EXHIBIT 18 (Part 2)

However, to carry out the annealing of a coil, even in a coil for which rolling up in a high temperature state was carried out, it is necessary to maintain a temperature above a certain necessary temperature a certain necessary time (the necessary temperature and necessary time both differ for each coil material) and, even though it is a coil for which rolling up in a high temperature state has been carried out according to the well-known technology mentioned above, and it was left in a natural standing to cool state because both the coil's inner and outer circumferential vicinity and edge vicinity [Translator's note: "and the edge vicinity" is repeated here in an, apparent, mistake] both rapidly cool, and the coil could not self-anneal with a good yield.

A specific and efficient method to maintain the necessary temperature of a coil, for which rolling up has been carried out in the above-mentioned high temperature state, the necessary time has not been proposed yet, consequently, in order to anneal a coil with a good yield, the step that carries out annealing by means of a coil annealing furnace still has not been able to be omitted.

The present invention aims to solve the weak point of the former method described above, and can maintain the necessary temperature and necessary time, using the heat that a coil that has been rolled up in a high temperature state possesses itself, in addition to offering a coil self-annealing method with a good yield.

(Means of Solving the Problems)

The present invention is one that achieves the above-mentioned objective by means of a coil annealing method characterized in that, together with being made so that multiple hot coils mutually prevent each adjacent coil from rapidly cooling by being placed horizontally so that the centerline of the hole of each coil is within the same vertical plane, and the end faces of each coil are mutually adjacent, annealing of the coils is carried out by means of self-possessed heat that the coils have themselves due to the fact that the periphery of multiple coils, including one part of a coil carrier machine, is covered by a thermal insulation cover.

And, to carry out the thermal insulation of the coil, a thermal insulation cover is provided to the outer circumferential part of the carrier machine on which the coil of the coiler exit is placed.

As for the coil annealing method of the present invention, self-annealing is possible since a coil temperature that is impossible to be held for a long time by one coil by itself can be held by successively adjacently placing hot coils that have been rolled up in a high-temperature state in the hot rolling line, and carrying while maintaining the temperature by means of thermal insulation covers. Particularly, rapid cooling of the edge part (both edge faces of the coil) that is the coil area that most easily cools in the natural standing to cool state can be prevented by arranging the coils mutually adjacent to both of those end faces. Furthermore, for a long time the method that carries coils arranged with the coils at the coiler exit side in a horizontal state and the center of the hole thereof in the same straight line (carrying coil horizontally longways), and the equipment therefor are well-known (walking beam and eye horizontal conveyor and the like), but so that the coils with the largest dimension specifications do not interfere with each other, the coil placement point is set so that the coil interval is as large as possible.

That is, the placement point of the coil is set so that the coil width direction (carrying direction) center point thereof is placed in a predetermined fixed position (normally larger than 2400 mm, about 3000 ~ 3500 mm). Consequently, the coil interval fluctuated depending on the coil width, to the effect that it was small, for example, about 1000 mm for coils that have a large width, and it became larger, for example, about 2500 mm, for coils that have a small coil width.

And, in former coil carrying methods, efficiently (quickly with a small force) carrying a coil a fixed coil carrying distance was the primary objective thereof, consequently, the coil placement pitch was determined taking into consideration workability at the time of demounting using a wire and crane and the balance of the rolling up time pitch of the coil and the coil carrying speed, as well as a coil during a particular carry. That is, in order to not disturb the coil rolling up pitch by the coiler it was necessary for the coil carrying of the coiler exit side to function so as to pay out and send the coil to the rearward line as quickly as possible.

Consequently, the coil interval in the former coil carrying method was 500 mm or more, usually, about 1000 ~ 3000 mm.

In contrast to this, the method of the present invention is one that is characterized in that the coil is caused to stay on the coil carrying equipment of the coiler exit side as long as possible in a range that does not disturb the rolling up pitch of the coil.

In order to do this, in the method of the present invention, in coil horizontal carrying, the rear placed coil is placed so that the coil interval becomes a fixed value, based on the rear end face of the forward placed coil in the carrying direction. That is, regardless of the size of the coil width, the coil is placed so that the coil interval becomes a fixed interval.

As for the coil interval in the method of the present invention, 0 mm (the state in which the front coil and the rear coil have made contact) is desirable in terms of theoretical performance in order to maintain the temperature of the coils, but from the viewpoint of preventing the occurrence of damage to the coil end faces, it is made 300 mm or less, desirably, 50 ~ 300 mm.

In this way, as a specific method that sets the coil interval to a fixed value, for example, on a coil carrying cart a coil end face detector (for example, a photocell and the like) is placed in a two-piece set at the expected coil interval with respect to the carrying direction, and at the position that detected the forward end face of the rearward-placed coil by the second coil end face detector positioned to the rear, said rearward-placed coil is received, next, when the carrying cart is caused to advance and stop at the position at which the first coil end face detector positioned forward detected the rear end face of the forward-placed coil and the rearward-placed coil is placed, the coil interval of both becomes the expected value.

