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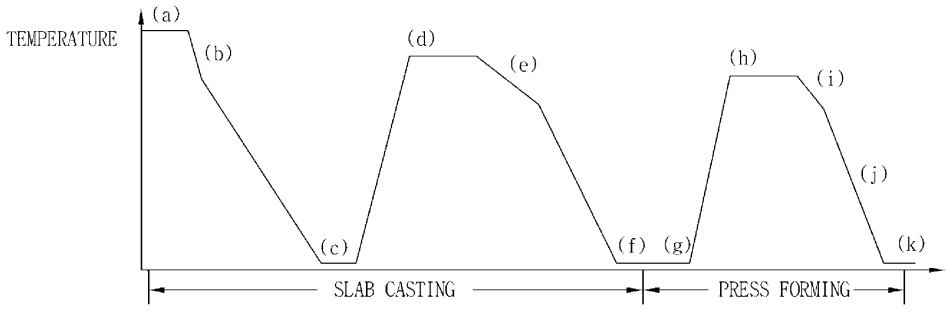
(54) CONTINUOUS PRESS HARDENING PROCESS AND APPARATUS THEREFOR

(57) The present invention relates to a continuous press hardening process, and an apparatus therefor. The present invention comprises: a slab casting step for continuously casting molten steel refined in an electric furnace and blast furnace to make slabs, followed by re-heating and hot-rolling the slabs to prepare a hot-rolled steel sheet; a blanking step after the slab casting step for transferring the hot-rolled steel sheet to a blank through a sealed oven and then blanking the hot-rolled steel sheet; and a press hardening step after the blanking step for transferring the hot-rolled steel sheet to a press mold and then press-molding it. Since the present invention can immediately inject the high-temperature steel sheet generated in hot-rolling in the press hardening step, an additional re-heating step is not required. Thus, the present invention has an effect of reducing costs through simplification of a process.

FIG.3



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Description

[Technical Field]

[0001] The present invention relates to a continuous press hardening process and apparatus therefor, and more particularly, to a process of continuous press hardening which integrates hot rolling with press hardening to simplify the process and an apparatus therefor.

[Background Art]

[0002] In general, when the strength increases, the formability decreases in typical machining steel sheets which are used as parts for vehicles; therefore, steel sheets having low strength and high elongation are generally used for parts that are complicated and needs lots of portions transformed. Accordingly, the strength of the finished parts is weak and the thickness of the material increases to ensure rigidity such that weight of the parts increases. Parts for press hardening are used to overcome those problems.

[0003] A method of manufacturing a part in press hardening is a process of manufacturing a high-strength part for vehicles, which includes heating a steel material having improved hardenability by adding boron (B) at about 900°C above Ac3 transformation point in complete an austenite state, and then hot-forming and rapidly cooling the steel sheet to a desired shape at one time in a press die into martensite structure.

[0004] As well known in the art, since when the steel sheets are heated, the elongation increases, the formability is better than cold-worked steel sheet and the strength is very high (1400 Mpa) such that they can greatly contribute to reducing weight of vehicles, and they are used for ultra-high parts that are difficult to form, because there is little springback after machining.

[0005] The press hardening is achieved by reheating a blanking device B which is obtained from a hot-rolled steel sheet coil C and is not hardened through a straight furnace O, conveying the blank to a press P with a robot R, and then pressing it (hot forming), as shown in FIG. 1.

[0006] Further, a hot-rolled steel sheet that is supplied in press hardening of the related art is as follows. A slab is manufactured by continuously casting molten metal discharged from an electric furnace or a blast furnace. The slab is reheated and rolled at austenite transformation temperature or more (about 1100°C), scales are removed using high-pressure cooling water, and through cooling process, the hot-rolled steel sheet having desired dimensions and the desired shape is manufactured in a coil shape.

[0007] However, the method of manufacturing a part in press hardening process has a problem in terms of manufacturing cost and processing time, because the process of manufacturing a hot-rolled steel sheet and the press hardening are separated such that the process of reheating and cooling is added before the press hardening.

[0008] That is, according to the method of manufacturing a part in press hardening, as shown in FIGS. 2A and 2B, a hot-rolled steel sheet is manufactured by a slab casting process that is performed in the order of (a) manufacturing molten metal - (b) continuous casting - (c) manufacturing a slab - (d) reheating the slab - (e) hot rolling - (f) winding, and then press hardening is performed in the order of (g) blanking - (h) reheating a steel sheet - (i) forming - (j) cooling - (k) achieving a complete product (high-strength part); therefore, an apparatus for reheating the steel sheet is necessarily required and the working time increases.

[Disclosure]

[Technical Problem]

[0009] In order to solve the above problems, the present invention has been made in an effort to provide a continuous press hardening process and apparatus therefor which integrates the process lines for hot rolling with press hardening such that a part for press hardening is continuously hot-rolled and press-hardened in the manufacturing process.

[Technical Solution]

[0010] In order to achieve the objects, an embodiment of the present invention provides a process of continuous press hardening, which includes: slab casting that includes making a slab by continuously casting molten steel refined by an electric furnace or a blast furnace, and then reheating and hot-rolling the slab into a hot-rolled steel sheet; blanking that includes, after the slab casting, conveying the hot-rolled steel sheet to a blanking device through a sealed oven and blanking the hot-rolled steel sheet; and press hardening that includes, after the blanking, conveying the hot-rolled steel sheet to a press die and pressing the hot-rolled steel sheet.

[0011] Another embodiment of the present invention provides a process of continuous press hardening, which includes: thin slab casting or strip casting that includes making a hot-rolled steel sheet by continuous-casting molten steel refined by an electric furnace or a blast furnace; blanking that includes, after the thin slab casting or strip casting, conveying the hot-rolled steel sheet to a blanking device through a sealed oven and blanking the hot-rolled steel sheet; and press hardening that includes, after the blanking, conveying the hot-rolled steel sheet to a press die disposed at an outlet of the sealed oven and pressing the hot-rolled steel sheet.

[0012] The blanking of a hot-rolled steel sheet is performed in the sealed oven that is supplied with hot air from a blast furnace or a electric furnace.

[0013] The internal temperature of the sealed oven is maintained in the range of 1000 to 1200°C such that the temperature of the hot-rolled steel sheet is maintained in

an austenite region.

[0014] The steel sheet pressed in the press hardening is cooled such that the structure becomes a martensite structure.

[0015] A path changing process that changes a conveying path of the hot-rolled steel sheet when a problem occurs in the press die is included.

[0016] The path changing process includes: sensing, by a sensor, a problem in the press die; determining, by a controller, whether a problem has occurred in the press die in response to the signal from the sensor and changing the conveying path of the hot-rolled steel sheet by driving an emergency cutter and leading roller when a problem has occurred; and winding the hot-rolled steel sheet transferred through the changed conveying path.

