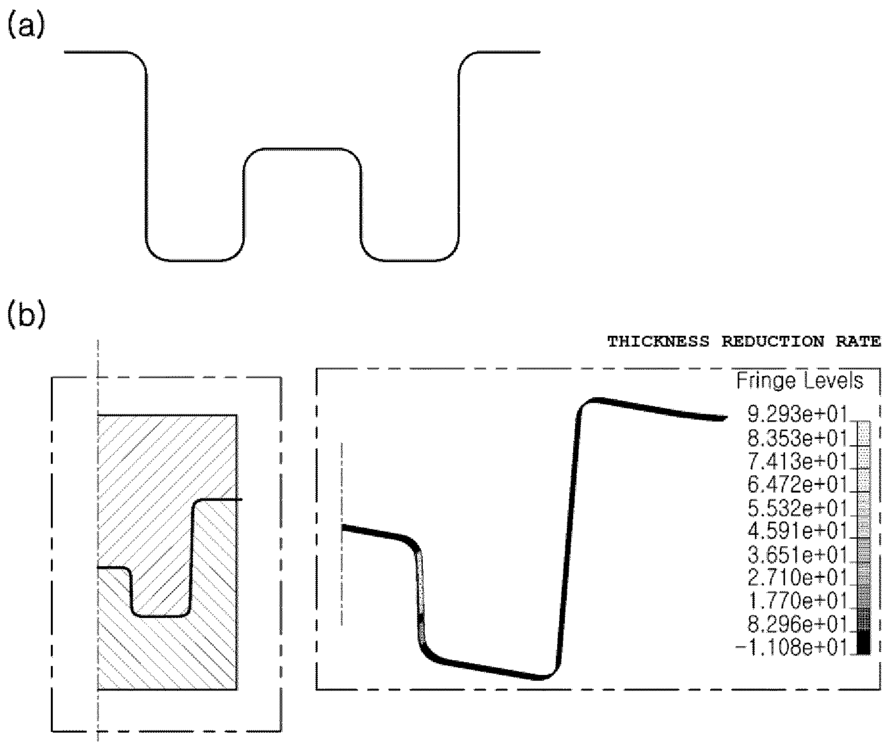
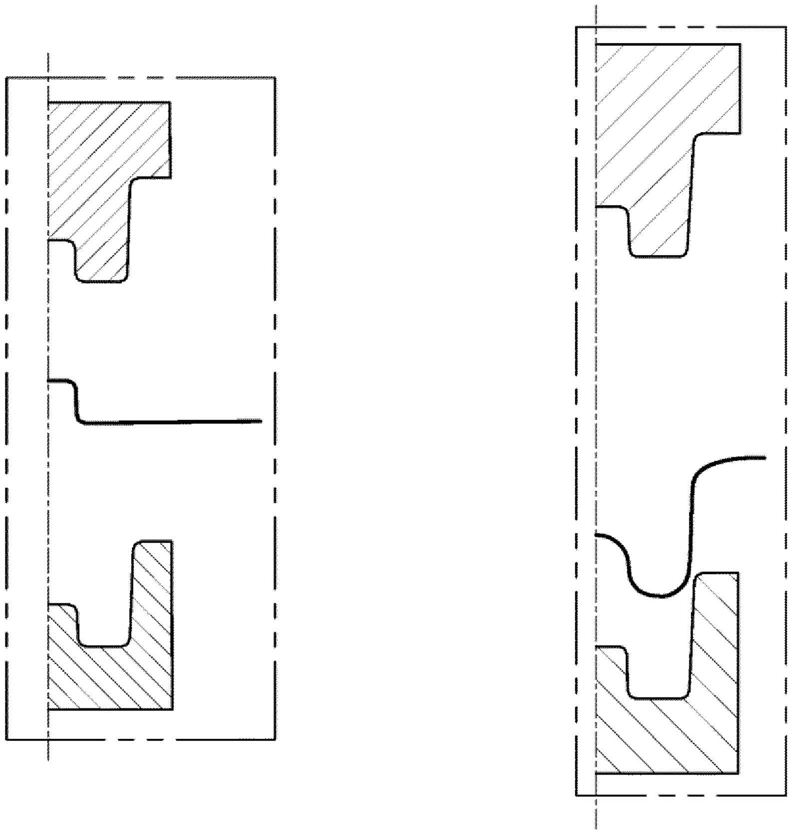
400
300
200
MATERIAL TEMPERATURE (DEGREE)
0
4
8
12
16
TIME (SECOND)

[FIG. 9]