Furthermore, concerning the thermal insulation of the hot coils in the method of the present invention, it is carried out by the installation of a coil thermal insulation cover in the vicinity of the coil carrier machine at the exit side of the coil, formerly, the installation of this kind of thermal installation cover was not carried out.

The present invention is concretely shown by means of the following drawings.

Figure 1 and Figure 2 are drawings that explain one embodiment of the present invention. Figure 1 shows the state in which multiple coils 1 (1_1, 1_2, ... , 1_4) and the center line x – x of the holes 2 of the coils are oriented in the same direction, and arranged mutually adjacent, and *a* in the figure shows the edge part in the vicinity of the outer circumference of the coils, and *b* shows the edge part in the vicinity of the inner circumference of the coils.

In Figure 2, in the next stage on a coil carrying device 4 that provides a coil skid 3 that carries coils 1 (1_1, 1_2, ... , 1_n), high temperature coils rolled up on a coil strip car 9 [Translator's note: In the next section, "Operation", this is referred to as the "coil stripper car" which, apparently, is the correct name] having a coil winding shaft 5, a cradle roll 6 and a cylinder for traveling use 7 that travels on a travel rail 8 are sequentially placed adjacent so that the center line x – x of the coil holes 2 becomes on the same line, and a heat insulation cover 10 is placed as though said multiple coils (1_1, ..., 1_n) are covered. Furthermore, 11 shows a coiler.

As this kind of carrying device that can apply the method of the present invention there are, for example, the walking beam type coil carrying device, the eye horizontal type coil conveyor device, coil force with a fixed skid attached and the like.

It is acceptable to make the thermal insulation cover with any material that has heat resistance and great insulation effectiveness. Furthermore, it is also acceptable if the thermal insulation cover takes the shape of a thermal insulation box and the like.

The method of the present invention, as shown in Figure 1 and Figure 2, causes high temperature rolled up coils 11, ..., 1_n immediately after being rolled up by a hot rolling coiler 11 to stay at the coiler exit side in the state in which both end faces thereof are extremely close by means of the horizontal placement state (or in a state in which they have been caused to touch each other) and, in addition, by means of covering the periphery of the coils with a thermal insulation cover, rapid cooling of the coils is prevented, and by means of the self-retained heat that the coils themselves have, the annealing of the coils can be carried out.

[Operation]

In Figure 3 the changes over time of the temperature of the coil edge part, when based on the former coil annealing method, and when based on the method of the present invention are compared and set forth. In Figure 3 the vertical axis shows the coil temperature and the horizontal axis shows the elapsed time, and the origin point (O) shows the point in time immediately after a coil 1_n has been demounted by means of the coil stripper car 9 from the winding shaft 5 of the coiler 11. At this point in time the edge part in the vicinity of the outer circumference of the coil *a* maintains a high temperature X close to the winding temperature of the strip, but the edge part in the vicinity of the inner circumference of the coil *b* is cooled by means of the winding shaft 5 that is a low temperature body and, in addition, because the degree of being cooled from the coil end face (edge surface) during coil winding is greater than the edge part in the vicinity of the outer circumference of the coil *a*, a substantially lower temperature (normally 300 ~ 500 °C) Z than the rolled up temperature of the strip (normally, 500 ~ 900 °C) forms. With respect to the coil temperature level Y necessary to carry out the self-annealing of a coil, the temperature fluctuations (A') of the edge part in the vicinity of the outer circumference of a coil and the temperature fluctuations (B') of the edge part in the vicinity of the inner circumference in the former coil carrying method, and the temperature fluctuations (A) of the edge part in the vicinity of the outer circumference and the temperature fluctuations (B) of the edge part in the vicinity of the inner circumference when the method of the present invention was used are set forth in the graph of Figure 3.

Furthermore, in Figure 3 the edge part in the vicinity of the outer circumference of a coil *a* cools in accordance with the passage of time from the temperature X immediately after demounting due to natural standing to cool from immediately after having been demounted from the winding shaft 5 of the coiler 11 (time point O) but, depending on whether or not multiple coils are placed close to each other at the time point of time F the time that a temperature at or above the temperature necessary for self-annealing is maintained (that is, in contrast to $\overline{OH}$; the time in the case of the former coil carrying method in which the coils are not placed close to each other; $\overline{OJ}$; the time when placed close to each other) differs, and there are the characteristics that time $\overline{OH}$ is too short as a temperature retention time to carry out the self-annealing of a coil, and the time $\overline{OJ}$ is a sufficiently long time.

Furthermore, the edge part in the vicinity of the inner circumference of the coil *b* recuperates by means of heat of the inner part of the coil from immediately after having been demounted from the winding shaft 5 and, in addition, becomes like (B), the changes over time of the temperature when due to the method of the present invention, compared to becoming like (B'), the changes over time of the temperature in the case of the former coil annealing method, in order to self-anneal. In the temperature fluctuation of the former method (B') it does not come to recuperate to the necessary coil annealing temperature Y, even in the edge part in the vicinity of the inner circumference of a coil *b*, but, according to the method of the present invention, together with recuperating to temperature Y and above, that temperature retention time $\overline{GI}$ can be ensured to more than the necessary temperature retention time of self-annealing. Furthermore, because rapid cooling in the vicinity of the outer circumference of the coil can be prevented by covering the periphery of the coil with a thermal insulation cover, the rapid cooling of all regions of the coil can be prevented.

