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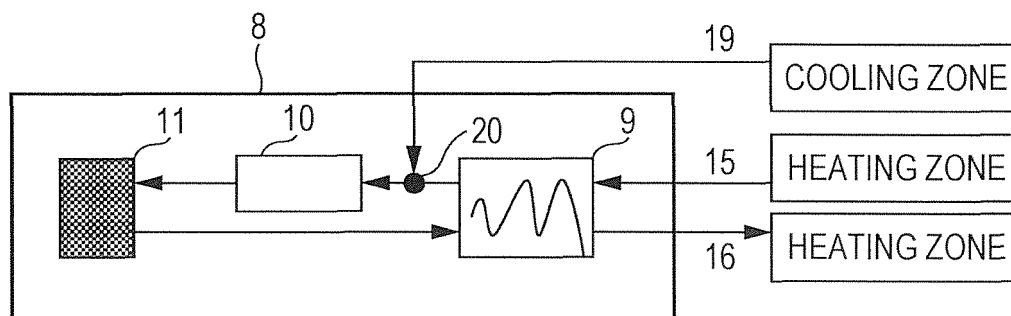
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(54) **METHOD FOR LOWERING DEW POINT OF AMBIENT GAS WITHIN ANNEALING FURNACE, DEVICE THEREOF, AND METHOD FOR PRODUCING COLD-ROLLED ANNEALED STEEL SHEET**

(57) Part of an atmosphere gas in a heating zone 1 and/or a soaking zone is sucked out and is cooled through a high-temperature gas passage of a heat exchanger 9 by heat exchange with a gas in a low-temperature gas passage, is then further cooled by mixing with part of an atmosphere gas in a cooling zone 2, is then further cooled through a gas cooler 10, is then dehumidified to a dew

point of -45°C or less in a dryer 11, is then heated through the low-temperature gas passage of the heat exchanger 9 by heat exchange with a gas in the high-temperature gas passage, and is returned to the heating zone 1 and/or the soaking zone. These can achieve a low dew point of -45°C or less with high energy efficiency.

FIG. 9



Description

Technical Field

5 **[0001]** The present invention belongs to the field of advantageous production of a steel strip that can reduce the dew point of an atmosphere gas in a continuous annealing furnace and has high wettability and, in particular, relates to a method for reducing the dew point of an atmosphere gas in an annealing furnace, an apparatus for the method, and a method for producing a cold-rolled and annealed steel sheet.

10 Background Art

[0002] It is known that when the dew point of an atmosphere gas in a continuous annealing furnace is -45°C or less, surface segregation of Mn during annealing can be suppressed, and the adhesion of zinc or zinc alloy plating after annealing is improved (see Non Patent Literature 1).

15 **[0003]** The following are examples of a method in the related art for reducing the dew point of an atmosphere gas in a continuous annealing furnace.

[0004] A: A method for supplying another atmosphere gas having a low dew point from the outside of a furnace to a heating zone or a soaking zone (see Patent Literature 1).

20 **[0005]** B: A method for providing a mechanism for circulating a furnace atmosphere gas in the outside of the furnace and thereby performing heat exchange between the circulating high-temperature atmosphere gas and a room-temperature atmosphere gas having a low dew point, which is to be supplied separately to the furnace (see Patent Literature 2).

[0006] C: A method for performing heat exchange between a high-temperature furnace atmosphere gas and an atmosphere gas having a dew point that has been reduced in the outside of a furnace and reducing the dew point with a water adsorption filter (see Patent Literature 3).

25 Citation List

Patent Literature

30 **[0007]**

PTL 1: Japanese Unexamined Patent Application Publication No. 2002-3953

PTL 2: Japanese Unexamined Patent Application Publication No. 62-290830

PTL 3: Japanese Unexamined Patent Application Publication No. 11-124622

35 Non Patent Literature

[0008]

40 NPL 1: Tetsu To Hagane (Bulletin of the Iron and Steel Institute of Japan), 96-1 (2010), pp. 11-20

Summary of Invention

Technical Problem

45 **[0009]** In accordance with the related art A, the low-temperature gas is directly introduced into the high-temperature furnace. Thus, a large amount of thermal energy is required to maintain the steel strip temperature in the furnace, the gas temperature cannot be controlled, and the energy efficiency is very low.

50 **[0010]** In accordance with the related art B, even when the low-temperature gas has a low dew point, the low-temperature gas is mixed with a large amount of atmosphere gas having a high dew point in the furnace. Thus, the dew point of the atmosphere gas in the furnace cannot be sufficiently reduced.

[0011] In accordance with the related art C, the temperature of a gas to be returned to the furnace is not sufficiently increased and, as described in Patent Literature 3, the water adsorption filter having a low dehumidification capacity reduces the dew point only to approximately -30°C and cannot reduce the dew point to -45°C or less, which is a target of the present application. Thus, known techniques for reducing the dew point of the atmosphere of a continuous annealing furnace have problems that they cannot achieve a low dew point of -45°C or less and that they have very low energy efficiency.

Solution to Problem

[0012] As a result of extensive studies to solve the problems described above, the present inventors completed the present invention by considering means for installing a dryer, for example, of a desiccant method or a compressor method that allows a dew point of -45°C or less in order to reduce the dew point of an annealing furnace atmosphere gas and a circulator to reduce the dew point to -45°C , installing a heat exchanger in the circulator to increase or decrease the temperature of the gas, and modifying a gas inflow (gas introduction) into a heating zone and a cooling zone of the furnace to improve energy efficiency.