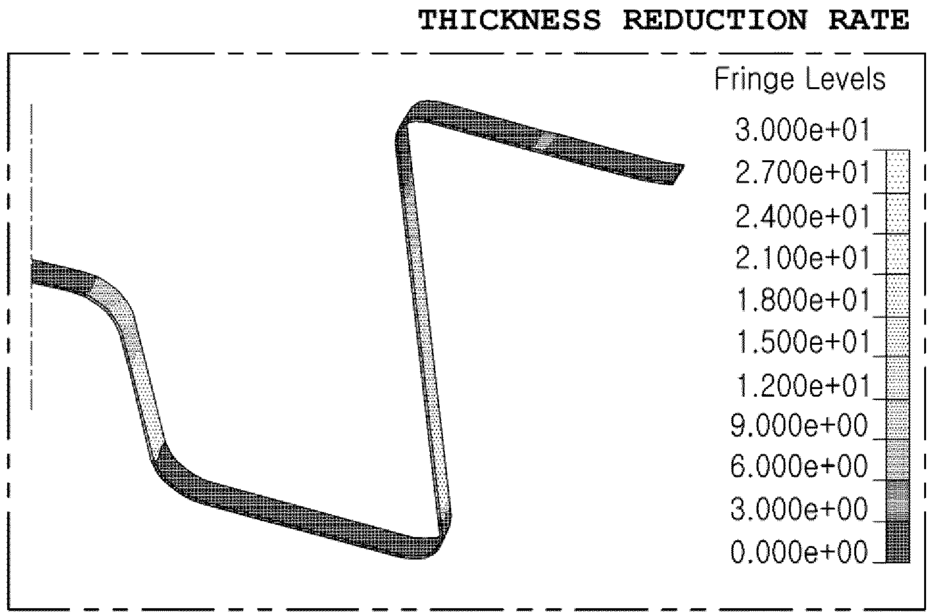

(a)
(b)
THICKNESS REDUCTION RATE
Fringe Levels
9.293e+01
8.353e+01
7.413e+01
6.472e+01
5.532e+01
4.591e+01
3.651e+01
2.710e+01
1.770e+01
8.296e+01
-1.108e+01

[FIG. 10]

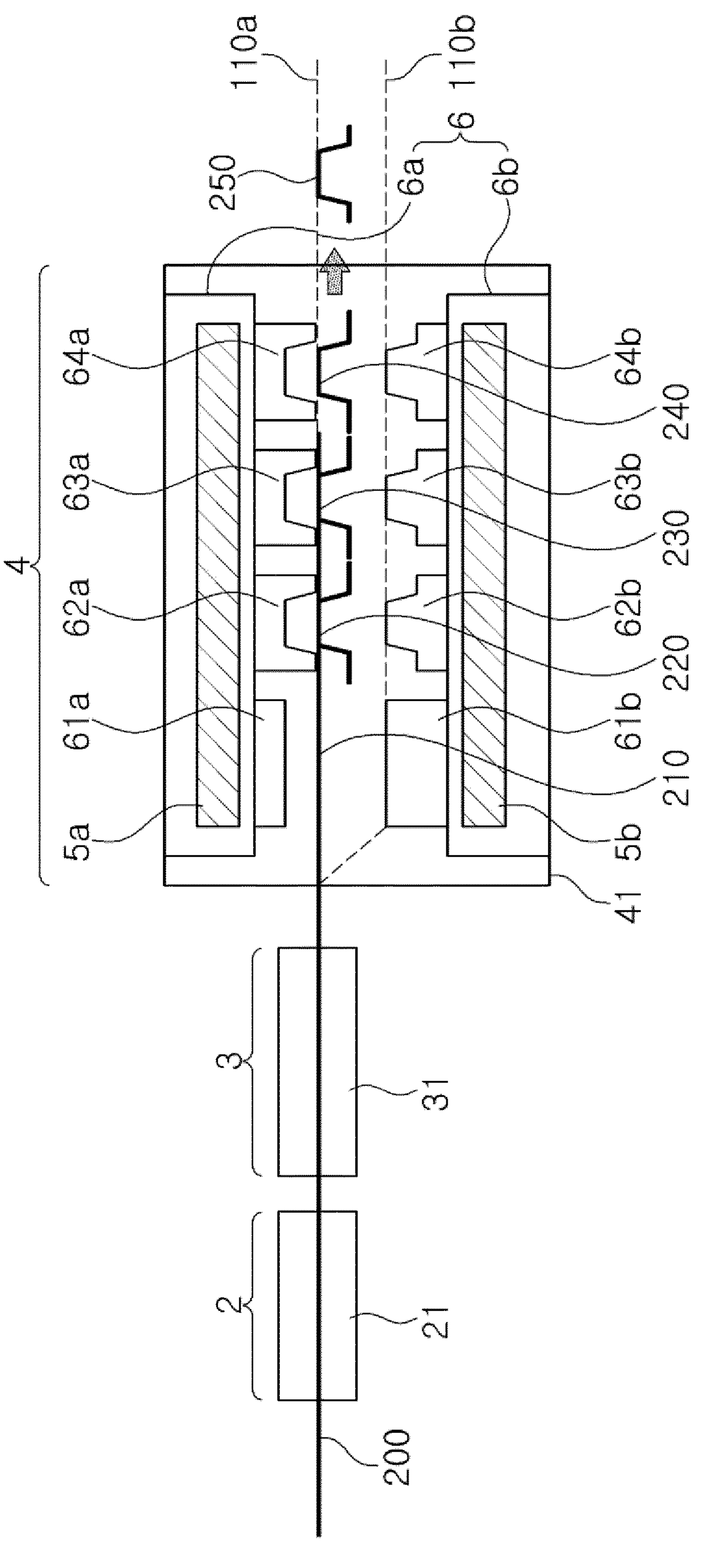
(a)