Example

There is the relationship of the following formula (1)

$T = T_0 - c \bullet l_n t$ °C (1)

between the necessary temperature T °C and the temperature retention time t minutes, necessary to coil annealing in the method of the present invention. Here,

T_0 °C: temperature constant that differs for each material

c: a fixed number.

For example, in steel grade M

the temperature retention time t_A (corresponding to $\overline{OJ}$ of Figure 3) of the edge part in the vicinity of the outer circumference, when

T_O (corresponding to the Y point temperature of Figure 3) is 770 °C

was

t_A = 5 minutes

and, when T_O is 750 °C

was

t_A = 10 minutes.

The temperature retention time t_B (corresponding to $\overline{GI}$ of Figure 3) of the edge part in the vicinity of the inner circumference, when

T_O was 770 °C,

was t_B = 5 minutes

and when,

T_O was 750 °C

was t_B = 10 minutes.

Here, in Figure 3 for the sake of convenience the respective curves of A, A', B and B' were represented on the same coordinates, but, since it is also acceptable to enter these on separate coordinates, the size relationship of t_A and t_B is not one that is prescribed by Figure 3.

(Effects of the Invention)

The method of the present invention, since a coil rolled up at a high temperature after hot strip steel rolling can be maintained the necessary time at the temperature necessary for self-annealing by the heat the coil possesses itself, in addition to being able to realize self-annealing of the coils with a good yield, is a highly economical, advantageous method in terms of steps, in terms of energy and, moreover, in terms of equipment investment, because the coil annealing furnace that was still necessary in the former method can be eliminated.

4. Brief Explanation of the Drawings

Figure 1 is a drawing that explains the state in which the coils have been adjacently placed on the same axis in the method of the present invention.

Figure 2 is a drawing that explains an embodiment of the present invention.

Figure 3 is a graph that shows the changes over time in the temperatures of the edge parts in the vicinity of the outer circumferences of the coils and of the edge parts in the vicinity of the inner circumferences of the coils.

Sub-representative Akira Uchida

Sub-representative Akikazu Hagiwara

Practitioner's Docket No. 201141.00292 ***PATENT***

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: David L. CHASE

Application No.: New U.S. Continuation Application

Filed: October 13, 2006

Group No.: Not yet assigned.

For: ANNEALING OF HOT ROLLED STEEL COILS WITH CLAM SHELL FURNACE

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

ATTENTION: Special Program Examiners (M.P.E.P. §1002.02(s))

PETITION TO MAKE SPECIAL FOR NEW APPLICATION UNDER M.P.E.P. § 708.02, VIII AND § 708.02(a), I

1. Petition

Applicant hereby petitions to make this new application special. This application has not received any examination by an Examiner.

2. Claims

The claims in this case apply to an annealing furnace apparatus and method of using the annealing furnace.

3. Search

The European Patent Office conducted an EP Standard Search in the following International Classes:

C21D

F27B

The EP Standard Search includes U.S. patents and patent application publications, foreign patent documents, and non-patent literature.

International Class **C21D** includes the following U.S. Classifications: **72**/53; **110**/173A; **148**/95, 98-99, 108, 500-512, 515, 519-534, 537-548, 557-664; **219**/155-157, 162; **236**/15BC, 29; **266**/ 78-98, 102-121, 123-134, 249-264, 287; **419**/29; **432**/21, 62, 68, 183, 260-261.

International Class **F27B** includes the following U.S. Classifications: **48**/89, 99-101, 119-120, 122-123; **65**/483, 486-491, 495-499, 502-503, 507, 510-514, 516, 519, 524, 527-528, 533-534, 537, 539; **219**/388-390, 420-427; **373**/77, 84; **422**/139-147; **432**/7-8, 13-18, 22-23, 26-27, 31, 34, 36, 37, 43-45, 58-61, 67, 69-71, 89-92, 94, 103-124, 128-138, 139-153, 155-176, 184-198, 200-213, 215, 248.

4. Copy of references

Applicant submits herewith an Information Disclosure Statement and copies of the foreign references with a translation of a Japanese reference. A copy of the European search report is submitted.

5. Detailed discussion of the references

Applicant submits herewith a detailed discussion of the references.

6. Additional Statements under § 708.02(a)

Applicant agrees to make an election without traverse in a telephonic interview if necessary.

Applicant agrees to have an interview if requested by the Patent Examiner.

Applicant agrees that in any appeal during an accelerated prosecution of this application not to argue separately for patentability of pending dependent claims.

7. Fee

Please charge Deposit Account number 15-0450 $130.00 required by 37 C.F.R. 1.17(h).

SIGNATURE OF PRACTITIONER

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Practitioner's Docket No. 201141.00292 *PATENT*

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: David L. CHASE

Application No.: New U. S. Continuation Application

Filed: October 13, 2006

Group No.: Not yet assigned.