[0013] The present invention can be summarized as follows:

(1)

A method for reducing the dew point of a furnace atmosphere gas in a continuous annealing furnace for annealing a metal strip in a reducing atmosphere by passing the metal strip through a heating zone and a cooling zone in this order or through a heating zone, a soaking zone, and a cooling zone in this order, including:

a step (a) for providing a circulator that includes a heat exchanger for heat exchange between a low-temperature gas and a high-temperature gas, a gas cooler for cooling a gas, and a dryer for dehumidifying a gas to a dew point of -45°C or less;

a step (b) for sucking part of the atmosphere gas from the heating zone and/or the soaking zone;

then a step (c) for passing the sucked part of the atmosphere gas through a high-temperature gas passage of the heat exchanger and decreasing the temperature of the sucked part of the atmosphere gas by heat exchange with a gas in a low-temperature gas passage;

then a step (d) for mixing the part of the atmosphere gas having a decreased temperature with part of an atmosphere gas sucked from the cooling zone to further decrease the temperature of the part of the atmosphere gas;

then a step (e) for passing the part of the atmosphere gas further cooled by mixing with the part of the atmosphere gas sucked from the cooling zone through the gas cooler to further cooling the part of the atmosphere gas;

then a step (f) for dehumidifying the part of the atmosphere gas further cooled through the gas cooler to a dew point of -45°C or less in the dryer;

then a step (g) for passing the dehumidified part of the atmosphere gas through the low-temperature gas passage of the heat exchanger to increase the temperature of the dehumidified part of the atmosphere gas by heat exchange with a gas in the high-temperature gas passage; and

then a step (h) for returning the part of the atmosphere gas having an increased temperature to the heating zone and/or the soaking zone.

(2)

The method for reducing the dew point of an atmosphere gas in an annealing furnace according to (1), wherein the part of gas flowing from the dryer toward the low-temperature gas passage of the heat exchanger is returned directly to the cooling zone without passing through the heat exchanger.

(3)

An apparatus for reducing the dew point of an atmosphere gas in a continuous annealing furnace for annealing a metal strip in a reducing atmosphere by passing the metal strip through a heating zone 1 and a cooling zone 2 in this order or through a heating zone, a soaking zone, and a cooling zone in this order, comprising:

a gas passage including a heat exchanger 9 for heat exchange between a low-temperature gas and a high-temperature gas, a gas cooler 10 for cooling a gas, a dryer 11 for dehumidifying a gas to a dew point of -45°C or less, and a gas mixer 20,

wherein the apparatus includes

a gas passage extending from the heating zone 1 and/or the soaking zone through a gas passage 15 to a high-temperature gas passage of the heat exchanger 9 and through the gas cooler 10 to the dryer 11,

a gas passage 16 extending from the dryer 11 to a low-temperature gas passage of the heat exchanger 9 and from the heat exchanger 9 to the heating zone and/or the soaking zone, and

a gas passage 19 extending from the cooling zone 2, the gas passage 19 being connected to a gas passage extending from the gas cooler 10 to the dryer 11 in the gas mixer 20.

(4)

The apparatus for reducing the dew point of an atmosphere gas in an annealing furnace according to (3), further comprising a gas passage 17 for returning part of gas flowing from the dryer 11 toward the low-temperature gas

passage of the heat exchanger 9 directly to the cooling zone through a gas distributor 13 but without passing through the heat exchanger 9.

(5)

A method for producing a cold-rolled and annealed steel sheet, comprising continuously annealing a cold-rolled steel strip, wherein

the dew point of an atmosphere gas in the continuous annealing furnace according to (1) or (2) is reduced by the method for reducing the dew point of an atmosphere gas in an annealing furnace according to (1) or (2) during the continuous annealing.

Advantageous Effects of Invention

[0014] In accordance with the present invention, part of an atmosphere gas in the heating zone and/or the soaking zone is sucked out and is cooled through a high-temperature gas passage of the heat exchanger by heat exchange with a gas in a low-temperature gas passage, is then further cooled by mixing with part of an atmosphere gas of the cooling zone, is then further cooled through the gas cooler, is then dehumidified to a dew point of -45°C or less in the dryer, is then heated through the low-temperature gas passage of the heat exchanger by heat exchange with a gas in the high-temperature gas passage, and is returned to the heating zone and/or the soaking zone. More preferably, part of gas flowing from the dryer toward the low-temperature gas passage of the heat exchanger is returned directly to the cooling zone without passing through the heat exchanger. These can achieve a very low dew point of -45°C or less in the annealing furnace and significantly improve energy efficiency.

Brief Description of Drawings

[0015]

[Fig. 1] Fig. 1 is a schematic view of Conventional Example 1.

[Fig. 2] Fig. 2 is a schematic view of Conventional Example 2.

[Fig. 3] Fig. 3 is a schematic view of a circulation system according to Conventional Example 2.

[Fig. 4] Fig. 4 is a schematic view of Conventional Example 3.

[Fig. 5] Fig. 5 is a schematic view of a circulation system according to Conventional Example 3.

[Fig. 6] Fig. 6 is a schematic view of Comparative Example 1.

[Fig. 7] Fig. 7 is a schematic view of a circulation system according to Comparative Example 1.

[Fig. 8] Fig. 8 is a schematic view of Example 1 of the present invention.

[Fig. 9] Fig. 9 is a schematic view of a circulation system according to Example 1 of the present invention.