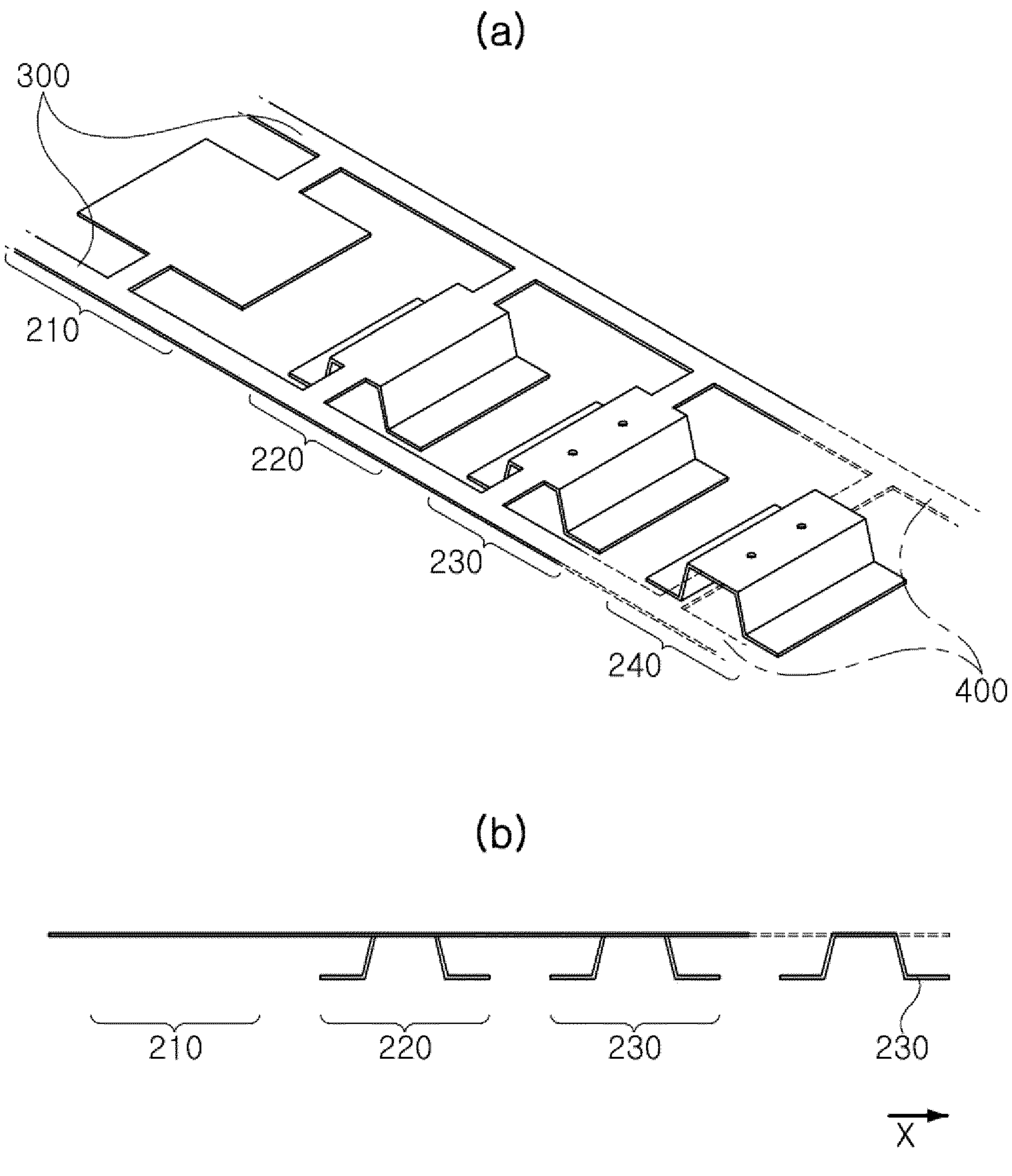
(b)