[0017] When a problem has occurred in the press die, a plurality of press dies is operated to continuously press the blanked hot-rolled steel sheet, wherein a conveying direction of the blanked hot-rolled steel sheet is determined by the controller receiving the signal from the sensor that has sensed the problem, and the blanked hot-rolled steel sheet is supplied to a corresponding press die through a high-speed conveyer disposed between the outlet of the sealed oven and the press dies.

[0018] Yet another embodiment of the present invention provides an apparatus for press hardening, including: a slab casting device that manufactures a hot-rolled steel sheet; a blank that is disposed at an outlet of a rolling machine in the equipment for slab casting and blanks the hot-rolled steel sheet in a predetermined size; a press die that comprises into upper and lower die portions located at an outlet side of the blank and presses the blanked steel sheet at a high temperature; and a sealed oven that is disposed between the outlet of the rolling machine and the press die such that the blank is positioned therein, and connected with an air channel of a blast furnace or an electric furnace to maintain the temperature of the hot-rolled steel sheet passing through the sealed oven within an austenite region.

[0019] The sealed oven has an inlet and an outlet and is provided with a conveying line extending from the inlet toward the outlet therein such that the hot-rolled steel sheet is conveyed.

[0020] Leading rollers that guides the hot-rolled steel sheet toward a position lower than the outlet of the rolling machine when a problem occurs in the press die and a winder that winds the hot-rolled steel sheet guided by the leading rollers disposed between the outlet of the rolling machine and the sealed oven.

[0021] A plurality of the press dies are provided, and a high-speed conveyer that conveys the hot-rolled steel sheet discharged from the outlet of the sealed oven to the press dies and is disposed between the outlet of the sealed oven and the press die.

[Advantageous Effects]

[0022] According to the embodiments of the present invention, it is possible to supply a steel sheet to press hardening before micro-structure transformation by maintaining high temperature in hot rolling, without accompanying cooling and winding after hot rolling in manufacturing a steel sheet. Further, it is possible to manufacture a high-strength part by controlling the cooling rate after press forming.

[0023] The method does not need additional reheating, because of directly putting hot steel sheet obtained by hot rolling into the press hardening. Therefore, it is possible to reduce the prime cost by simplifying the process.

[0024] Further, according to the embodiments of the present invention, it is possible to reduce the manufacturing cost because specific equipment for cooling, winding, and reheating a hot-rolled steel sheet is not needed, and it is possible to improve productivity because press hardening is sequentially performed after hot rolling.

[0025] Further, since a configuration to resolve any problem in the press die is provided, the continuous process can be continued and it is possible to improve production efficiency.

[Description of Drawings]

[0026]

FIG. 1 is a view schematically showing press hardening of the related art.

FIGS. 2 and 3 are process diagrams illustrating press hardening of the related art.

FIGS. 4 and 5 are process diagrams illustrating continuous press hardening according to the present invention.

FIG. 6 is a view schematically showing the configuration of a sealed oven that is used in an embodiment of a continuous press hardening apparatus according to the present invention.

FIG. 7 is a view schematically showing the configuration of a sealed oven that is used in another embodiment of a continuous press hardening apparatus according to the present invention.

FIG. 8 is a view schematically showing the configuration of a sealed oven that is used in yet another embodiment of a continuous press hardening apparatus according to the present invention.

FIG. 9 is a CCT curve showing temperature changes according to forming and cooling in the process of continuous press hardening of the present invention.

FIGS. 10 and 11 are process diagrams illustrating another embodiment of the process of continuous press hardening according to the present invention.

FIG. 12 is a picture of the structure of a press-hardened part manufactured according to the present invention.

[Best Mode]

[0027] A continuous press hardening process and apparatus therefor according to an embodiment of the present invention is described hereafter in detail with reference to the accompanying drawings.

[0028] A method of press hardening according to an embodiment of the present invention includes: sequential processes of slab casting that includes making a slab by continuously casting molten steel refined by an electric furnace or a blast furnace, and then reheating and hot-rolls the slab into a hot-rolled steel sheet; and press hardening that includes conveying, blanking, and pressing the hot-rolled steel sheet manufactured by the slab casting.

[0029] For those processes, the slab casting and the press hardening are implemented in a continuous line. A blanking device B for cutting the hot-rolled steel sheet into a predetermined width and a hot press die P are disposed to the outlet side of the equipment for slab casting for manufacturing the hot-rolled steel sheet instead of equipment for cooling and winding. For reference, the press die P includes upper and lower dies which are respectively provided with cooling water for hardening the surface structure of the hot-rolled steel sheet.

[0030] The slab casting is implemented in the order of (a) manufacturing molten metal - (b) continuous casting - (c) manufacturing a slab - (d) reheating the slab - (e) hot rolling and the press hardening is implemented in the order of (f) blanking - (g) forming - (h) cooling - (i) achieving a complete product. The processes are sequentially implemented, and the processes and temperature changes in the processes are shown in FIGS. 3 and 4.

[0031] A hot-rolled steel sheet S finally hot-rolled by the slab casting equipment is conveyed to the blanking device B and cut in a predetermined width, and then conveyed and pressed by the press die P, which sequentially proceeds.

[0032] Press forming is hot forming and should be performed to the hot-rolled steel sheet at temperature above austenite transformation temperature where the elongation is good; therefore, blanking is performed in a sealed oven M to maintain the temperature of the hot-rolled steel sheet during the rolling.

[0033] The rolling and blanking are processes before the press forming. When the hot-rolled steel sheet S is exposed to the air in the rolling and blanking, it is cooled at a rate of 20°C per second and the temperature can be below the austenite transformation temperature in the press forming after the blanking is finished, thereby deteriorating formability of the hot-rolled steel sheet. Therefore, it is required to provide a sealed section before the press forming. Further, the sealed section also prevents the hot-rolled steel sheet from oxidation.

[0034] As shown in FIG. 6, a space having a predetermined size is defined in the sealed oven M and the space communicates with the outside through an inlet and an outlet. A conveyer line L extending outside through the inlet and the outlet is disposed in the space to convey the hot-rolled steel sheet from the inlet to the outlet.

[0035] The temperature of the sealed oven M is maintained by hot air blown out of an electric furnace or a blast furnace between 1000 and 1200°C such that temperature of the blanked hot-rolled steel sheet, that is, the hot-rolled steel sheet blank S1 is maintained at 900°C or more in press forming, assuming that hot rolling temperature is 1000°C or more. This is determined in consideration of that the movement time of the hot-rolled steel sheet from the blanking to the press forming is about 8 seconds and the hot-rolled steel sheet is cooled for the time.

[0036] However, since the movement time and the cooling of the hot-rolled steel sheet may change in accordance with the dimensions of the equipment for press forming, and the width and thickness of the hot-rolled steel sheet, the temperature inside the sealed oven M can be adjusted in consideration of the process design change. For this reason, the sealed oven M is connected to an air channel 10 of the blast furnace or the electric furnace such that hot air is consistently supplied into the space.

[0037] Meanwhile, the present invention provides a configuration against a problem of the press die, because the process is sequentially implemented.