[Fig. 10] Fig. 10 is a schematic view of Example 2 of the present invention.

[Fig. 11] Fig. 11 is a schematic view of a circulation system according to Example 2 of the present invention.

Description of Embodiments

[0016] When a cold-rolled steel strip is continuously annealed and is subsequently plated with zinc or a zinc alloy, the adhesion of plating depends greatly on the dew point in an annealing furnace. It is known that this results from the amount of Mn oxide on the surface of the steel strip. At a dew point in the vicinity of -10°C , Mn oxide is present within an oxide film on the surface of the steel strip and is rarely found on the surface of the steel strip. At a dew point of -45°C or less, Mn oxide is negligibly produced. At an intermediate dew point in the vicinity of -35°C (-15°C to -40°C), a large amount of Mn oxide is produced on the surface of the steel strip and inhibits the adhesion of plating. Thus, the present inventors considered providing the annealing furnace with a circulator equipped with a dryer that allows a dew point of -45°C or less in order to achieve a very low dew point to prevent concentration of Mn oxide on the surface of the steel strip.

[0017] Attention is now focused on the temperatures of an atmosphere gas sucked from the furnace into the circulator (hereinafter referred to as a sucked gas) and an atmosphere gas introduced from the circulator into the furnace (hereinafter referred to as an introduced gas). The desired atmosphere gas temperature in the annealing furnace is different in a heating zone, a soaking zone, and a cooling zone. More specifically, the sucked gas is cooled to approximately room temperature in a gas cooler before entering the dryer, is dehumidified in the dryer, and is returned to the furnace. Thus, if a low-temperature gas is directly introduced into a high-temperature region, such as the heating zone or the soaking zone, a high temperature required for annealing the steel strip cannot be maintained. For this reason, the temperature of the introduced gas from the circulator must be increased.

[0018] The present inventors employed a method for installing a heat exchanger between the furnace and the gas cooler. More specifically, a high-temperature gas sucked from the heating zone or the soaking zone of the furnace (sucked gas) is cooled in the cooler before entering the dryer. Utilizing thermal energy resulting from the temperature difference, therefore, the gas cooled in the gas cooler and dehumidified in the dryer can be heated. Thus, thermal energy

discharged from the gas cooler can be effectively utilized. A high-temperature gas sucked from the heating zone or the soaking zone of the furnace is passed through the heat exchanger, is cooled in the gas cooler, is dehumidified in the dryer, is heated in the heat exchanger, and is then returned to the heating zone or the soaking zone of the furnace.

[0019] The temperature of the high-temperature gas sucked from the heating zone or the soaking zone after the heat exchange is sometimes higher than the gas temperature in the cooling zone. Thus, the gas after the heat exchange can advantageously be mixed with a low-temperature gas sucked from the cooling zone to reduce energy required to further cool the gas in the downstream gas cooler.

[0020] Furthermore, since the gas temperature after cooling with the gas cooler is lower than the temperature of the cooling zone of the furnace, part of gas cooled in the gas cooler, dehumidified in the dryer, and returned directly to the cooling zone without passing through the heat exchanger can reduce the temperature and the dew point of the cooling zone, thus further improving energy efficiency.

[0021] Unlike a water adsorption filter made of activated alumina, alternately operated and stopped, and having a low dehumidification capacity as described in Patent Literature 3, a dryer for use in the present invention preferably has a high dehumidification capacity, for example, of a desiccant method for continuous dehumidification using calcium oxide, zeolite, silica gel, or calcium chloride or a compressor method using an alternative chlorofluorocarbon.

EXAMPLES

[0022] Figs. 1 to 11 illustrate the structure and gas passages of a continuous annealing furnace having a heating zone and a cooling zone according to Examples, Comparative Example, and Conventional Examples.

[0023] Fig. 1 illustrates Conventional Example 1 described in Patent Literature 1. Atmosphere gas supply equipment 12 directly supplies another low-temperature atmosphere gas to a heating zone 1 and a cooling zone 2.

[0024] Figs. 2 and 3 illustrate Conventional Example 2 described in Patent Literature 2. A gas sucked from a cooling zone 2 enters a circulator 8 through a flow path 15, passes through a heat exchanger 9 to heat a gas from atmosphere gas supply equipment 12, and returns to the cooling zone 2 through a flow path 16. The low-temperature atmosphere gas supplied from the gas supply equipment 12 is heated in the heat exchanger 9 and is introduced into a heating zone 1 through an atmosphere gas pipe 7.

[0025] Figs. 4 and 5 illustrate Conventional Example 3 described in Patent Literature 3. A gas sucked from heating zone 1 is introduced into a circulator 8 through a flow path 15, is cooled in a heat exchanger 9 with a gas from a water adsorption filter 18, is dehumidified with the water adsorption filter 18 made of activated alumina, is heated in the heat exchanger 9, and is returned to the heating zone 1 through a flow path 16. Each apparatus includes three water adsorption filters 18, which are alternately operated at intervals of three hours.

[0026] Figs. 6 and 7 illustrate Comparative Example 1. A gas sucked from a heating zone 1 is introduced into a circulator 8 through a flow path 15, is cooled in a heat exchanger 9 with a gas that has been dehumidified in a dryer 11, is further cooled in a gas cooler 10, is dehumidified in the dryer 11, is heated in the heat exchanger 9 with a gas from the heating zone 1, and is returned to the heating zone 1 through a flow path 16.