For: ANNEALING OF HOT ROLLED STEEL COILS WITH CLAM SHELL FURNACE

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450
ATTENTION: Special Program Examiners

ACCELERATED EXAMINATION SUPPORT DOCUMENT
UNDER USPTO MPEP § 708.02(a)

This Accelerated Examination Support Document under USPTO MPEP § 708.02(a) is being filed in the above-referenced application entitled "Annealing of Hot Rolled Steel Coils with Clam Shell Furnace." According to the terms of USPTO MPEP § 708.02(a), a pre-examination search was made. An Information Disclosure Statement is submitted herewith. This detailed Accelerated Examination Support Document points out, with the particularity required by 37 C.F.R. § 1.111(b) and (c), how the claimed subject matter is patentable over the references.

REMARKS

The present invention has utility as an annealing furnace for annealing coils of hot rolled steel. The furnace comprises a furnace housing that pivots between an open position and a closed position in a clam shell configuration. Coils to be annealed are positioned in the furnace of the present invention with their coil axes in a horizontal position. The furnace further comprises a sealing device that seals the furnace housing to a base portion when the housing is in the closed position, a system capable of establishing a reducing atmosphere, and heating elements for heating the coils during the annealing process.

The claims were part of the application as filed, and therefore are *per se* fully supported by the specification. The claims also find support under the first paragraph of 35 U.S.C. § 112 in the written description of the specification as filed in the paragraphs [0010] through [0025] and [0032] to [0035].

There is no disclosure or suggestion of the claimed invention of the application in the submitted prior art.

U.S. Patent 6,346,214 to Knudsen et al. teaches a tiltable top hat furnace for annealing metal coils, providing an apparatus that simplifies the loading and unloading of metal coils. The apparatus has an arbor or arbors for holding a coil of metal in a vertical position for annealing, as well as an annealing hood and a heating hood. Col. 3, ll. 46-56. The annealing hood is sealed over the coils, and then the hood assembly with the coils is positioned into a vertical position for annealing. Col. 3, ll. 54-56. The heating hood has an opening on a side, through which the annealing hood can pass through, and doors or other means for opening and closing the opening.

Col. 3, ll. 64-67. The heating hood is movable relative to the annealing hood so that the heating hood moves laterally over the annealing hood, the annealing hood passing through the opening in the side of the heating hood. Col. 2, ll. 31-36, 46-51.

U.S. Patent 6,346,214 to Knudsen does not anticipate the present invention because the '214 patent's coils are positioned on standard arbors in a vertical position during annealing. Further, the heating hood of the present invention is not translated laterally as specified by the '214 patent. Nor does the '214 patent teach or suggest annealing coils positioned with their coil axes horizontal as provided in the presently claimed invention. The '214 patent teaches away by providing an elaborate apparatus to position the coils in a vertical position for annealing. *See* col. 3, ll. 9-14. Patent 6,346,214 does not disclose or suggest an annealing furnace comprising a housing comprising a pivot member with a lateral axis, where the housing pivotably rotates about a pivot member between an opened and a closed position, and a retaining element within the furnace housing where the retaining element holds each coil such that the axis of each coil is generally horizontal to the base portion as provided in the presently claimed subject matter.

JP 61-060829 to Mitsubishi Heavy Industries Ltd. teaches a method for annealing coils using heat retained in the hot-rolled coils themselves without an annealing furnace. An English translation is attached hereto. The method involves placing coils of hot rolled steel in series on a coil skid while the rolls are still hot. An insulated cover is placed over the coils to prevent the temperature of the coils from decreasing rapidly so the coils are annealed by retaining heat from the coils. (translation, section "Means of Solving the Problems")

JP 61-060829 does not disclose or suggest the presently claimed invention. To the contrary, the JP '829 patent teaches away from using the present coil annealing furnace, as the stated purpose of the JP '829 patent is to make a coil annealing furnace unnecessary. *See* translation, section "Effects of the Invention". JP '829 does not disclose or suggest an annealing furnace comprising a housing comprising a pivot member with a lateral axis, where the housing pivotably rotates about a pivot member between an opened and a closed position, and a plurality of heating elements located within the furnace housing capable of heating hot rolled steel coil during the annealing process as provided in the presently claimed subject matter.

U.S. Patent 4,504,957 to McClelland et al. teaches a high temperature annealing furnace having a removable bell (col. 4, ll. 37-43, col. 5, ll. 58-60) over a base, which supports the coils for annealing in a conventional vertical position. Col. 1, ll. 61-67. The removable bell includes heating elements in the bell, and insulation on the sides and roof of the bell. Col. 6, ll. 39-62.

U.S. Patent 4,504,957 does not disclose or teach the presently claimed invention. To the contrary, the '957 patent teaches that orienting the coils with horizontal coil axes is unsuccessful for annealing, and that vertical positioning of the coils is required for successful annealing. *See* col. 1, ll. 61-67. Patent 4,504,957 does not disclose or suggest an annealing furnace comprising a housing comprising a pivot member with a lateral axis, where the housing pivotably rotates about a pivot member between an opened and a closed position, and a retaining element within the furnace housing where the retaining element holds each coil such that the axis of each coil is generally horizontal to the base portion as provided in the presently claimed subject matter.

