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(54) PRESS-CURE MOLD COOLING DEVICE

FORMKÜHLUNGSVORRICHTUNG MIT DRUCKHÄRTUNG

DISPOSITIF DE REFROIDISSEMENT DE MOULE DE VULCANISATION SOUS PRESSE

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Description

[Technical Field]

[0001] The present invention relates to a press hardening die cooling device, and more particularly, to a press hardening die cooling device which has a structure improved for adjusting cooling rate in order to adjust hardness of the surface structure of a portion that is cut by trimming die of a steel plate blank.

[Background Art]

[0002] In general, a method of manufacturing a high-strength press-hardened product is to heat a steel material of which hardenability is improved by adding B, Mo, and Cr etc. at a high temperature, about 900°C, above an Ac3 transformation point to be completely changed into an austenite state, and then hot-forming the steel plate at one time into a product shape with a press die and rapidly cooling it into martensite structure.

[0003] As well known in the related art, a steel plate is easy to form, because its ductility is increased when being heated at a high temperature. Thus, the machinability of a steel plate manufactured by press hardening is slightly better than that of typical steel plates for machining and considerably better than that of high-strength steel.

[0004] Further, a steel plate manufactured by press hardening has very high strength (above 1,400 MPa) such that it is significantly advantageous in terms of specific strength, obtained by dividing yield strength by density, and thus can considerably contribute to reducing weight of vehicles. Further, the steel plate manufactured by press hardening is used to manufacture ultra high-strength parts that are difficult to form, because there is little spring back after machining.

[0005] It is required to heat a steel plate at about 900°C or more for several minutes to transform the steel plate into an austenite state in press hardening process, and this should be automated for an efficient process.

[0006] Press hardening includes heating a blank before being hardened from a wound steel plate coil in a furnace, and carrying the blank into a press with a robot, and pressing it in the related art.

[0007] The press includes upper and lower dies of a press hardening die, cooling water is supplied to cooling water supplier for the upper and lower dies to harden the surface structure of a steel plate blank and cools the steel plate blank.

[0008] Steel plate blanks of the related art are cut into a middle part which is substantially used for a part, and scraps which are disposed at both sides and are substantially cut by a trimming die in the post-machining.

[0009] However, the portion to be trimmed by a trimming die of the related art is hardened by the cooling using a press die described above. Thus, the trimming die is severely worn in trimming, and accordingly machinability of the trimming is reduced, work loss is caused by replacing the trimming die, and productivity decreases.

[0010] The German patent DE 10 2005 032113 B1 discloses an apparatus for thermally deforming and partially hardening a component in a mold of at least two parts, between which the component, at its hardening temperature or above, is compressed to the mold contour by a press.

[0011] The German patent application DE 197 23 655 A1 discloses a method for manufacturing a steel sheet product by heating a cut sheet, hot working the steel sheet in a mold pair and hardening of the formed product by cooling, while it is still in the mold pair. Afterwards the steel sheet product is further processed.

[Disclosure]

[Technical Problem]

[0012] In order to solve the above problems, the present invention has been made in an effort to provide a press hardening die cooling device that facilitates trimming a steel plate blank by applying cooling processes to a part differently from the other part of the blank, by using an improved structure of a press hardening die.

[Technical Solution]

[0013] In order to accomplish the above object, an embodiment of the present invention provides a press hardening die cooling device, which includes: a press hardening die including upper and lower dies and pressing a steel plate blank; a plurality of cooling water suppliers spaced apart from each other in the upper and lower dies to be channels through which cooling water flows; and a cooling water temperature adjuster configured to adjust temperature of the cooling water supplied to the cooling water suppliers, wherein the cooling water temperature adjuster includes a controller that operates such that cooling water is supplied at a higher temperature to the cooling water suppliers close to trimming portions of the steel plate blank than the other cooling water suppliers in the cooling suppliers, and wherein the controller includes a heater configured to heat the cooling water supplied to the cooling water suppliers close to trimming portions.

[0014] The controller controls the heater to maintain the temperature of the cooling water supplied to the cooling water suppliers close to the trimming portions between 45 and 80°C.

[0015] Holes are formed between the cooling water suppliers close to the trimming portions of the steel plate blank and the contact surface of the steel plate blank.

[0016] The press hardening die is provided with insulators.

[0017] The press hardening die cooling device further includes temperature sensors disposed between the trimming portions of the steel plate blank and the cooling

water supplier to sense temperature of the press hardening die, and outputting sensed signals to the controller.