THICKNESS REDUCTION RATE
Fringe Levels
3.000e+01
2.700e+01
2.400e+01
2.100e+01
1.800e+01
1.500e+01
1.200e+01
9.000e+00
6.000e+00
3.000e+00
0.000e+00

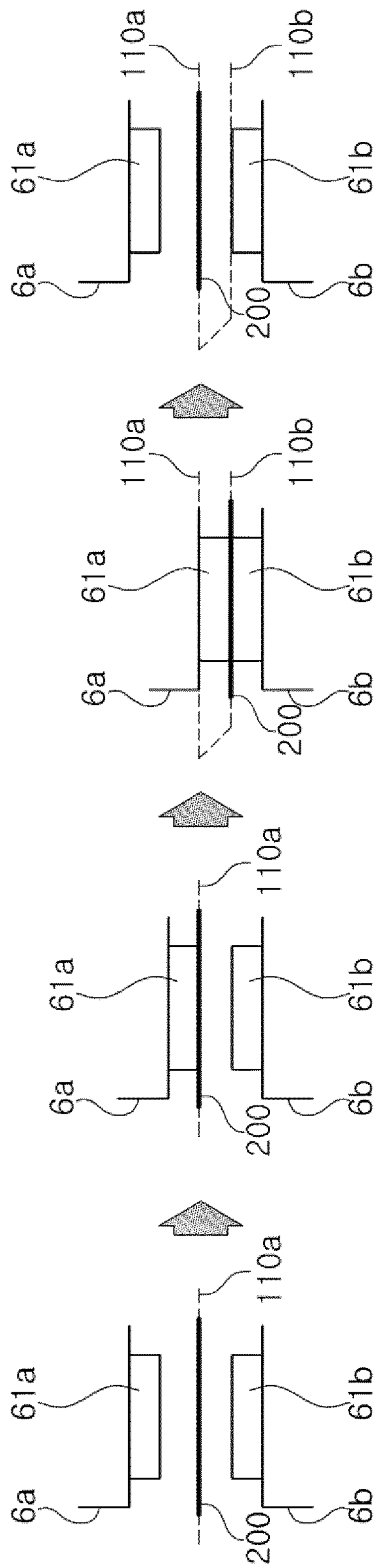
[FIG. 11]


110a
110b
6
6a
6b
250
4
64a
63a
62a
61a
5a
64b
240
63b
230
62b
220
61b
210
5b
41
3
31
2
21
200

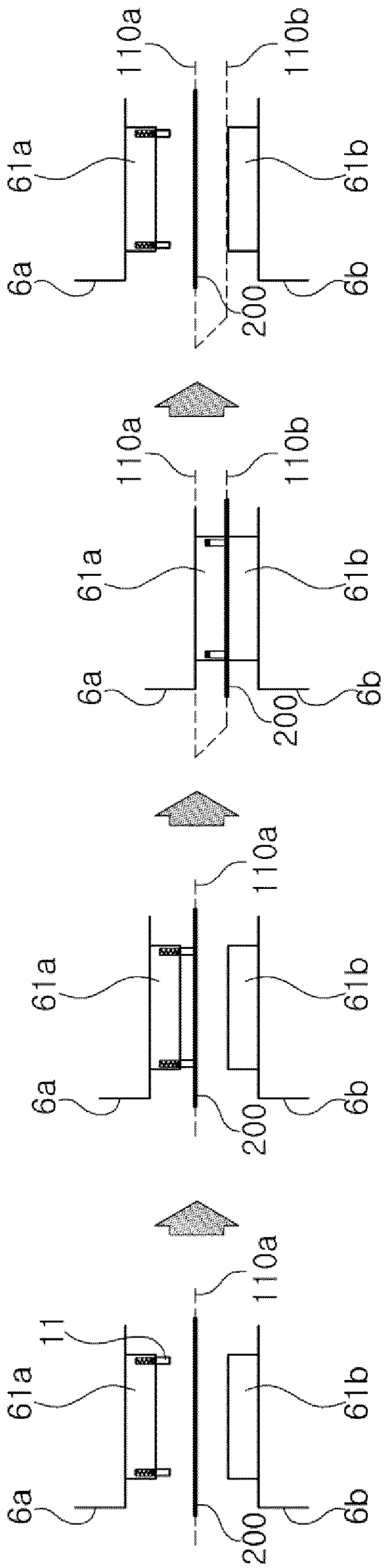
[FIG. 12]