U.S. Patent 4,817,920 to Erfort, Jr. teaches an annealing furnace arranged in an annular shape. Col. 3, l. 11. The furnace comprises a stationary housing and a rotating annular hearth. Col. 4, l. 4. The rotating hearth comprises coil supports for positioning coils of steel horizontally with their coil axes in a radial direction. FIG. 1. The furnace comprises a plurality of heating stations, where hot gases are blown against the ends of the coils. Col. 4, ll. 31-46. The rotating hearth indexes the coils from one heating station to another as the hearth rotates inside the housing. Col. 4, ll. 46-49.

U.S. Patent 4,817,920 to Erfort, Jr. does not disclose or teach the presently claimed invention. To the contrary, patent 4,817,920 teaches away by providing a plurality of stations in a furnace housing, where each station treats one coil at a time. *See* col. 4, l. 20. Patent 4,817,920 does not disclose or suggest an annealing furnace comprising both a housing comprising a pivot member with a lateral axis, where the housing pivotably rotates about a pivot member between an opened and a closed position, and a retaining element within the furnace housing where the retaining element holds each coil such that the axis of each coil is generally horizontal to the base portion as provided in the presently claimed subject matter.

U.S. Patent 4,147,506 to Southern et al. provides an insulated cover for use in an annealing furnace. Col. 2, ll. 24-25. The insulated cover is placed between the heating elements and a vertical coil to shield the coil from excessive heat that could damage the outer wrap of the coil. Col. 1, ll. 29-33.

U.S. Patent 4,147,506 to Southern et al. does not disclose or teach the presently claimed invention. The coils in patent 4,147,506 are annealed in a vertical position through a bell furnace. Col. 1, ll. 10-14. Patent 4,147,506 does not disclose or suggest an annealing furnace comprising a housing comprising a pivot member with a lateral axis, where the housing pivotably rotates about a pivot member between an opened and a closed position, and a retaining element within the furnace housing where the retaining element holds each coil such that the axis of each coil is generally horizontal to the base portion as provided in the presently claimed subject matter.

U.S. Patent 2,613,070 to Verwohlt teaches a method of annealing a single coil of steel, wherein the steel is wound onto a mandrel, col. 4, ll. 36-40, and the coil is rotated in an annealing furnace during annealing. Col. 4, ll. 57-58. The coil may be covered by a protective steel cover (col. 4, ll. 36-40), and the atmosphere in the furnace may be modified by injecting a protective gas. Col. 4, ll. 45-48. The coil may begin to open up as it rotates allowing heat and gas to enter the convolutions of the coil. Col. 5, ll. 18-23.

U.S. Patent 2,613,070 does not disclose or teach the presently claimed invention. The coils are not maintained stationary in horizontal position during annealing. To the contrary, the '070 teaches away from the present invention by teaching that the coils are rotated during annealing. *See* col. 5, ll. 18-28. Patent 2,613,070 does not disclose or suggest an annealing furnace comprising both a housing comprising a pivot member with a lateral axis, where the housing pivotably rotates about a pivot member between an opened and a closed position, and a retaining element within the furnace housing where the retaining element holds each coil such that the axis of each coil is generally horizontal to the base portion as provided in the presently claimed subject matter.

The following patents were considered where analysis seems unnecessary:

U.S. Patent 6,358,337 to Esteban Sanz et al. teaches a process for annealing a coil of drawn carbon steel, providing a method that reduces a loss of carbon from the steel caused by reaction with water. The process includes a step of holding the heat treatment at a temperature below the temperature where carbon and water in a vapor phase react, thereby avoiding a reaction between carbon in the steel and water vapor, and maintaining that temperature until the core of the coil is the same temperature as the outer part of the roll. This intermediate temperature is maintained reducing the water vapor from the core of the coil. Then the coil is further heated to an annealing temperature.

U.S. Patent 5,788,483 to Drigani et al. teaches a furnace for maintaining coil temperature, containing a coil transfer system providing a system for moving horizontal coils from one end of the furnace to the other, and queuing the coils at the output of the furnace. The furnace contains a coil transfer system comprising a plurality of positioning stations and a means for lifting and moving coils. The positioning stations have a raised position and a lowered position, such that when the positioning stations are in the lowered position, the lifting and moving means cooperate with the coils to advance the coils to the next station, and when the positioning stations are in the raised position, the coils remain in the present positioning station.

U.S. Patent 4,527,409 to Ouwerkerk teaches a process for hot rolling steel using heat reflecting screens, providing a process that reduces the heat loss from the hot steel while the steel moves between processes. Heat reflecting screens are placed over the hot steel for reflecting heat back onto the steel. The heat reflecting screen swings or pivots upwardly away from the steel. The heat reflecting screens are cooled so that the temperature of the reflecting surface is above the dew point of the atmosphere.

U.S. Patent 4,463,585 to Laws et al. teaches a heat shield arrangement for hot sheet material, providing an insulated reflecting surface for reducing the heat loss from the hot sheet material. The heat shields are arranged over and under the travel path of the sheet. The heat shields comprise a ceramic fiber insulation covered by a heat reflecting material such as stainless steel. Heating elements may be incorporated in the heat shields to maintain sheet temperature. The upper heat shield is adapted to pivot up out of the way if the traveling sheet material leaves its intended path.