[0027] Figs. 8 and 9 illustrate Example 1 of the present invention and correspond to (1) and (3) in Solution to Problem. A gas sucked from a heating zone 1 is introduced into a circulator 8 through a flow path 15, is cooled in a heat exchanger 9 with a dehumidified gas from a dryer, is mixed in a mixer 20 with another gas sucked from a cooling zone 2 through a flow path 19, is further cooled in a cooler 10, is dehumidified in a dryer 11, is heated with a gas from the heating zone 1, and is returned to the heating zone 1 through a flow path 16.

[0028] Figs. 10 and 11 illustrate Example 2 of the present invention and correspond to (2) and (4) in Solution to Problem. In addition to Example 1 of the present invention illustrated in Figs. 8 and 9, the gas dehumidified in the dryer 11 is distributed with a gas distributor 13. One part of the distributed gas is introduced into the heat exchanger 9, is heated therein with a gas from the heating zone 1 and is returned to the heating zone 1 through a flow path 16. The other part of the distributed gas is returned directly to a cooling zone 2 through a flow path 17.

[0029] The conditions of these sucked gases and introduced gases were changed. Table 1 shows the dew points of the sucked gases and the dew points of the introduced gases passing through the gas passages and exhausted heat energy during the passage in Examples and Conventional Examples. Table 1 shows that the dew points of the gases introduced into the annealing furnaces in No. 1 to No. 3 of Example 1 and No. 4 to No. 6 of Example 2 are satisfactorily lower than the target temperature of -45°C , as compared with Conventional Examples No. 7 to No. 10. Furthermore, the dew points in the furnaces measured upstream from an annealing furnace outlet 21 are also satisfactorily lower than -45°C . Furthermore, No. 1 to No. 3 of Example 1 and No. 4 to No. 6 of Example 2 exhausted less heat energy and have very high energy efficiency.

[0030] The adhesion of zinc alloy plating was examined in zinc alloy plating of a steel strip after continuous annealing in accordance with a JIS-H8504(g) tape test method (a chipping test method). As a result, Examples No. 1 to No. 6 had satisfactorily strong adhesion, but Conventional Examples No. 7 to No. 10 had coating defects.

[Table 1]

No.	Sucked gas				Introduced gas				Dew point in furnace measured upstream from continuous annealing furnace outlet (°C)	Exhausted heat energy kJ/Nm ³	Dehumidification method	Adhesion of Zn alloy plating after continuous annealing	Note
	Position	Flowrate Nm ³ /Hr	Temperature °C	Dew point °C	Position	Flowrate Nm ³ /Hr	Temperature °C	Dew point °C					
1	Heating zone	500	800	-20	Heating zone	750	600	-52	-50	68	Calcium oxide	Strong	Example 1
	Cooling zone	250	50	-25									
2	Heating zone	500	850	-25	Heating zone	1000	500	-55	-52	80	Zeolite	Strong	Example 1
	Cooling zone	500	150	-15									
3	Heating zone	1500	950	-25	Heating zone	2000	700	-60	-55	78	Silica gel	Strong	Example 1
	Cooling zone	500	20	-15									
4	Heating zone	1000	700	-10	Heating zone Cooling zone	1000 1000	550 20	-50	-48	42	Zeolite	Strong	Example 2
	Cooling zone	1000	200	-10									
5	Heating zone	500	850	-25	Heating zone Cooling zone	250 1750	600 25	-51	-49	35	Calcium chloride	Strong	Example 2
	Cooling zone	1500	30	-15									
6	Heating zone	2000	950	-15	Heating zone Cooling zone	1500 1000	600 5	-70	-65	40	Compressor method	Strong	Example 2
	Cooling zone	500	20	-25									

(continued)

No.	Sucked gas				Introduced gas				Dew point in furnace measured upstream from continuous annealing furnace outlet (°C)	Exhausted heat energy kJ/Nm ³	Dehumidification method	Adhesion of Zn alloy plating after continuous annealing	Note
	Position	Flowrate Nm ³ /Hr	Temperature °C	Dew point °C	Position	Flowrate Nm ³ /Hr	Temperature °C	Dew point °C					
7	Cooling zone	0	-	-	Cooling zone	3000	25	-50	-35	253	-	Coating defect	Conventional example 1
8	Heating zone	0	-	-	Heating zone	1500	5	-45	-32	402	-	Coating defect	Conventional example 1
9	Heating zone	500	950	-20	Heating zone	500 (250)	700 200	-20 -40	-21	155	-	Coating defect	Conventional example 2
10	Heating zone	4000	800	-15	Heating zone	4000	600	-35	-23	189	-	Coating defect	Conventional example 2
[Note] A flow rate in parentheses is the flow rate of another supplied gas.													

Reference Signs List

[0031]

- 5 1 Heating zone
- 2 Cooling zone
- 3 Steel strip
- 4 Roller
- 5 Suction port
- 10 6 Inlet
- 7 Atmosphere gas pipe
- 8 Circulator
- 9 Heat exchanger
- 10 Gas cooler
- 15 11 Dryer (dehumidifier)
- 12 Equipment for supplying another atmosphere gas
- 13 Gas distributor
- 15 Gas flow path from heating zone
- 16 Gas flow path to heating zone
- 20 17 Gas flow path to cooling zone
- 18 Water adsorption filter
- 19 Gas flow path from cooling zone
- 20 Gas mixer
- 21 Annealing furnace outlet