[0038] A first alternative is a winder 20 disposed under and between the outlet of a rolling machine R and the sealed oven M, as shown in FIG. 7. The winder 20 is provided to wind the hot-rolled steel sheet without blanking, when a problem occurs in the press die P.

[0039] Leading rollers 21 and 23 are disposed above the winder 20 to guide the hot-rolled steel sheet S to not the sealed oven M, but the winder 20.

[0040] The leading rollers 21 and 23 are an upper leading roller 21 and a lower leading roller 23. The upper leading roller 21 is movable up/down with respect to the lower leading roller 23 such that it allows the hot-rolled steel sheet S to smoothly move into the sealed oven M by moving up when the press die is in normal operation. The downward movement of the roller changes the conveying path of the hot-rolled steel sheet S to the winder 20 when a problem occurs in the press die P.

[0041] For reference the upper leading roller 21 can be moved up/down by an external driving unit or hydraulic pressure.

[0042] A sensor 25 is provided to sense a problem in the press die P. The sensor 25 is disposed close to the press die P and senses a problem in the press die P. The sensor 25 is a typical sensor that is widely used. A signal for a problem in the press die P is transmitted from the sensor 25 to a controller 27.

[0043] When determining that a problem has occurred in the press die P in response to the signal received from the sensor 25, the controller 27 controls the upper leading roller 21 to move to the lower leading roller 23 such that the hot-rolled steel sheet S is guided downward to be wound by the winder 20.

[0044] An emergency cutter 29 is provided between the outlet of the rolling machine R and the lead rollers 21 and 23. The emergency cutter 29 cuts the hot-rolled steel sheet S that is being conveyed, when the upper leading roller 21 moves down. This is because cutting the hot-rolled steel sheet S is required to guide downward the hot-rolled steel sheet S, which is being conveyed, to be wound by the winder 20.

[0045] That is, the present invention includes a process of changing the path that changes the conveying path of the hot-rolled steel sheet S, when a problem occurs in the press die P.

[0046] The path changing process includes: sensing a problem of the press die P and outputting a signal in the sensor 25; determining, by a controller 27, whether a problem has occurred in the press die P in response to the signal from the sensor 25 and changing the conveying path of the hot-rolled steel sheet S by operating the emergency cutter 29 and the leading rollers 21 and 23 when there is a problem; and winding the hot-rolled steel sheet S with the changed conveying path.

[0047] For reference, reference numeral '28' in FIG. 7 indicates a robot that carries a hot-rolled steel sheet blank S1 to the press P. Although supplying the hot-rolled steel sheet blank S1 to the press die P with the robot exemplified in this embodiment, it is not limitative and it is possible to connect the rollers to the press die P in a continuous line without using the robot.

[0048] A second alternative is to operate a plurality of press dies P1, P2, and P3, as shown in FIG. 8. This is for continuing the press forming when a problem occurs in any one press die P1, by distributing the hot-rolled steel sheet blank S1 that has been guided to the outlet of the sealed oven M to the other press dies P2 and P3 having no problem.

[0049] A high-speed conveyer 30 is provided between the sealed oven M and the press dies P1, P2, and P3. The high-speed conveyer 30 is an apparatus for conveying the hot-rolled steel sheet blank S1 that has been guided to the outlet of the sealed oven M to any one of the press dies P1, P2, and P3.

[0050] The high-speed conveyer 30 has a main line 31 and sub-lines 33 diverging from the main line 31. The main line 31 and the sub-lines 33 are implemented, for example, by a plurality of rollers and the rollers in the main line 31 conveys the hot-rolled steel sheet blank S1 to the sub-lines 33 while rotating forward or backward.

[0051] Further, the hot-rolled steel sheet blank S1 conveyed to the sub-lines 33 is conveyed and pressed between the upper and lower dies of the press die. In this configuration, it may be possible to convey the hot-rolled steel sheet blank S1 between the upper and lower dies of the press dies P1, P2, and P3, using a robot at the end of the sub-line 33.

[0052] A sensor 35 is provided to sense a problem in the press dies P1, P2, and P3.

[0053] The sensor 35 is disposed close to the press dies P1, P2, and P3 and senses a problem in the press dies P1, P2, and P3. The sensor 35 is a typical sensor that is widely used. A signal for a problem in the press dies P1, P2, and P3 is transmitted from the sensor 35 to a controller 39.

[0054] The controller 39 determines the conveying direction of the hot-rolled steel sheet blank S1 that has been guided to the outlet of the sealed oven M in response to a detection signal from the sensor 35 and then controls the operation of the high-speed conveyer 30.

[0055] In detail, when determining a problem has occurred in the press die P1 in response to the detection signal from the sensor 35, the controller 39 controls the operation of the high-speed conveyer 30 such that the hot-rolled steel sheets blank S1 are distributed to the other press dies P2 and P3 that have no problem.

[0056] When the second alternative is selected, it is advantageous to maintain the hot-rolled steel sheet blank S1 at high temperature by variably operating the press dies P1, P2, and P3 in accordance with the conveying speed of the hot-rolled steel sheet blank S1.

[0057] Further, the hot-rolled steel sheet S that has been finally hot-rolled by the equipment for slab casting can continue being conveyed to be blanking device B, cut in a predetermined width, conveyed to the other press dies P2 and P3, and pressed therein, even if a problem occurs in any one, for example, the press die P1 in the press dies P1, P2, and P3.

[0058] The pressed hot-rolled steel sheet is cooled by water such that the structure of the hot-rolled steel sheet becomes to have a martensite structure, without crossing the low-strength ferrite and pearlite transformation curves in the CCT curve shown in FIG. 9.

[0059] Meanwhile, the press hardening described above is also applied to thin slab casting and strip casting equipment, in which the rolling line is short, in addition to the slab casting.

[0060] When the press hardening is applied to the thin slab casting and the strip casting, the process of manufacturing a part for press hardening proceeds, as shown in FIGS. 10 and 11, in the order of (a) manufacturing molten metal - (b) continuous casting - (c) hot-rolled steel sheet - (d) blanking - (e) forming - (f) cooling, and manufacturing a slab, reheating the slab, winding, and reheating the hot-rolled reheating for press forming are not performed.

[0061] The operation of a process of continuous press hardening according to the present invention is described hereafter.

[0062] A process of manufacturing a part for press hardening is described with reference to FIGS. 4 to 6.

[0063] First, a continuous-cast slab is hot-rolled and the hot-rolled steel sheet S is conveyed into the sealed oven M. The hot-rolled steel sheet conveyed in the sealed oven is conveyed to the blanking device B by the conveying line and blanked (cut) to a predetermined size. The blanked hot-rolled steel sheets S1 are sequentially conveyed and discharged to the outlet of the sealed oven M.

[0064] In this process, the internal temperature of the sealed oven M is about 1000°C, which maintains the temperature of the hot-rolled steel sheet within the austenite region until press forming. The configuration of the section where the sealed oven M may be changed in consideration of temperature in the hot-rolling for the slab casting and the thin slab casting/strip casting (see FIGS. 10 and 11).