[0018] The cooling water temperature adjuster controls temperature of the cooling water such that the trimming portions of the steel plate blank changes to a mixed structure of ferrite, pearlite, and bainite.

[0019] Another embodiment of the present invention provides a press hardening die cooling device, which includes: a press hardening die including upper and lower dies provided with insulators therein and pressing a steel plate blank; a plurality of cooling water suppliers spaced apart from each other in the upper and lower dies to be channels through which cooling water flows; and a cooling water temperature adjuster adjusting temperature of the cooling water supplied to the cooling water suppliers using temperature sensors disposed in the press hardening die.

[Advantageous Effects]

[0020] The present invention provides an apparatus for a press hardening die which is improved to decrease cooling rate of trimming portions in pressing a steel plate blank for manufacturing a part for press hardening. According to the embodiments of the present invention, it is possible to improve durability and productivity by reducing wear of the trimming die, because it is possible to prevent the trimming portion from changing to a martensite structure having high hardness by decreasing cooling rate by the cooling water suppliers in the upper and lower dies to prevent the trimming portions from being rapidly cooled.

[Description of Drawings]

[0021]

FIG. 1 is a view showing the configuration of a first embodiment of a press hardening die cooling device according to the present invention.

FIG. 2 is a perspective view showing a second embodiment of the present invention.

FIG. 3 is a view showing the configuration of a third embodiment of a press hardening die cooling device according to the present invention.

FIG. 4 is a view showing the configuration of a fourth embodiment of a press hardening die cooling device according to the present invention.

FIG. 5 is a view showing the configuration of a fifth embodiment of a press hardening die cooling device according to the present invention.

FIG. 6 is a view showing the configuration of a sixth embodiment of a press hardening die cooling device according to the present invention.

FIG. 7 is a graph showing a cooling process to time of a steel plate blank according to the present invention.

[Best Mode]

[0022] Hereinafter, embodiments of the present invention will be described in detail with reference to the accompanying drawings.

[0023] Referring to FIG. 1, the first embodiment of a press hardening die cooling device according to the present invention includes: a press hardening die P composed of upper and lower dies 10 and 20 equipped with cooling water suppliers 12 and 22 therein to press a steel plate blank S from the top and the bottom; and a cooling water temperature adjuster disposed between the cooling water suppliers 12 and 22 of the upper and lower dies 10 and 20 and the contact surface of the steel plate blank S to adjust temperature of cooling water supplied to the steel plate blank S.

[0024] In detail, the cooling water temperature adjuster is provided with a controller 100 for supplying cooling water at different temperatures to the cooling water suppliers 12 and 22, and the controller 100 includes a heater 150 for heating the cooling water supplied to the cooling water suppliers 12 and 22 close to trimming portions T1.

[0025] The controller 100 controls the turning on/off of the heater 150 such that the temperature of the cooling water, which is supplied to the cooling water suppliers 12 and 22 close to the trimming portions T1, is maintained between 45 and 80°C. The other cooling suppliers 12 and 22 are supplied with cooling water at a temperature between 10 and 25°Cwhich is the same as in the related art.

[0026] That is, controller 100 operates such that cooing water at 10 to 25°C is supplied to the cooling water suppliers 12 and 22 close to the middle portion of the steel plate blank S, which will be a part, and cooling water at 45 to 80°C heated by the heater 150 is supplied to the cooling water suppliers 12 and 22 close to the trimming portions T1 located at both sides.

[0027] In this configuration, adjusting the temperature of the cooling water between 45 and 80°C is for transforming the structure of the trimming portions T1 in the steel plate blank S into a mixed structure with ferrite, pearlite, and bainite, which has excellent toughness and ductility, as compared with a martensite structure.

[0028] The operation of the present invention having this configuration is described hereafter.

[0029] A press hardening die cooling device according to the present invention controls cooling rate of the cooling water suppliers 12 and 22 during the press hardening of the steel plate blank heated at 900°C or more through a furnace and carried into the press hardening die P using a robot in order to manufacture a press-hardened product such that heat conduction rate of the trimming portions T1 interfacing each scrap and the middle portion which will be a product is different from the other portions of the steel plate blank S.

[0030] For this configuration, the some cooling air suppliers 12 and 22 which are close to the trimming portions T1 among the cooling water suppliers 12 and 22 disposed

in the upper and lower dies 10 and 20 of the press hardening die P are supplied with cooling water at a higher temperature than the other portions such that the cooling rate becomes lower at the trimming portions T1 than the other portions to be trimmed, and accordingly, hardenability can be more decreased than the other portions of the steel plate blank S.