U.S. Patent 3,855,019 to Salsgiver et al. teaches an improved process for producing electromagnetic silicon steel, the improvement including a step of annealing the hot rolled coil at a temperature between 1400 °F and 1700 °F.

U.S. Patent 3,636,579 to Sakakura et al. teaches an improved process for producing electromagnetic steel sheet, the improvement including a step of annealing the steel at a temperature between 750 °C and 1200 °C before a cold rolling process.

U.S. Patent 2,113,537 to Hiemens teaches a process for producing steel, including steps of annealing the steel at a temperature at 1000 °C before a cold rolling process and annealing the steel at a temperature at 1250 °C after cold rolling.

EP 0,468,716 to Allegheny Ludlum Corporation teaches a heat shield arrangement for transferring a hot metal material to a finishing mill, providing an insulated heat shield for reducing the heat loss from the hot metal bar before the metal enters the finishing mill. The heat shields are arranged over and under the travel path of the sheet. The heat shields comprise modules of ceramic fiber blankets.

Respectfully submitted,

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2006-10-13
	First Named Inventor	David L. CHASE
	Art Unit	
	Examiner Name	
	Attorney Docket Number	201141.00292

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code1	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	2113537		1938-04-05	HIEMENZ	
	2	2613070		1952-10-07	VERWOHLT	
	3	3636579		1972-01-25	SAKAKURA et al.	
	4	3855019		1974-12-17	SALSGIVER et al.	
	5	4147506		1979-04-03	SOUTHERN et al.	
	6	4504957		1985-03-12	McCLELLAND et al.	
	7	4817920		1989-04-04	ERFORT Jr.	
	8	6346214	B1	2002-02-12	KNUDSEN et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2006-10-13
	First Named Inventor	David L. CHASE
	Art Unit	
	Examiner Name	
	Attorney Docket Number	201141.00292

	9	6358337	B1	2002-03-19	ESTEBAN SANZ et al.	
	10	5788483	A	1998-08-04	DRIGANI et al.	
	11	4527409	A	1985-07-09	OUWERKERK	
	12	4463585	A	1984-08-07	LAWS et al.	

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FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	0468716	EP	A2	1992-01-29	ALLEGHENY LUDLUM CORPORATION		☐
	2	61 060829 w/abstr	JP	A	1986-03-28	MITSUBISHI HEAVY IND LTD		☑

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	Application Number	
	Filing Date	2006-10-13
	First Named Inventor	David L. CHASE
	Art Unit	
	Examiner Name	
	Attorney Docket Number	201141.00292

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☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☑ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/William S. Nabors/	Date (YYYY-MM-DD)	2006-10-13
Name/Print	William S. Nabors	Registration Number	56419

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ANNEALING OF HOT ROLLED STEEL COILS WITH CLAM SHELL FURNACE

[0001] This application is a continuation of U.S. Patent Application No. 11/279,192 filed April 10, 2006, which is hereby incorporated by reference.

BACKGROUND

[0002] The present invention relates to the field of high temperature annealing of steel coils.

[0003] In the manufacture of flat-rolled steel sheet and strip products, it may often be important to intermittently anneal the material for further cold-rolling operations. It may also be necessary to anneal the material at the finish gauge to render it suitable for fabrication (e.g., stamping and cold forming). Annealing is important because cold reduction elongates the grains of the steel microstructure, distorts the crystal lattice, and induces internal stresses. The steel that results from the cold reduction process is typically very hard and has reduced ductility. The annealing process recrystallizes the cold-worked steel, and if the steel is held at the proper annealing temperature for a sufficient time, the microstructure of the annealed steel will return to substantially undistorted lattices and the steel will be more ductile. Cold-rolled steel and heat-resisting steel sheets can be produced by hot rolling, hot annealing and pickling, cold rolling-finish annealing and pickling (cold-rolled annealing and pickling), and subsequent skin-pass rolling. The finish annealing and pickling procedure generally comprises a continuous annealing, pickling or continuous bright annealing.

[0004] Annealing techniques may be divided into two general categories: (a) batch operations, such as conventional box annealing; and (b) continuous operations. In the steelmaking, the softening of flat rolled sheet and strip products is typically accomplished through the use of continuous annealing.

[0005] The continuous annealing process involves unwinding the coil from a payoff reel, continuously feeding the coil through an annealing furnace, and then rewinding the coil on a take-up reel. The annealing furnace is typically electric or gas fired. The steel strip, while traveling through the furnace, is typically heated to a temperature in the range of about 1800 °F to about 2200 °F in the case of austenitic alloys, and to a temperature in the range of about 1400 °F to about 1800 °F for ferritic alloys. The annealing temperatures vary depending upon the particular alloy being annealed and desired microstructure, as well as the end-use of the steel alloy.

[0006] A continuous annealing line is useful for mass production, but may not always appropriate for smaller production runs. Instead of finish annealing (cold-roll annealing) and pickling requiring huge facilities, the use of box annealing (also called "bell annealing" or "batch annealing") may be of economically advantageous in shorter production runs.