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Claims

- 30 1. A method for reducing the dew point of a furnace atmosphere gas in a continuous annealing furnace for annealing a metal strip in a reducing atmosphere by passing the metal strip through a heating zone and a cooling zone in this order or through a heating zone, a soaking zone, and a cooling zone in this order, comprising:
 - a step (a) for providing a circulator that includes a heat exchanger for heat exchange between a low-temperature gas and a high-temperature gas, a gas cooler for cooling a gas, and a dryer for dehumidifying a gas to a dew point of - 45°C or less;
 - a step (b) for sucking part of the atmosphere gas from the heating zone and/or the soaking zone;
 - then a step (c) for passing the sucked part of the atmosphere gas through a high-temperature gas passage of the heat exchanger and decreasing the temperature of the sucked part of the atmosphere gas by heat exchange with a gas in a low-temperature gas passage;
 - 40 then a step (d) for mixing the part of the atmosphere gas having a decreased temperature with part of an atmosphere gas sucked from the cooling zone to further decrease the temperature of the part of the atmosphere gas;
 - then a step (e) for passing the part of the atmosphere gas further cooled by mixing with the part of the atmosphere gas sucked from the cooling zone through the gas cooler to further cooling the part of the atmosphere gas;
 - 45 then a step (f) for dehumidifying the part of the atmosphere gas further cooled through the gas cooler to a dew point of -45°C or less in the dryer;
 - then a step (g) for passing the dehumidified part of the atmosphere gas through the low-temperature gas passage of the heat exchanger to increase the temperature of the dehumidified part of the atmosphere gas by heat exchange with a gas in the high-temperature gas passage; and
 - 50 then a step (h) for returning the part of the atmosphere gas having an increased temperature to the heating zone and/or the soaking zone.
- 55 2. The method for reducing the dew point of an atmosphere gas in an annealing furnace according to Claim 1, wherein the part of gas flowing from the dryer toward the low-temperature gas passage of the heat exchanger is returned directly to the cooling zone without passing through the heat exchanger.
- 3. An apparatus for reducing the dew point of an atmosphere gas in a continuous annealing furnace for annealing a metal strip in a reducing atmosphere by passing the metal strip through a heating zone 1 and a cooling zone 2 in

this order or through a heating zone, a soaking zone, and a cooling zone in this order, comprising:

a gas passage including a heat exchanger 9 for heat exchange between a low-temperature gas and a high-temperature gas, a gas cooler 10 for cooling a gas, a dryer 11 for dehumidifying a gas to a dew point of -45°C or less, and a gas mixer 20,

wherein the apparatus includes

a gas passage extending from the heating zone 1 and/or the soaking zone through a gas passage 15 to a high-temperature gas passage of the heat exchanger 9 and through the gas cooler 10 to the dryer 11,

a gas passage 16 extending from the dryer 11 to a low-temperature gas passage of the heat exchanger 9 and from the heat exchanger 9 to the heating zone and/or the soaking zone, and

a gas passage 19 extending from the cooling zone 2, the gas passage 19 being connected to a gas passage extending from the gas cooler 10 to the dryer 11 in the gas mixer 20.

4. The apparatus for reducing the dew point of an atmosphere gas in an annealing furnace according to Claim 3, further comprising a gas passage 17 for returning part of gas flowing from the dryer 11 toward the low-temperature gas passage of the heat exchanger 9 directly to the cooling zone through a gas distributor 13 but without passing through the heat exchanger 9.

5. A method for producing a cold-rolled and annealed steel sheet, comprising continuously annealing a cold-rolled steel strip, wherein the dew point of an atmosphere gas in a continuous annealing furnace is reduced by the method for reducing the dew point of an atmosphere gas in an annealing furnace according to Claim 1 or 2 during the continuous annealing.