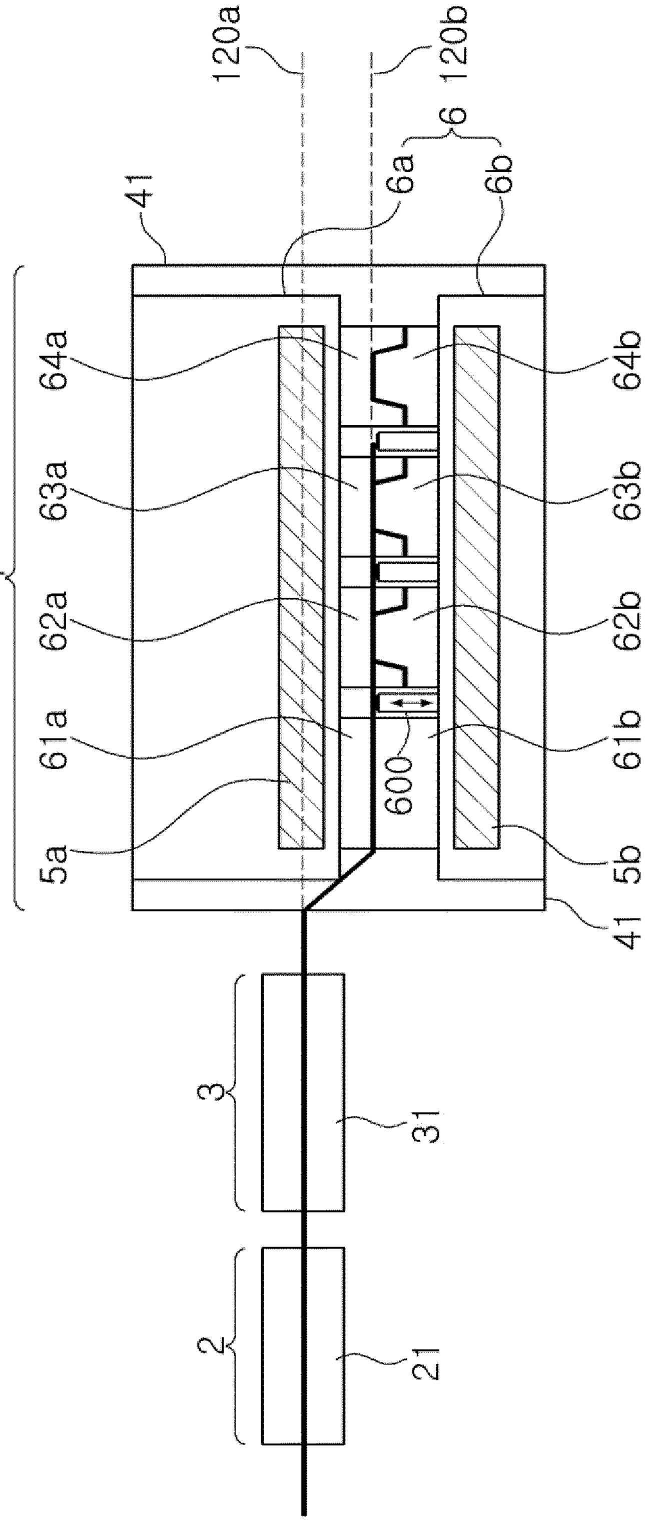
[FIG. 13]