[0065] Thereafter, the blank S1 conveyed outside through the outlet of the sealed oven M is conveyed between the upper and lower dies of the press die and then pressed into a complete product S2. The pressed hot-rolled steel sheet is cooled into a martensite structure having high structure strength by cooling.

[0066] It was ascertained as a result of an experiment that the part for press hardening which was manufactured by the processes described above had a martensite structure shown in FIG. 12.

[0067] According to the process of continuous press hardening, the entire process is simplified with a continuous line of the manufacturing process of the part for press hardening, by making the blanking device and the press die for press hardening in a continuous line outside the equipment for slab casting and the equipment for thin slab casting/strip slab casting.

[0068] Therefore, the process of cooling and winding the steel sheet in a coil after hot rolling and the process of reheating the hot-rolled steel sheet for press forming are removed. In this configuration, since the temperature of the hot-rolled steel sheet is maintained at the austenite transformation temperature or more by the sealed oven, until before the hot-rolled steel sheet is pressed after being hot-rolled, even if the reheating is removed, a high-strength part can be manufactured.

[0069] Meanwhile, when a problem occurs in the press die P, it is possible to dealt with the problem of the press die by moving down the upper leading roller 21 to the lower leading roller 23 such that the hot-rolled steel sheet S is guided down, and winding it with the winder 20.

[0070] Further, it is possible to continue press forming by using the plurality of press dies P1, P2, and P3 and conveying the hot-rolled steel sheet to the other press dies P2 and P3, when a problem occurs in any one, for example, the press die P1.

[0071] The present invention may be modified in various ways by those skilled in the art, within the basic scope of the present invention, and the scope of the present invention should be construed on the basis of the claims.

Claims

1. A process of continuous press hardening, comprising:

   slab casting step that comprises making a slab by continuously casting molten steel refined by an electric furnace or a blast furnace, and then reheating and hot-rolling the slab into a hot-rolled steel sheet;

   blanking step that comprises, after the slab casting step, conveying the hot-rolled steel sheet to a blanking device through a sealed oven and blanking the hot-rolled steel sheet; and

   press hardening step that comprises, after the blanking step, conveying the hot-rolled steel sheet to a press die and pressing the hot-rolled steel sheet.

2. A process of continuous press hardening, comprising:

   thin slab casting or strip casting step that comprises making a hot-rolled steel sheet by continuous-casting molten steel refined by an electric furnace or a blast furnace;

   blanking step that comprises, after the thin slab casting or strip casting step, conveying the hot-rolled steel sheet to a blanking device through a sealed oven and blanking the hot-rolled steel sheet; and

   press hardening step that comprises, after the blanking step, conveying the hot-rolled steel sheet to a press die disposed at an outlet of the sealed oven and pressing the hot-rolled steel sheet.

3. The process of continuous press hardening according to claim 1 or 2, wherein the blanking of a hot-rolled steel sheet is performed in the sealed oven that is supplied with hot air from a blast furnace or an electric furnace.

4. The process of continuous press hardening according to claim 3, wherein the internal temperature of the sealed oven is maintained between 1000°C and 1200°C such that the temperature of the hot-rolled steel sheet is maintained within an austenite region.

5. The process of continuous press hardening according to claim 4, wherein the steel sheet pressed in the press hardening is cooled such that the structure becomes to a martensite structure.

6. The process of continuous press hardening according to claim 1 or 2, comprising a path changing process that changes a conveying path of the hot-rolled steel sheet, when a problem occurs in the press die.

7. The process of continuous press hardening according to claim 6, wherein the path changing process includes:

   sensing, by a sensor, a problem in the press die and outputting a signal;

determining, by a controller, whether a problem has occurred in the press die in response to the signal from the sensor, and changing a conveying path of the hot-rolled steel sheet by driving an emergency cutter and leading roller, when a problem has occurred; and
winding the hot-rolled steel sheet transferred through the changed conveying path.

8. The process of continuous press hardening according to claim 1 or 2, wherein when a problem has occurred in the press die, a plurality of press dies is operated to continuously press the blanked hot-rolled steel sheet, wherein a conveying direction of the blanked hot-rolled steel sheet is determined by the controller receiving the signal from a sensor that has sensed the problem, and the blanked hot-rolled steel sheet is supplied to a corresponding press die through a high-speed conveyer disposed between the outlet of the sealed oven and the press dies.

9. An apparatus for press hardening, comprising:

a slab casting device that manufactures a hot-rolled steel sheet;
a blanking device that is disposed at an outlet of a rolling machine in the slab casting device and blanks the hot-rolled steel sheet in a predetermined size;
a press die that comprises into upper and lower die portions located at an outlet side of the blanking device and presses the blanked steel sheet at a high temperature; and
a sealed oven that is disposed between the outlet of the rolling machine and the press die such that the blanking device is positioned therein, and connected with an air channel of a blast furnace or an electric furnace to maintain the temperature of the hot-rolled steel sheet passing through the sealed oven within an austenite region.

10. The apparatus for press hardening according to claim 9, wherein the sealed oven has an inlet and an outlet and is provided with a conveying line extending from the inlet toward the outlet therein such that the hot-rolled steel sheet is conveyed.

11. The apparatus for press hardening according to claim 10, further comprising leading rollers that guides the hot-rolled steel sheet toward a position lower than the outlet of the rolling machine when a problem occurs in the press die and a winder that winds the hot-rolled steel sheet guided by the leading rollers disposed between the outlet of the rolling machine and the sealed oven.

12. The apparatus for press hardening according to claim 10, wherein a plurality of the press dies are provided, and a high-speed conveyer that conveys the hot-rolled steel sheet discharged from the outlet of the sealed oven to the press dies and is disposed between the outlet of the sealed oven and the press die.