FIG. 1

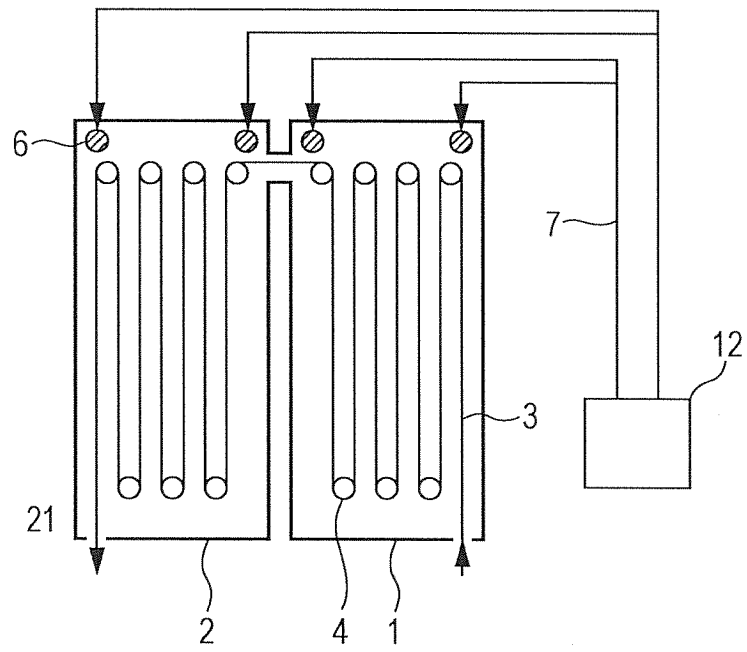


FIG. 2

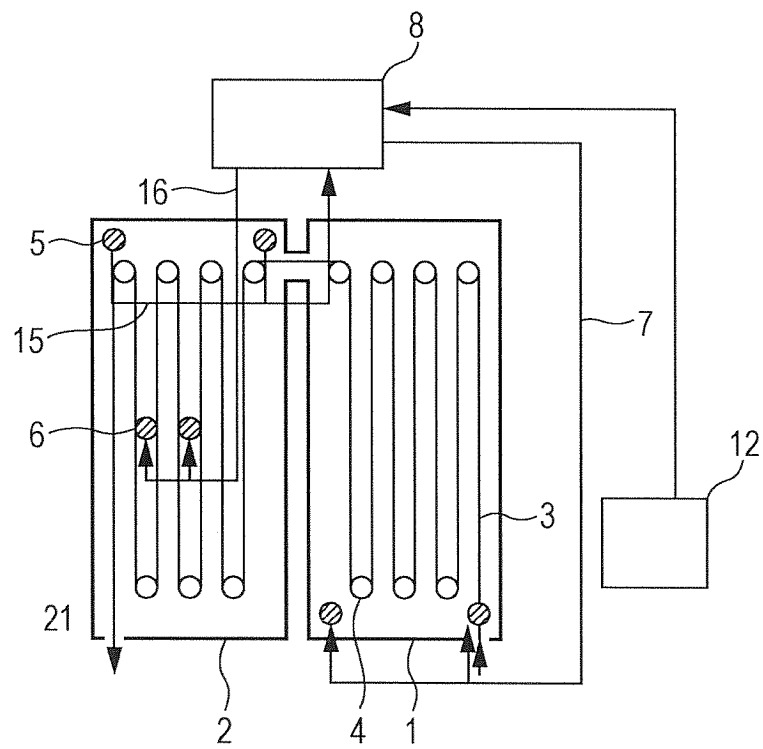


FIG. 3

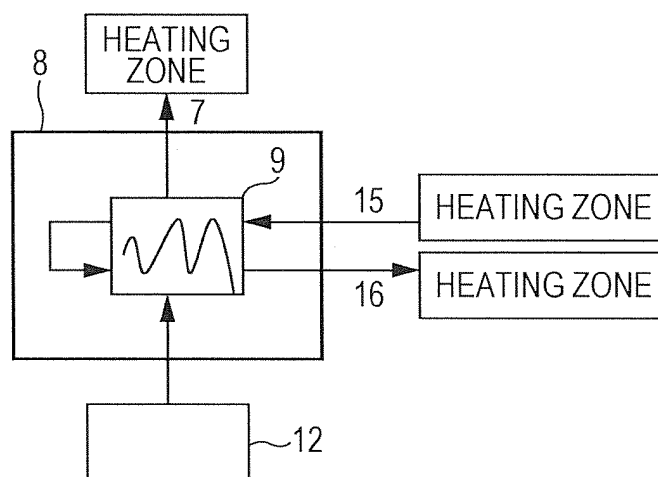


FIG. 4

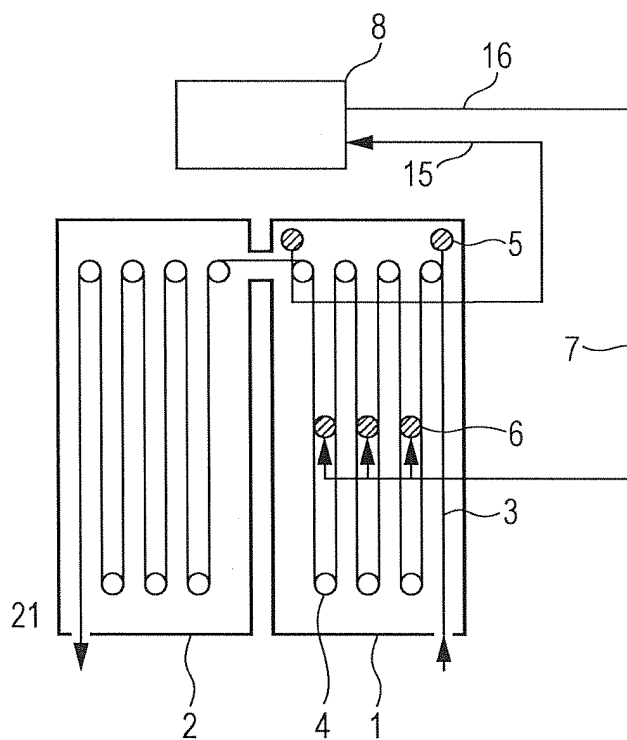


FIG. 5

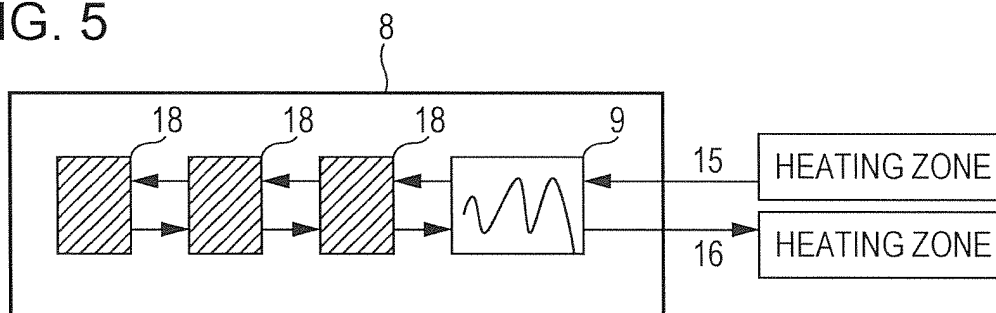


FIG. 6

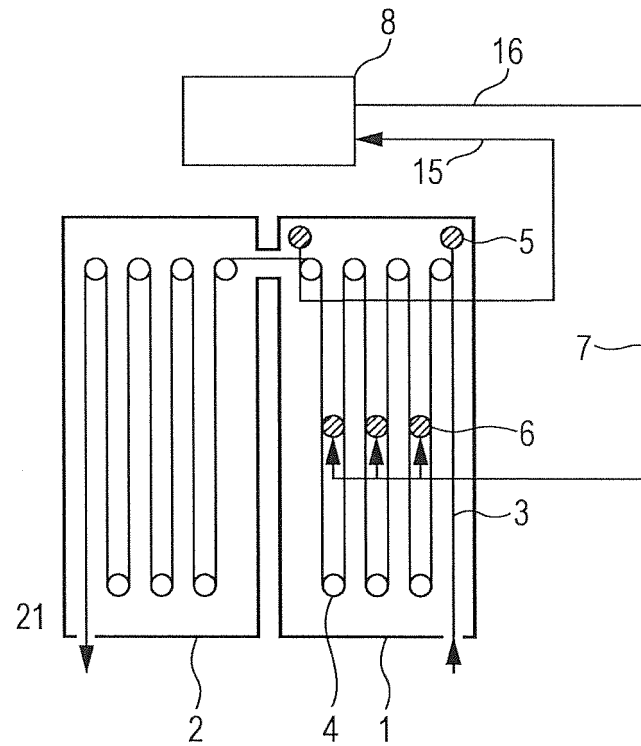


FIG. 7

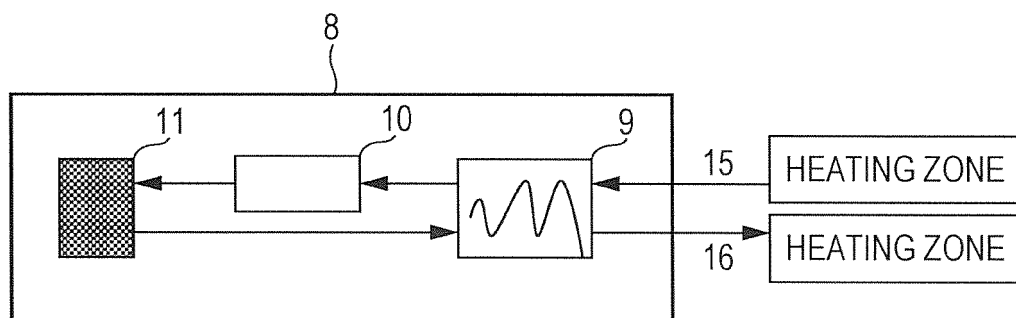


FIG. 8

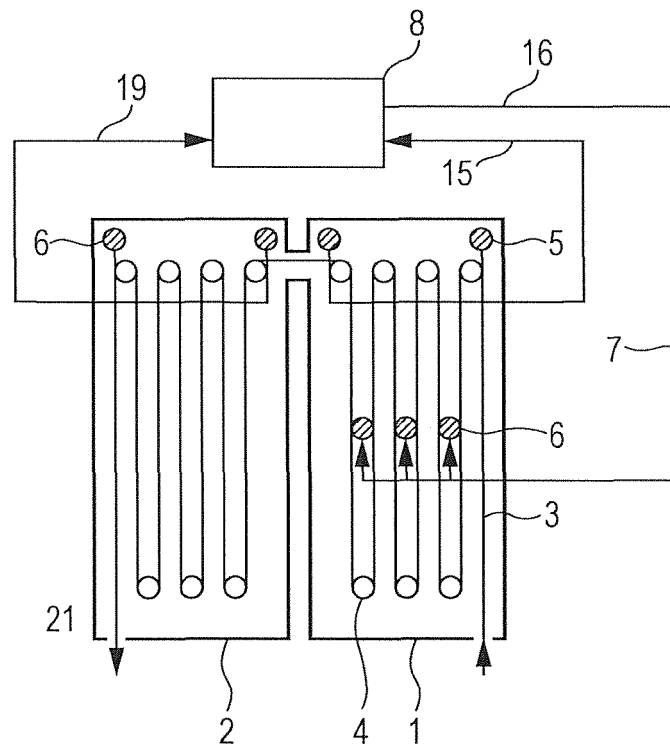


FIG. 9

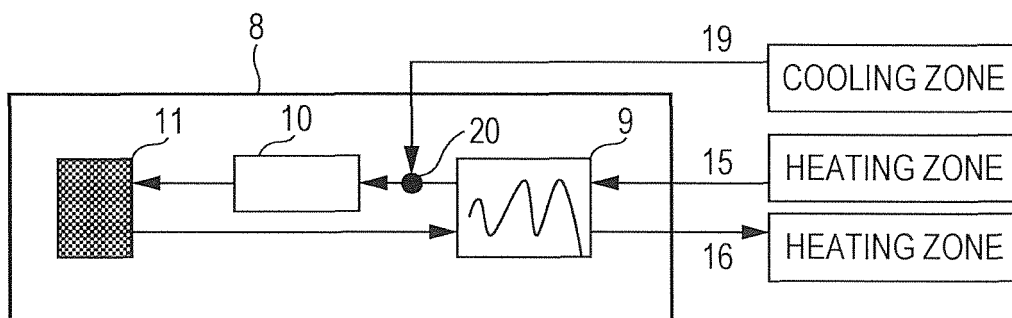


FIG. 10

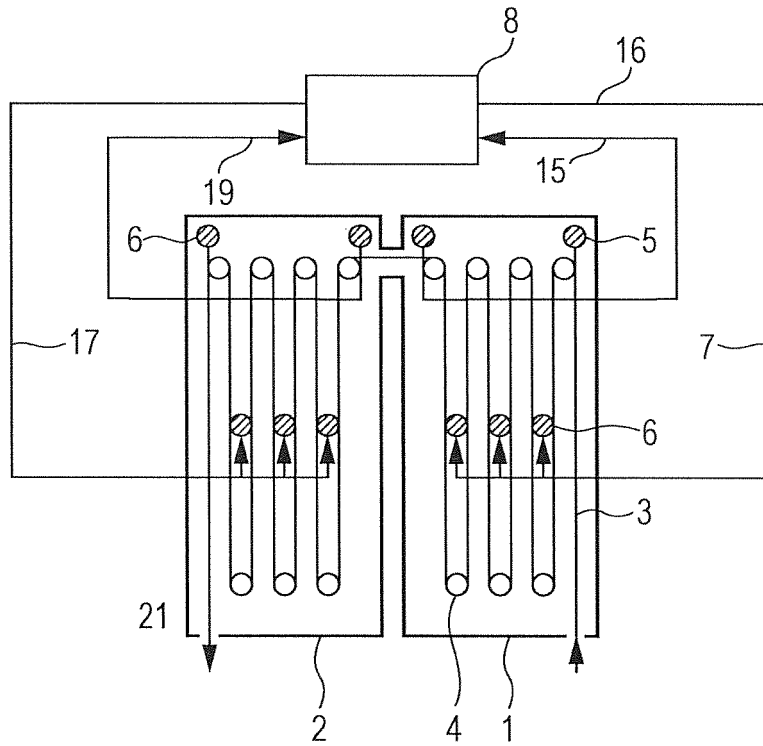
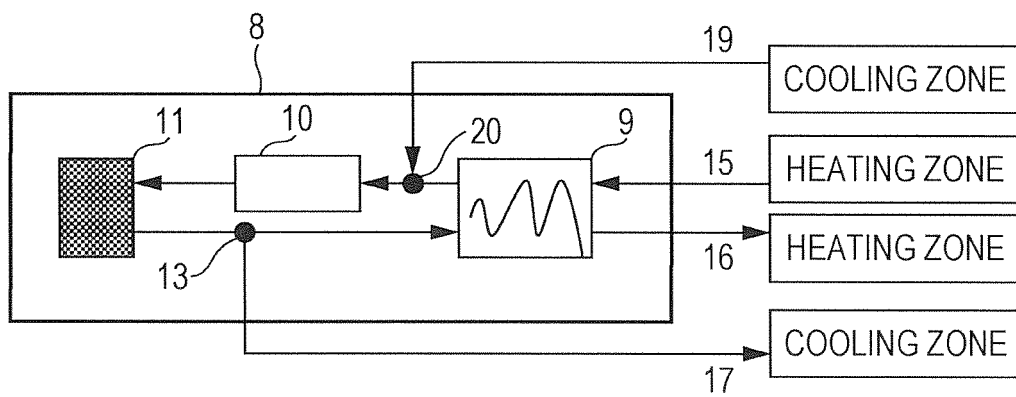


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/002353

A. CLASSIFICATION OF SUBJECT MATTER

C21D9/56(2006.01)i, C21D1/74(2006.01)i, C21D1/76(2006.01)i, F27D7/04
(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)
C21D9/52-9/66

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2013
Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2-236229 A (Kawasaki Steel Corp.), 19 September 1990 (19.09.1990), claims; page 2, upper left column, line 8 to upper right column, line 19; table 1; fig. 1 (Family: none)	1-5
A	JP 11-124622 A (Daido Steel Co., Ltd.), 11 May 1999 (11.05.1999), claim 2; paragraphs [0008], [0014]; fig. 1 (Family: none)	1-5
A	JP 3-47923 A (Nippon Yakin Kogyo Co., Ltd.), 28 February 1991 (28.02.1991), claim 3; page 3, upper left column, line 14 to page 4, upper left column, line 21; fig. 1, 2 (Family: none)	1-5

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

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Date of the actual completion of the international search
26 June, 2013 (26.06.13)

Date of mailing of the international search report
09 July, 2013 (09.07.13)

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 10-176225 A (Daido Steel Co., Ltd.), 30 June 1998 (30.06.1998), claim 1; paragraphs [0010] to [0012]; fig. 1, 2 (Family: none)	1-5
A	JP 2000-104123 A (Kawasaki Steel Corp.), 11 April 2000 (11.04.2000), claim 1; paragraphs [0019] to [0022]; fig. 2 & US 6228321 B1 & EP 976842 A2 & BR 9903002 A & TW 436526 B & EG 22296 A & MA 26034 A & KR 10-2000-0012024 A & CN 1243166 A	1-5
P, A	WO 2012/081719 A1 (JFE Steel Corp.), 21 June 2012 (21.06.2012), claims 1 to 3; paragraphs [0038] to [0052]; fig. 1, 2 & JP 2012-126983 A	1-5

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2002003953 A [0007]
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Non-patent literature cited in the description

- *Tetsu To Hagane*, 2010, vol. 96-1, 11-20 [0008]