[0031] Therefore, the trimming portions T1 have lower cooling rate than the other portions of the steel plate blank S in pressing, and thus, the structures become having lower hardness than the other portions.

[0032] Thereafter, the other portions of the steel plate blank S except for the portions T1 to be trimmed in trimming process are change into a martensite structure having high hardness, whereas the trimming portions are changed into a ferrite + pearlite + bainite structure, which has lower hardness and better machinability than the martensite structure.

[0033] In this case, hardenability of the trimming portions T1 is variable in accordance with cooling water temperature, and for example, there is a relationship that the cooling rate decreases when the cooling water temperature increases and the cooling rate increases when the cooling water temperature decreases.

[0034] Hereinafter, repeated description for the components that are the same as those in the above embodiment is not provided and they are given the same reference numeral, in describing the other embodiments of the present invention.

[0035] On the other hand, FIG. 2 is a view showing a second embodiment of the present invention, in which holes 210 are formed through the upper and lower dies , between the cooling water suppliers 12 and 22 close to the trimming portions T1 and the contact surface of the steel plate blank S.

[0036] The holes are formed to change the trimming portions T1 of the steel plate blank S into a mixed structure with ferrite + pearlite + bainite by reducing the rate of heat conduction to the cooling water suppliers 12 and 22, as described above.

[0037] That is, heat transferred from the cooling water suppliers 12 and 22 is conducted to the trimming portions T1 through the holes 210 such that cooling performance of the cooling water decreases at the portions than the other portions and the trimming portions T1 of the steel plate blank S are prevented from being rapidly cooled.

[0038] In this configuration, although the holes 210 are formed at both of the upper and lower dies 10 and 20, the hole may be formed only at the upper die or the lower die.

[0039] Further, it is preferable that the hole 210 has a rectangular or a circular cross section to decrease heat transfer efficiency.

[0040] FIG. 3 is a view showing the configuration of a third embodiment of the present invention. In addition to the configurations of the embodiments described above insulators 300 are vertically disposed in the upper and lower dies 10 and 20 of the press hardening die P.

[0041] The insulators 300 are vertically arranged to divide the upper and lower dies of the press hardening die P around the trimming portions T1.

[0042] This is for making the temperature of the cooling water supplied to the trimming portions T1 of the steel plate blank S different from the temperature of the cooling water supplied to the other portions.

[0043] That is, since the press hardening die P is divided into the middle portion and both sides by the insulators 300, it is possible to provide different cooling performance to each portion of the steel plate blank by supplying cooling water of the cooling water suppliers 12 and 22 with different temperatures.

[0044] FIG. 4 is a view showing the configuration of a fourth embodiment of the present invention, which includes the components of the embodiments described above and further includes temperature sensors 155 that are disposed in the press hardening die P to sense the internal temperature of the die and outputs sensed signals to the controller 100.

[0045] The temperature sensors 155 sense the temperature of the die in real time such that the heater 150 heats the cooling water and that temperature of specific portions is increased or maintained when the temperature of the die is decreased under temperature set in advance in the controller 100.

[0046] FIG. 5 is a view showing the configuration of a fifth embodiment of the present invention, in which the diameter of the cooling water suppliers 12 and 22 close to the trimming portions T1 is set smaller than the diameter of the other cooling water suppliers 12 and 22.

[0047] Further, FIG. 6 is a view showing the configuration of a sixth embodiment of the present invention, in which the cooling water suppliers 12 and 22 close to the trimming portions T1 at both sides in the press hardening die P are dispose further from the contact surface of the steel plate blank than the other cooling water suppliers 12 and 22.

[0048] That is, the cooling water suppliers 12 close to the trimming portions T1 in the upper die are disposed at a level higher than the other water suppliers 12 in the upper die, while the water suppliers 22 close to the trimming portions T1 in the lower die are disposed at a level lower than the other water suppliers 22, in the figure.

[0049] Therefore, the fifth and sixth embodiments of the present invention show that it is possible to make cooling performance of each portion of the steel plate blank different without making temperature of the supplied cooling water different.

[0050] That is, the embodiments of the present invention can prevent the trimming portions from changing to the martensite structure having high hardness by preventing the trimming portions T1 of the steel plate blanks S from being rapidly cooled by way of making the cooling rate of portions different using the cooling water suppliers 12 and 22 in the upper and lower dies 10 and 20 when pressing the steel plate blanks S.