[0007] Batch coil annealing furnaces (sometimes called "box annealing furnaces" or "bell shaped" furnaces) have been long used and are well known in the industry. In such furnaces steel coils are stacked vertically, edge to edge, on a base, and a removable inner cover is placed over the stacked coils. An outer cover then is placed over the inner cover, and the covers are removably sealed to the base. The outer cover typically contains gas fired burners that heat the inner cover, and in turn radiation heats the stacked coils. Batch coil annealing processes in the steel mill industry typically take about 20 hours to several days to complete.

[0008] Prior art annealing furnaces are off-line annealing furnaces. Because of the size and time requirements of annealing, the furnaces are usually not in-line in a steelmaking line. Annealing treatment of metal product in such off-line processes normally involves long cycle times, resulting in low productivity levels, high heat treatment costs and less energy savings.

SUMMARY OF THE DISCLOSURE

[0009] The present invention relates to an annealing furnace for thermal treating of hot rolled steel coils. The furnace of the present invention anneals hot rolled steel coils and includes a housing that pivotably opens and closes about a pivot member. The present invention overcomes the disadvantages of the prior art and can obtain cycle times of less than 75 hours at a temperature range from about 1200 °F to about 1650 °F. In one embodiment of the present invention, a method of converting hot rolled steel coil to a condition suitable for subsequent cold rolling includes annealing at least one hot rolled coil of steel in a furnace, wherein a portion of the furnace pivotably rotates about a pivot member between an opened and closed position, wherein the pivot member has a pivot axis generally lateral with its base portion, pickling the annealed steel coil, cold reducing the pickled steel coil and subjecting the cold reduced steel coil to a second annealing treatment.

[0010] A method is disclosed of annealing hot rolled steel coil comprising the steps of:

(a) assembling a furnace housing comprising a plurality of side walls, a base portion and a roof portion, where the housing pivotably rotates about a pivot member between an opened and closed position, wherein the pivot member has a lateral axis,

(b) positioning hot rolled coils of steel in the furnace such that the axis of the coil is generally horizontal to the base portion,

(c) pivoting housing about the hot rolled coils to close the furnace,

(d) establishing a reducing atmosphere with the furnace,

(e) annealing the hot rolled coil of steel in a furnace, and

(f) pivoting housing about the hot rolled coils to open the furnace.

[0011] The hot rolled coils of steel may be placed on its circumferential surface within a retaining element with the axis of each steel coil.

[0012] The reducing atmosphere may comprise at least one inert gas and at least one polyolefin gas, and at least one inert gas may be nitrogen and at least one polyolefin gas may be propylene. The reducing atmosphere may comprise nitrogen gas in an amount greater than about 90%, hydrogen gas in a range between about 5% to about 7%, and propylene gas in an amount less than about 1%. The annealing of the hot rolled steel coil may provide a cycle time of less than 75 hours at temperature range from about 1200 °F to about 1650 °F.

[0013] Also disclosed is a furnace for annealing hot rolled steel coil comprising:

(a) a furnace housing comprising a plurality of side walls, a base portion, a roof portion and a pivot member with an axis generally parallel with the base portion, where the housing pivotably rotates about a pivot member between an opened and a closed position;

(b) a retaining element within the furnace housing where the retaining element holds each coil such that the axis of each coil is generally horizontal to the base portion,

(c) a sealing device capable of sealing the furnace housing when in closed position,

(d) a system capable of establishing a reducing atmosphere within the furnace when sealed, and

(e) a plurality of heating elements located within the furnace housing capable of heating hot rolled steel coil during the annealing process.

[0014] The retaining element may be configured such that each of the hot rolled steel coils is capable of resting on circumferential surface of the coils within the retaining element.

[0015] The furnace may be capable of providing annealing of the hot rolled steel coil in a cycle time of less than 75 hours at temperature range between about 1200 °F and about 1650 °F. The system of the furnace may be capable of establishing a reducing atmosphere that comprises at least one inert gas, and at least one polyolefin gas and at least one inert gas may be nitrogen and at least one polyolefin gas may be propylene. The reducing atmosphere may comprise nitrogen gas in an amount greater than about 90%, hydrogen gas in a range between about 5% to about 7%, and propylene gas in an amount less than about 1%.

[0016] The above summary of the present invention is not intended to describe each embodiment or every implementation of the present invention. Advantages, together with a more complete understanding of the invention, will become apparent and appreciated by referring to the following detailed description and claims taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 is a plan view of the annealing furnace of the present invention;

[0018] FIG. 2 is a front elevation view of the annealing furnace of the present invention; and

[0019] FIG. 3 is a cross-section view across of the annealing furnace of the present invention across lines 2-2 of FIG. 2.

DETAILED DESCRIPTION OF THE DRAWINGS

[0020] For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

[0021] The present invention is directed towards the hot roll annealing of steel coils. The annealing of hot roll steel coils is a novel processing route when compared with the standard cold roll annealing route, wherein the hot roll steel coils are typically pickled, annealed, sometimes pickled again, cold reduced and then annealed one last time. In comparison, the new processing route of the present disclosure, which may be a batch process, has hot rolled steel coils avoid the initial pickling step of the cold rolled annealing process and proceed directly to the annealing stage, wherein the annealed steel coils are then pickled, cold reduced and then annealed one last time if desired. This hot roll annealing process provides substantial energy savings, since the steel coils are annealed while they are still hot, and more consistent mechanical properties, as measured in the ksi yield strength, when compared to the standard cold roll annealing process.