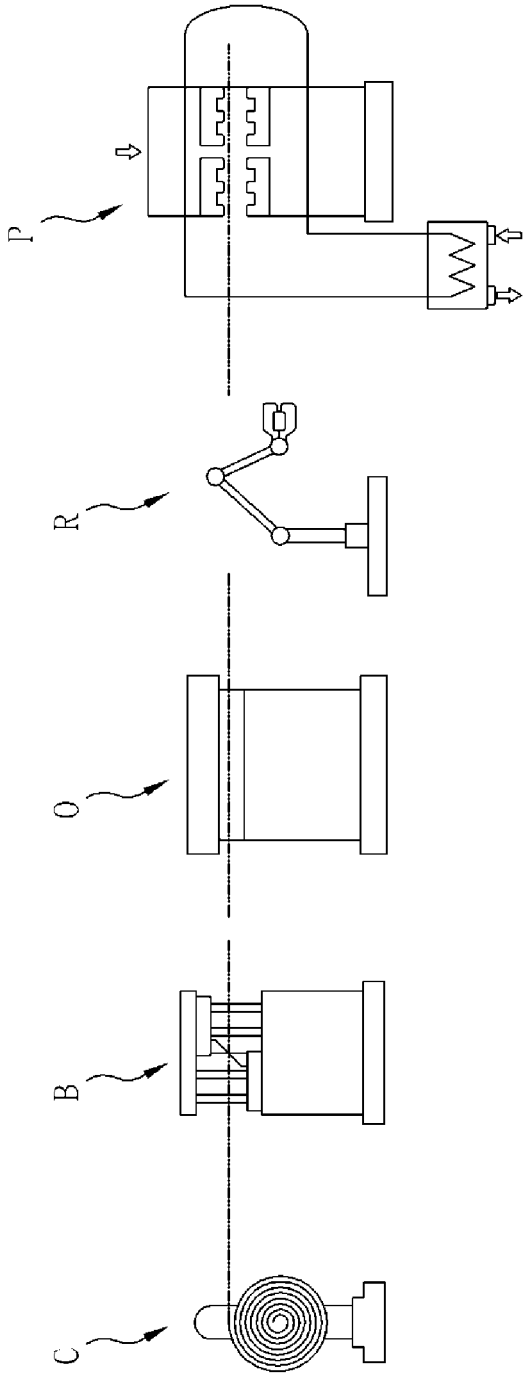

FIG. 1

FIG.2

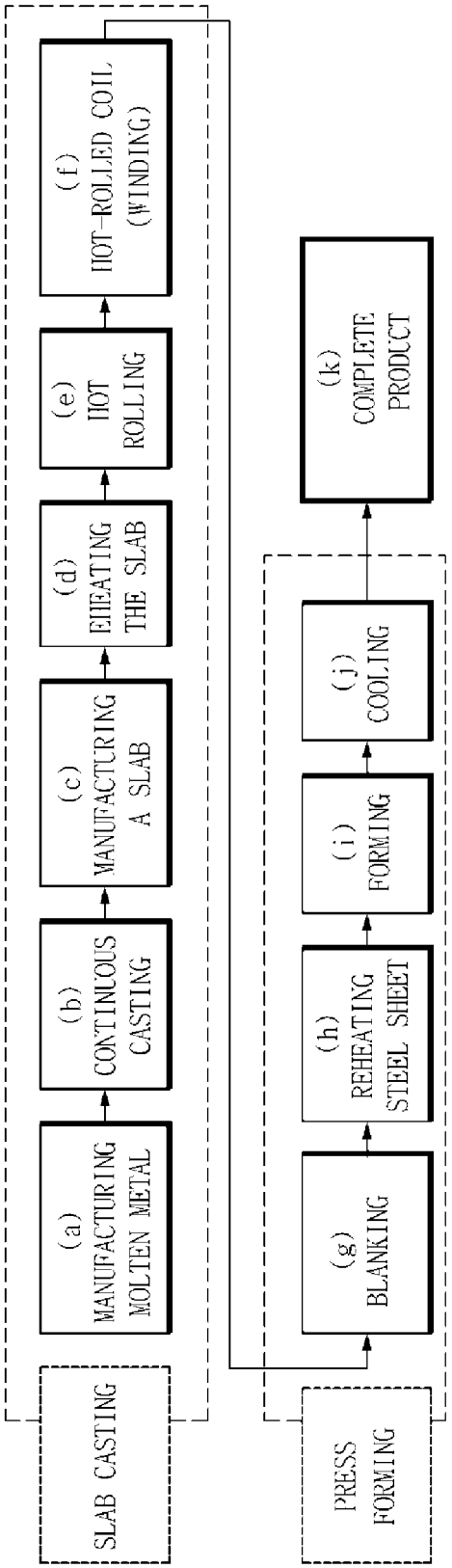
SLAB CASTING
(a) MANUFACTURING MOLTEN METAL
(b) CONTINUOUS CASTING
(c) MANUFACTURING A SLAB
(d) REHEATING THE SLAB
(e) HOT ROLLING
(f) HOT-ROLLED COIL (WINDING)
PRESS FORMING
(g) BLANKING
(h) REHEATING STEEL SHEET
(i) FORMING
(j) COOLING
(k) COMPLETE PRODUCT