[0051] Therefore, as shown in FIG. 7, temperature dis-

tribution of the steel plate blank S after the pressing is shown, in which the section A shows cooling rate at the middle portion of the steel plate blanks S and the section B shows cooling rate to time at the trimming portions T1. The cooling rates of the portions are different in the steel plate blank S. Accordingly, the structure corresponding to the section A is cooled at a rate of 17 to 24°C per second from 950°C to 800°C and then hardened by rapid cooling into the martensite structure, and the structure corresponding to the section B is slowly cooled from 800°C into the mixed structure.

Claims

1. A press hardening die cooling device, comprising:

   a press hardening die including upper and lower die portions and configured to press a steel plate blank;
   a plurality of cooling water suppliers spaced apart from each other in the upper and lower die portions and forming channels through which cooling water flows; and
   a cooling water temperature adjuster configured to adjust temperature of the cooling water supplied to the cooling water suppliers, wherein the cooling water temperature adjuster includes a controller configured to operate such that cooling water is supplied at a higher temperature to one of the plurality of cooling water suppliers close to a trimming portion of the steel plate blank than the other cooling water suppliers among the plurality of cooling suppliers, and wherein the controller includes a heater configured to heat the cooling water supplied to the cooling water supplier close to the trimming portion.

2. The press hardening die cooling device according to claim 1, wherein the controller configured to control the heater to maintain the temperature of the cooling water supplied to the cooling water supplier close to the trimming portion between 45 and 80°C .

3. The press hardening die cooling device according to claims 1 or 2, further comprising a hole formed between the cooling water supplier close to the trimming portion of the steel plate blank and a steel plate blank contacting surface.

4. The press hardening die cooling device according to claims 1 to 3, wherein the press hardening die is provided with an insulator.

5. The press hardening die cooling device according to claim 1 to 4, further comprising temperature sensors disposed between the trimming portion of the steel plate blank and the cooling water supplier to sense temperature of the press hardening die, and output sensed signals to the controller.

6. The press hardening die cooling device according to any one of claims 1 to 5, wherein the cooling water temperature adjuster configured to control temperature of the cooling water such that the trimming portion of the steel plate blank is changed into a mixed structure of ferrite, pearlite, and bainite.

Patentansprüche

1. Presshärtungsstempel-Kühlungsvorrichtung, die Folgendes umfasst:

   einen Presshärtungsstempel, der einen oberen und einen unteren Stempelabschnitt aufweist und konfiguriert ist, um einen Stahlplattenrohling zu pressen;
   mehrere Kühlwasserzuführungen, die im oberen und im unteren Stempelabschnitt voneinander beabstandet sind und Kanäle bilden, durch die Kühlwasser strömt; und
   eine Kühlwassertemperatur-Einstelleinrichtung, die konfiguriert ist, die Temperatur des Kühlwassers, das den Kühlwasserzuführungen zugeführt wird, einzustellen, wobei die Kühlwassertemperatur-Einstelleinrichtung eine Steuereinheit umfasst, die konfiguriert ist, in der Weise zu arbeiten, dass das Kühlwasser einer der mehreren Kühlwasserzuführungen in der Nähe eines Zurichtabschnitts des Stahlplattenrohlings mit einer höheren Temperatur als den anderen Kühlwasserzuführungen unter den mehreren Kühlwasserzuführungen zugeführt wird, und wobei die Steuereinheit eine Heizeinrichtung enthält, die konfiguriert ist, das Kühlwasser, das der Kühlwasserzuführung in der Nähe des Zurichtabschnitts zugeführt wird, zu erhitzen.

2. Presshärtungsstempel-Kühlvorrichtung nach Anspruch 1, wobei die steuereinheit konfiguriert ist, die Heizeinrichtung so zu steuern, dass sie die Temperatur des der Kühlwasserzuführung in der Nähe des Zurichtabschnitts zugeführten Kühlwassers im Bereich von 45 bis 80 °C hält.

3. Presshärtungsstempel-Kühlvorrichtung nach den Ansprüchen 1 oder 2, die ferner ein Loch aufweist, das zwischen der Kühlwasserzuführung in der Nähe des Zurichtabschnitts des Stahlplattenrohlings und einer Stahlplattenrohling-Kontaktoberfläche ausgebildet ist.

4. Presshärtungsstempel-Kühlungsvorrichtung nach

den Ansprüchen 1 bis 3, wobei der Presshärtungsstempel mit einem Isolator versehen ist.