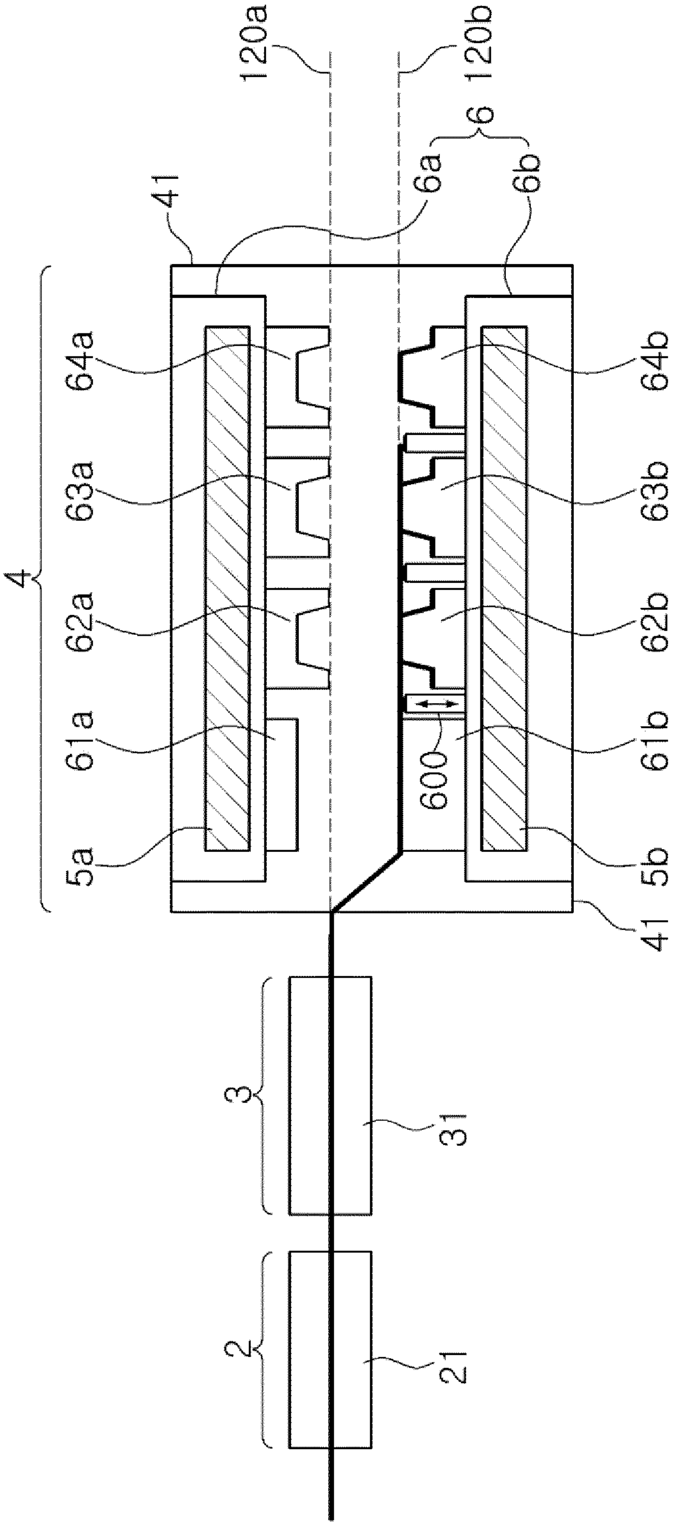
[FIG. 14]


110a
110b
61a
61b
6a
6b
200
110a
110b
61a
61b
6a
6b
200
110a
61a
61b
6a
6b
200
110a
11
61a
61b
6a
6b
200

[FIG. 15]


120a
120b
6
6a
6b
41
4
64a
63a
62a
61a
5a
64b
63b
62b
61b
5b
600
41
3
31
2
21

[FIG. 16]