FIG.3

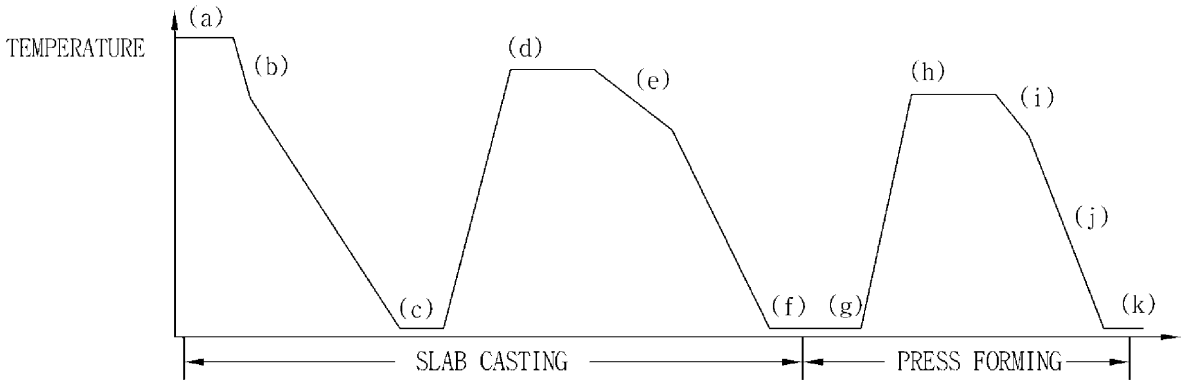

FIG. 4

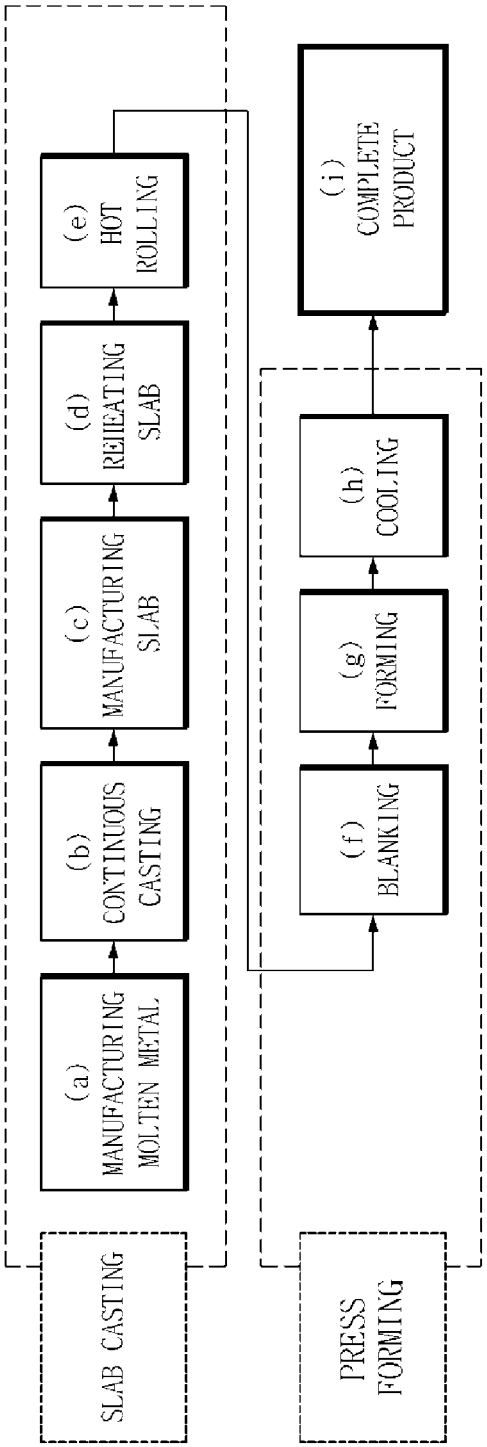
SLAB CASTING
(a) MANUFACTURING MOLTEN METAL
(b) CONTINUOUS CASTING
(c) MANUFACTURING SLAB
(d) REHEATING SLAB
(e) HOT ROLLING
PRESS FORMING
(f) BLANKING
(g) FORMING
(h) COOLING
(i) COMPLETE PRODUCT