5. Presshärtungsstempel-Kühlvorrichtung nach den Ansprüchen 1 bis 4, die ferner Temperatursensoren umfasst, die zwischen dem Zurichtabschnitt des Stahlplattenrohlings und der Kühlwasservorrichtung angeordnet sind, um die Temperatur des Presshärtungsstempels zu erfassen und um Erfassungssignale an die Steuereinheit auszugeben.

6. Presshärtungsstempel-Kühlungsvorrichtung nach einem der Ansprüche 1 bis 5, wobei die Kühlwassertemperatur-Einstelleinrichtung konfiguriert ist, um die Temperatur des Kühlwassers in der Weise zu steuern, dass der Zurichtabschnitt des Stahlplattenrohlings in eine Mischstruktur aus Ferrit, Perlit und Bainit geändert wird.

Revendications

1. Dispositif de refroidissement pour moule de durcissement sous presse, comportant :

un moule de durcissement sous presse comprenant des parties supérieure et inférieure de moule et configuré pour presser un flan de tôle d'acier;
une pluralité d'alimentateurs d'eau de refroidissement espacés les uns par rapport aux autres dans les parties supérieure et inférieure de moule et formant des conduits à travers lesquels circule de l'eau de refroidissement ; et
un régleur de température d'eau de refroidissement configuré pour régler la température de l'eau de refroidissement fournie aux alimentateurs d'eau de refroidissement, le régleur de température d'eau de refroidissement comprenant un régulateur configuré pour fonctionner de telle façon que de l'eau de refroidissement soit fournie à un alimentataur de la pluralité d'alimentateurs d'eau de refroidissement proche d'une partie de découpe du flan de tôle d'acier à une température plus élevée que celle des autres alimentateurs d'eau de refroidissement parmi la pluralité d'alimentateurs de refroidissement, et le régulateur comprenant un réchauffeur configuré pour chauffer l'eau de refroidissement fournie à l'alimentateur d'eau de refroidissement proche de la partie de découpe.

2. Dispositif de refroidissement pour moule de durcissement sous presse selon la revendication 1, le régulateur étant configuré pour commander le réchauffeur de façon à maintenir la température de l'eau de refroidissement fournie à l'alimentateur d'eau de refroidissement proche de la partie de découpe entre 45 et 80°C.

3. Dispositif de refroidissement pour moule de durcissement sous presse selon les revendications 1 ou 2, comportant en outre un trou pratiqué entre l'alimentateur d'eau de refroidissement proche de la partie de découpe du flan de tôle d'acier et une surface de contact avec le flan de tôle d'acier.

4. Dispositif de refroidissement pour moule de durcissement sous presse selon les revendications 1 à 3, le moule de durcissement sous presse étant muni d'un isolant.

5. Dispositif de refroidissement pour moule de durcissement sous presse selon la revendication 1 à 4, comportant en outre des capteurs de température disposés entre la partie de découpe du flan de tôle d'acier et l'alimentateur d'eau de refroidissement pour détecter une température du moule de durcissement sous presse et envoyer des signaux détectés au régulateur.

6. Dispositif de refroidissement pour moule de durcissement sous presse selon l'une quelconque des revendications 1 à 5, le régleur de température d'eau de refroidissement étant configuré pour réguler la température de l'eau de refroidissement de telle façon que la partie de découpe du flan de tôle d'acier soit transformée en une structure mixte de ferrite, de perlite et de bainite.