120a
120b
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6a
6b
41
4
64a
63a
62a
61a
5a
64b
63b
62b
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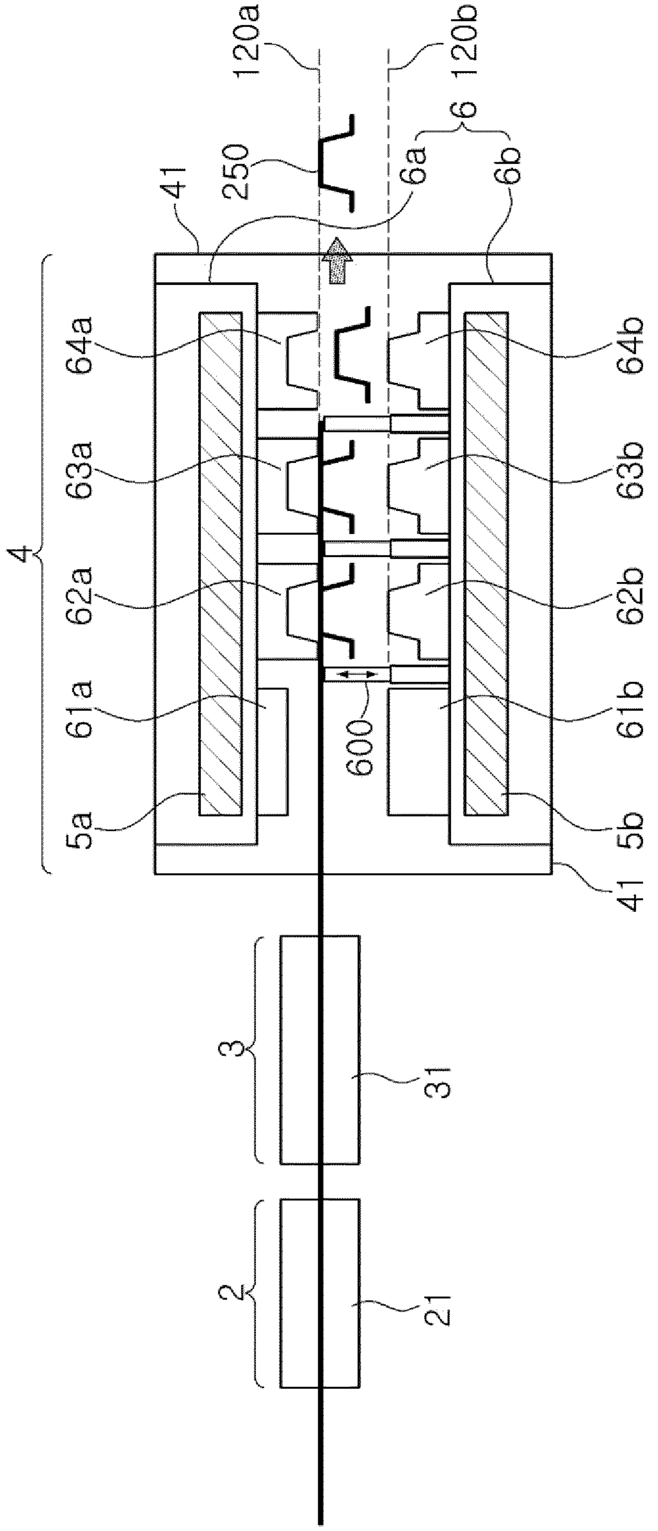
600
5b
41
3
31
2
21

[FIG. 17]


120a
120b
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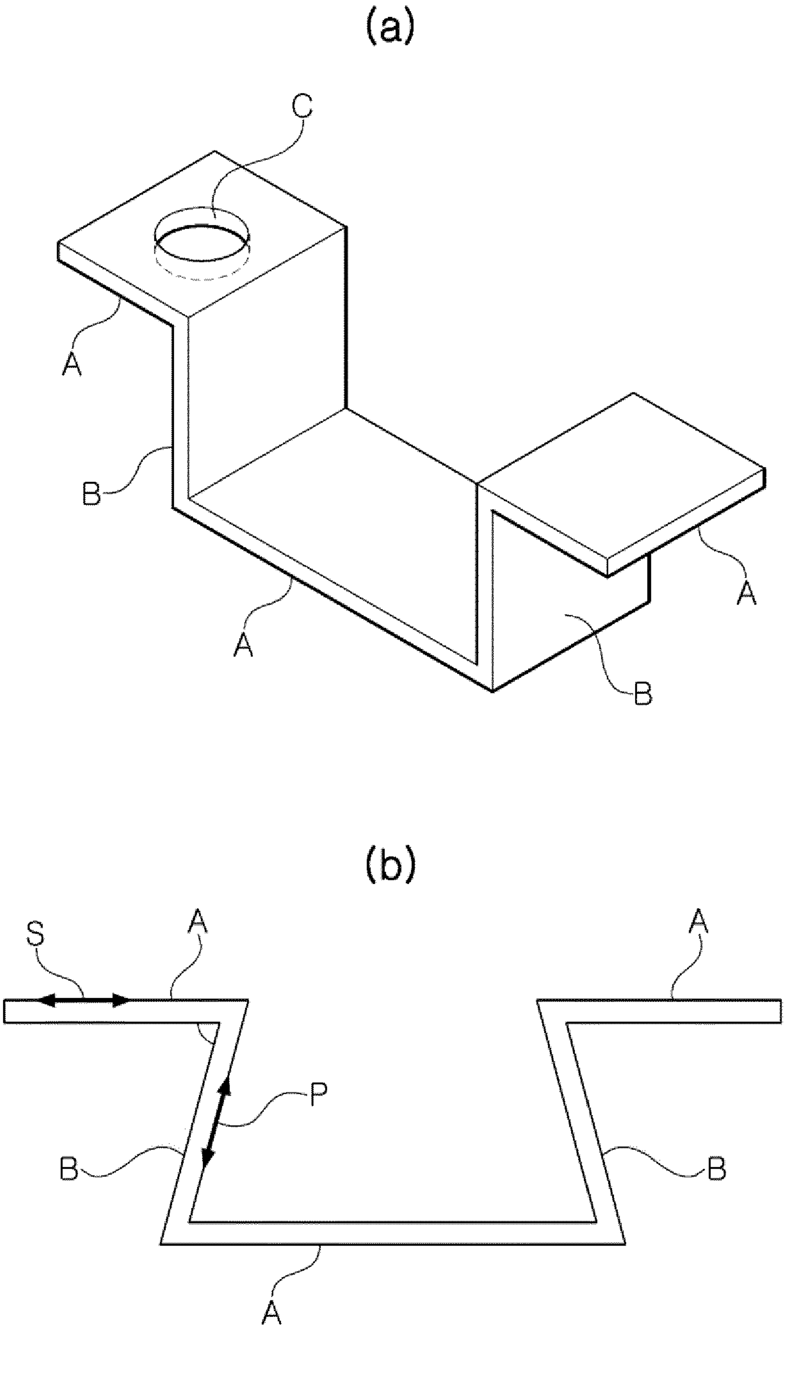
250
6a
6b
41
64a
64b
63a
63b
4
62a
62b
61a
61b
600
5a
5b
41
3
31
2
21