FIG.5

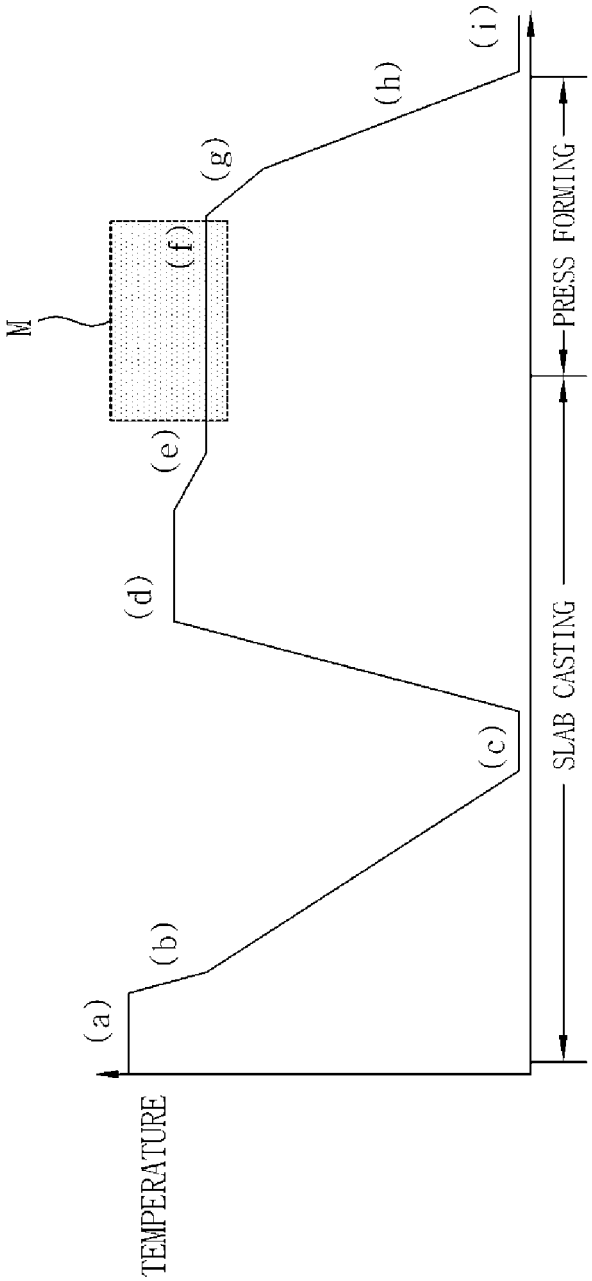

FIG.6

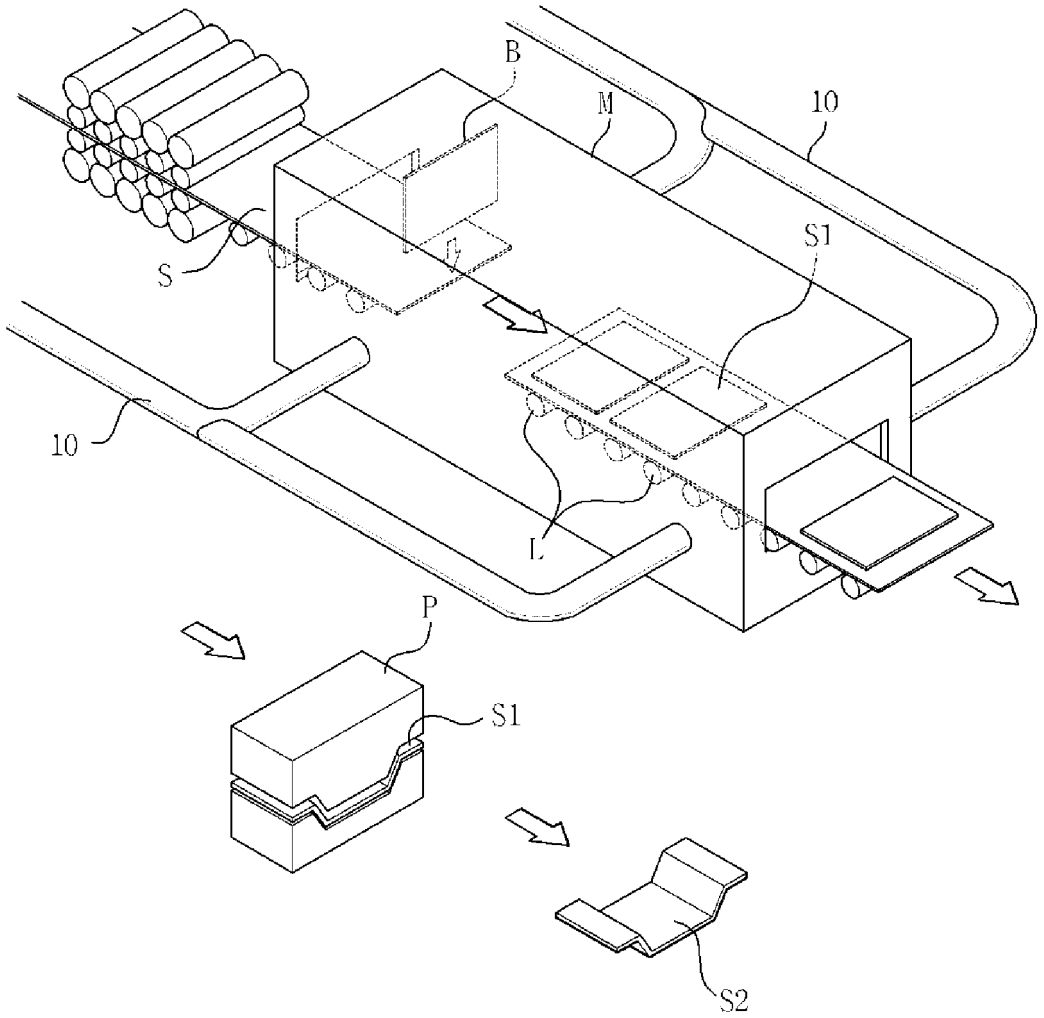

FIG.7

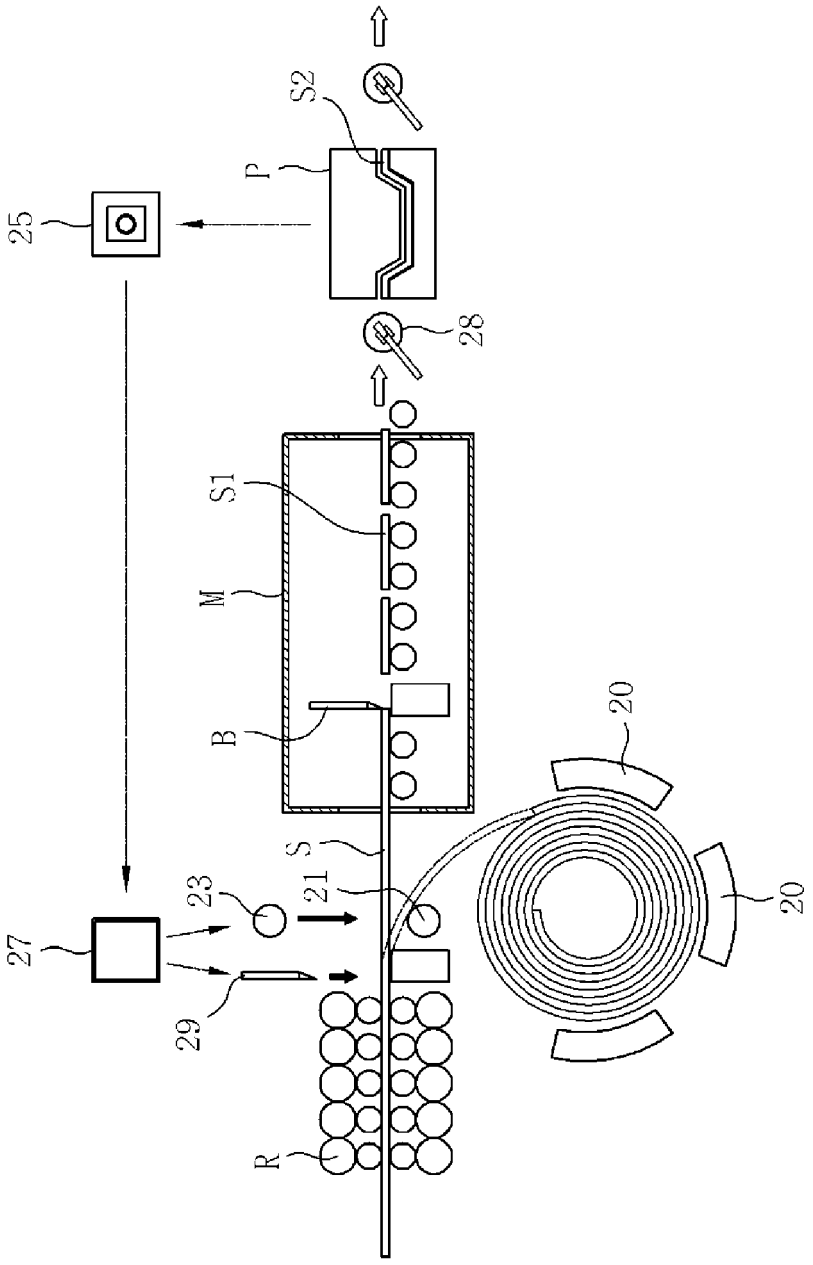

FIG.8

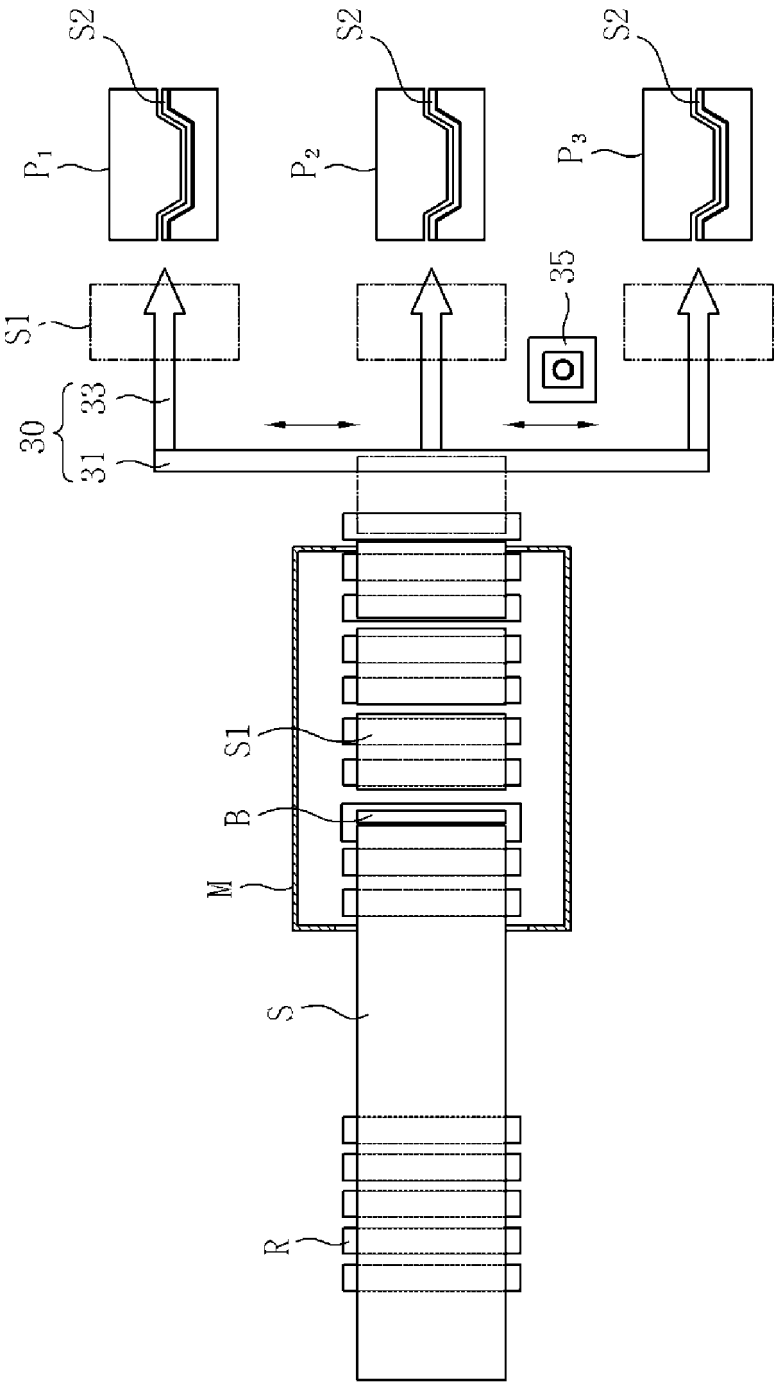

FIG. 9

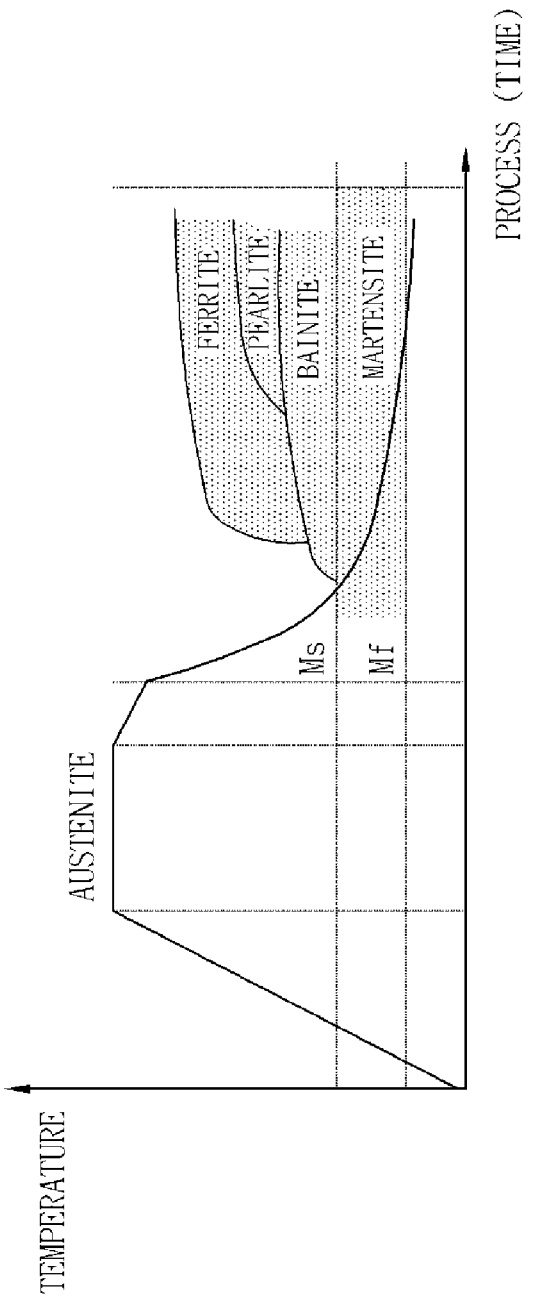
TEMPERATURE
AUSTENITE
Ms
Mf
FERRITE
PEARLITE
BAINITE
MARTENSITE