FIG. 1

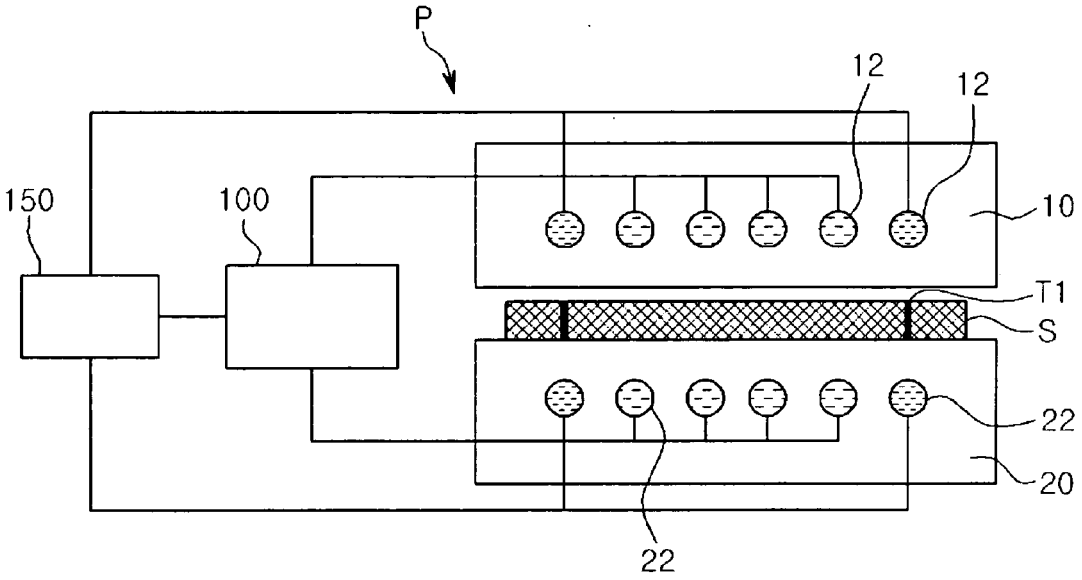


FIG. 2

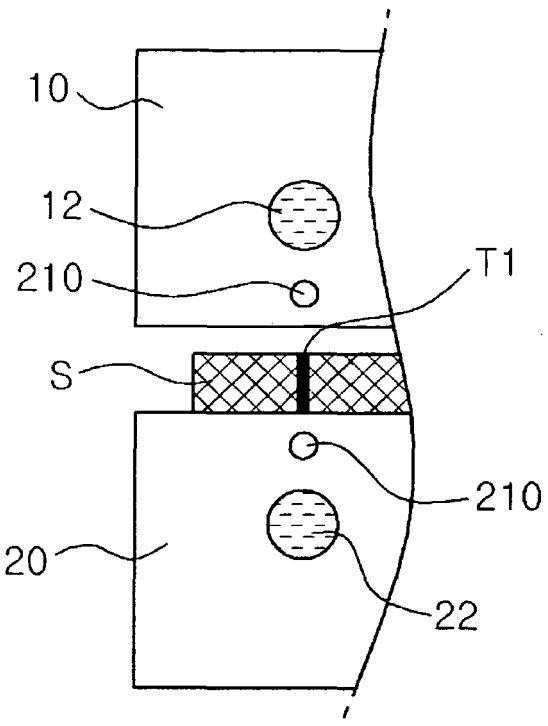


FIG. 3

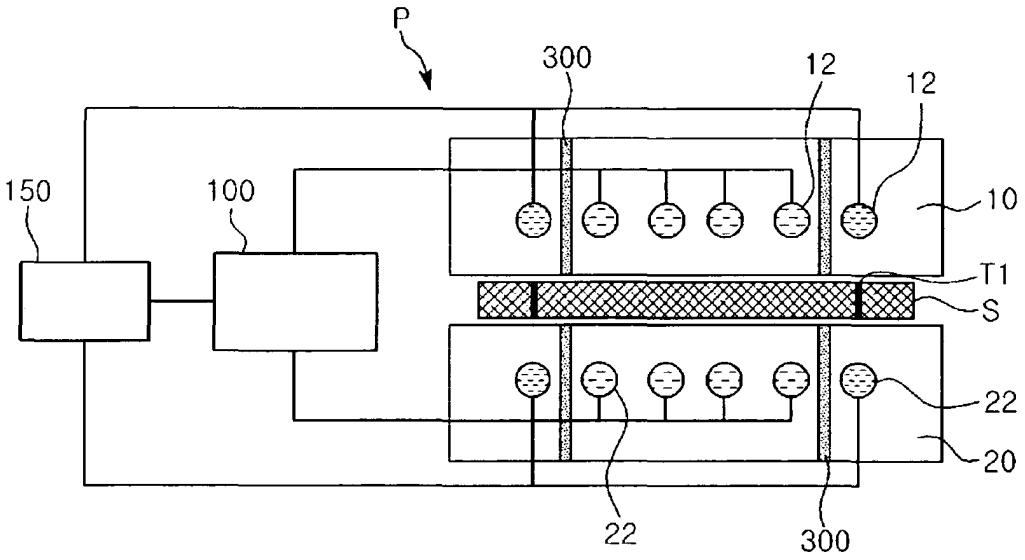

P
300
12
12
150
100
10
T1
S
22
20
22