[FIG. 18]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2021/008081

A. CLASSIFICATION OF SUBJECT MATTER

B21D 37/08(2006.01)i; **B21D 28/02**(2006.01)i; **B21D 31/02**(2006.01)i; **B21D 37/16**(2006.01)i; **B21D 43/05**(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)

B21D 37/08(2006.01); B21B 1/46(2006.01); B21D 22/02(2006.01); B21D 24/00(2006.01); B21D 35/00(2006.01); B21D 37/16(2006.01); C21D 1/18(2006.01); C21D 9/56(2006.01)

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: 열간 프레스(hot press), 프로그레시브(progressive), 금형(die), 핫포밍(hot forming), 스트립(strip)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-1149176 B1 (HYUNDAI STEEL COMPANY) 25 May 2012 (2012-05-25) See paragraphs [0004] and [0062], claims 1 and 9 and figures 6-7.	1-5,8,12-13,17
A		6-7,9-11,14-16
Y	US 2017-0175222 A1 (GM GLOBAL TECHNOLOGY OPERATIONS L.L.C.) 22 June 2017 (2017-06-22) See paragraphs [0036] and [0042]-[0043] and figures 2-3.	1-5,8,12-13,17
Y	JP 2007-144495 A (NIPPON STEEL CORP.) 14 June 2007 (2007-06-14) See paragraphs [0025] and [0027] and figure 1.	8,12
A	KR 10-2020-0076662 A (AUTOTECH ENGINEERING, S.L. et al.) 29 June 2020 (2020-06-29) See claim 1 and figure 1.	1-17

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

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- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "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
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- "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
10 September 2021	**14 September 2021**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office **Government Complex-Daejeon Building 4, 189 Cheongsa-ro, Seo-gu, Daejeon 35208**	
Facsimile No. **+82-42-481-8578**	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No. PCT/KR2021/008081

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2016-0059295 A1 (BENTELER AUTOMOBILTECHNIK G.M.B.H.) 03 March 2016 (2016-03-03) See claim 1 and figure 1.	1-17

Form PCT/ISA/210 (second sheet) (July 2019)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2021/008081

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
KR 10-1149176 B1	25 May 2012	EP 2287343 A2	23 February 2011
		EP 2287343 B1	26 December 2012
		JP 2011-523593 A	18 August 2011
		JP 5311429 B2	09 October 2013
		US 2011-0073220 A1	31 March 2011
		WO 2010-024530 A2	04 March 2010
		WO 2010-024530 A3	27 May 2010
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		DE 102015016532 A1	22 June 2017
		US 10280478 B2	07 May 2019
JP 2007-144495 A	14 June 2007	JP 4751186 B2	17 August 2011
KR 10-2020-0076662 A	29 June 2020	CA 3070746 A1	07 February 2019
		CN 111344079 A	26 June 2020
		EP 3437750 A1	06 February 2019
		EP 3661670 A1	10 June 2020
		EP 3763455 A1	13 January 2021
		JP 2020-529926 A	15 October 2020
		RU 2742549 C1	08 February 2021
		WO 2019-025569 A1	07 February 2019
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		DE 102014112244 A1	03 March 2016
		EP 2993241 A1	09 March 2016
		EP 2993241 B1	07 October 2020
		ES 2828966 T3	28 May 2021

Form PCT/ISA/210 (patent family annex) (July 2019)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- KR 20060054479 **[0006]**