PROCESS (TIME)

FIG. 10

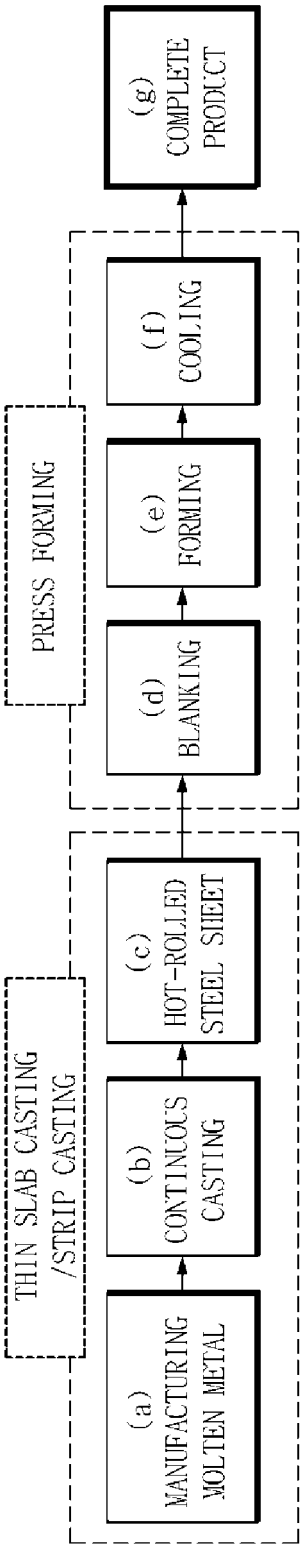
(a) MANUFACTURING MOLTEN METAL
(b) CONTINUOUS CASTING
(c) HOT-ROLLED STEEL SHEET
(d) BLANKING
(e) FORMING
(f) COOLING
(g) COMPLETE PRODUCT
THIN SLAB CASTING /STRIP CASTING
PRESS FORMING

FIG. 11

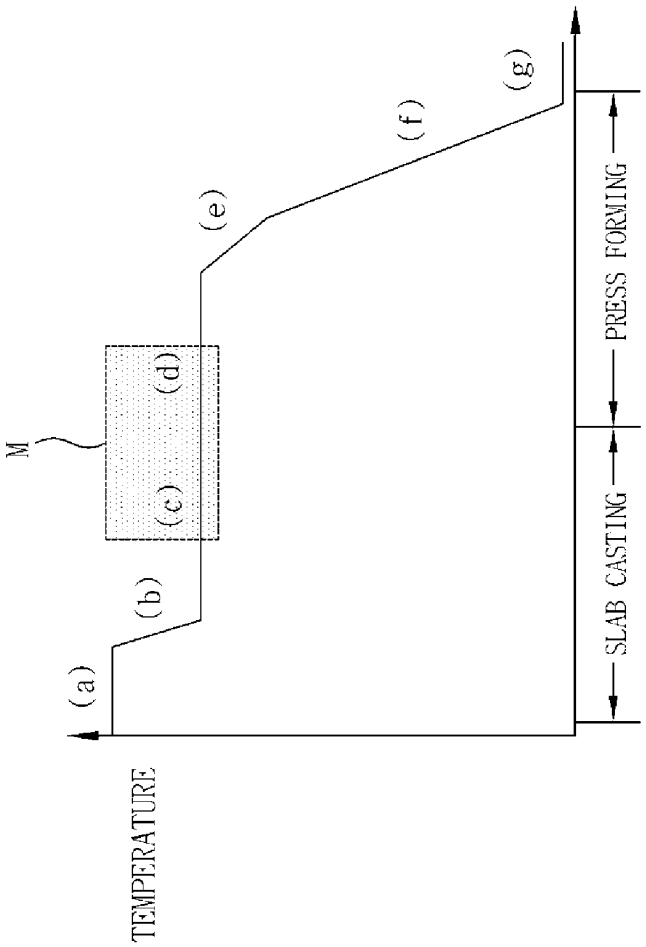

FIG. 12