300

FIG. 4

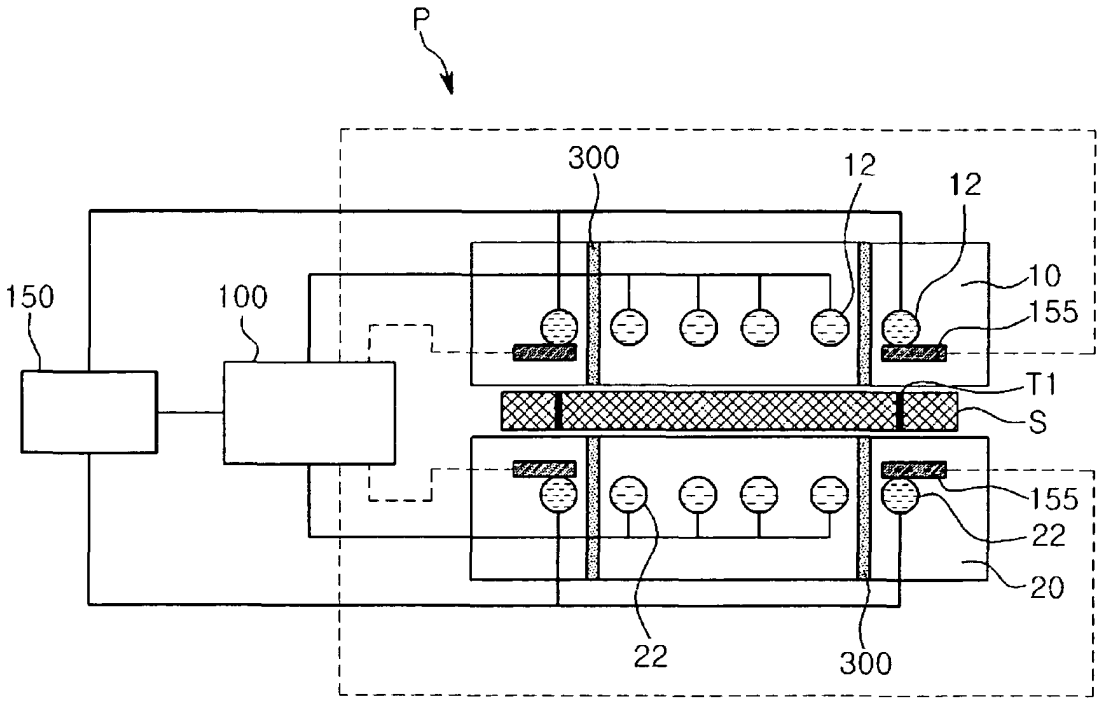

P
300
12
12
150
100
10
155
T1
S
155
22
20
22
300

FIG. 5

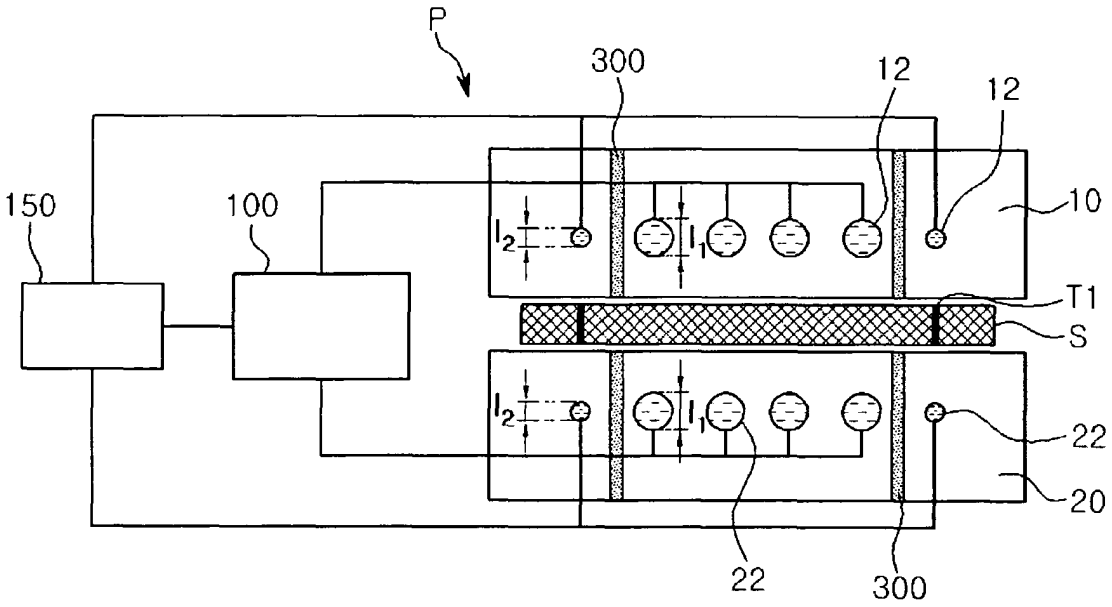


FIG. 6

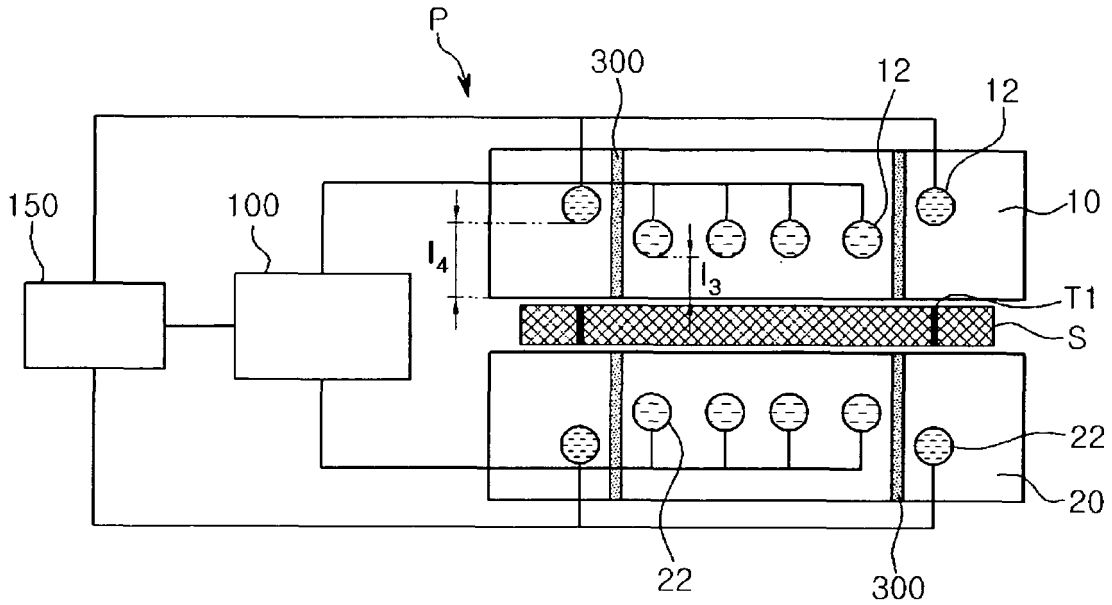
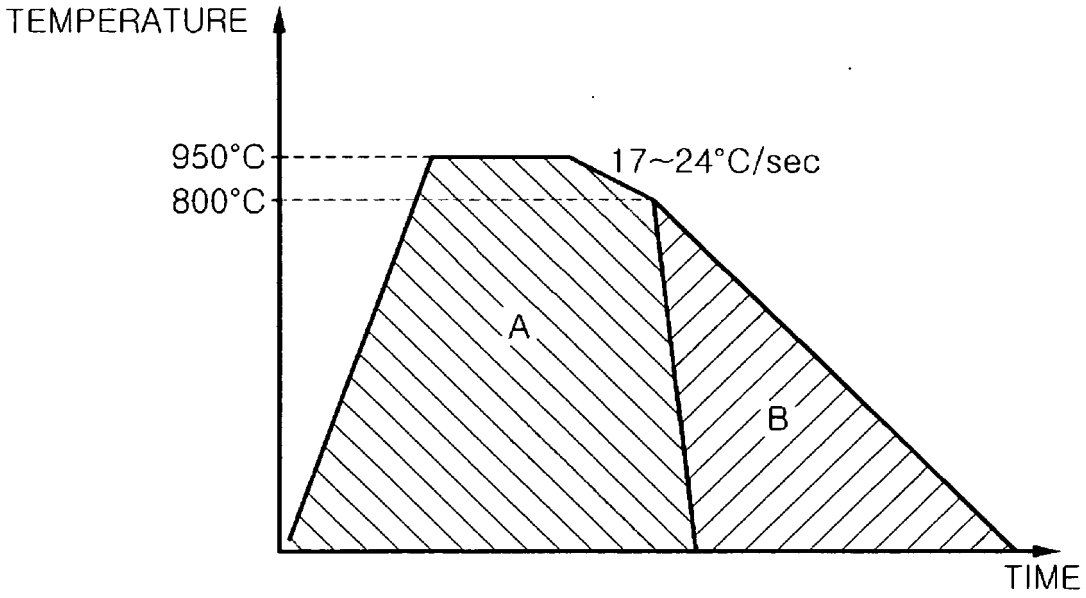


FIG. 7



REFERENCES CITED IN THE DESCRIPTION

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- DE 19723655 A1 **[0011]**