[0022] The high temperature annealing furnace of the present disclosure is illustrated in FIGS. 1-3. Reference numeral 10 indicates a furnace for annealing hot rolled steel coils. Furnace 10 includes a base portion 11 and a furnace housing 12. The base portion 11 is the base on which the furnace 10 is positioned on the floor of the steel plant. Housing 12 includes a roof portion 14 and a plurality of side walls 15, 16, 17 and 18. Located within housing 12 are a plurality of heating elements 19 that are used to heat the hot rolled steel coils during the annealing process. Housing 12 pivotably rotates about a pivot member 13 between an opened and closed position, as seen in FIG. 3. Pivot member 13 has a lateral axis and is generally parallel with base portion 11.

[0023] Located within housing 12 and secured to base portion 11 is a retaining element (not shown) that configured to support at least one hot rolled steel coil, wherein each steel coil has an axial opening therethrough which is substantially horizontal to base portion 11 of the furnace. The retaining element is capable of holding a plurality of hot rolled steel coils separate from one another. Prior to the annealing process and when housing 12 is in the opened position, the retaining element is configured such that when each of the hot rolled steel coils is placed on the retaining element. Each steel coil may be capable of resting on the circumferential surface of the coil within the retaining element.

[0024] Heating elements 19 are located within the interior of housing 12 of furnace 10. In one embodiment, heating elements 19 are curved pipes positioned in a predetermined arrangement along the sides of side walls 15, 16, 17 and 18, as seen in FIG. 3, which are directly exposed to the hot rolled steel coils during the annealing process. In order to reach the desired annealing temperature for the hot rolled steel coils, compressed air, which may be heated by natural gas burners, is circulated through heating elements 19.

[0025] It will be understood that the annealing furnace of the present disclosure will be provided with a full compliment of controls, sensors, piping and the like. These elements are well known in the art and do not constitute a part of the present invention. The furnace cycle, including heating and cooling rates, atmosphere control, and the like, can be manually or computer controlled, or both. Various types of computer and manual controls are well known in the art and again do not constitute a part of the present disclosure.

[0026] This invention relates to all hot rolled steel coils wherein the steel includes any commercially available steel, such as, for example, high carbon steel, medium carbon steel, low carbon steel, and high temperature austenite grain coarsening steel such as those described in U.S. Patent No. 7,048,033, which is hereby incorporated by reference.

[0027] Two grades of steel that can be annealed in the annealing furnace of the present disclosure include high carbon steel, having approximately 0.50 or more weight percent carbon in the total steel, and low carbon steel, having approximately less than 0.02 weight percent carbon in the total steel. The hot roll annealing of the high carbon steel in the furnace provides a softening of the material to permit more efficient downstream processing, for example cold reduction, of the steel coils. At an annealing temperature from about 1200 °F to about 1650 °F, the cycle time of the annealing process is less than 75 hours. At an annealing temperature in the range from about 1200 °F to about 1650 °F, the annealing process may have a cycle time in the range from about 40 hours to about 60 hours.

[0028] One type of high temperature annealing process is called "spherodize annealing". In this type of annealing process for high carbon steel, the controlled heating and cooling process produces spheroidal globular particles resulting in steel coils that have good machining characteristics. In this type of high temperature annealing, the use of a normal air atmosphere during the annealing promotes decarburization of the steel coil. The combination of high heat and a normal air atmosphere initially depletes a layer of carbon on the surface of the steel coil and decarburization results. Decarburization produces a steel product having both structural and mechanical inconsistencies throughout its surface.

[0029] In order to inhibit the effects of decarburization that takes place in a normal atmosphere during the high temperature annealing process, the annealing furnace includes a system capable of establishing a reducing atmosphere within the furnace when it is sealed. Included in furnace 10 is a sealing device (not shown) that is capable of sealing housing 12 when it is in the closed position. The sealing device promotes an efficient and effective annealing process by maintaining a desired annealing temperature and reducing atmosphere during the annealing process.

[0030] The reducing atmosphere includes at least one inert gas and at least one polyolefin gas. The at least one inert gas may include helium, neon, argon, xenon, and nitrogen. The reducing atmosphere can also include at least one other gas that facilitates the annealing process. The reducing atmosphere may include nitrogen as an inert gas, propylene as a polyolefin gas and hydrogen gas. In one embodiment, the reducing atmosphere used in the high temperature annealing process of high carbon steel includes nitrogen gas in an amount greater than about 90%, hydrogen gas in a range between about 5% to about 7% and propylene gas in an amount less than about 1%.

[0031] The hot roll annealing of low carbon steel coils is also an embodiment of the present disclosure. This type of steel includes a low carbon motor lam grade material that is used in motor lamination of electrical steels for motors of automotive vehicles. The hot roll annealing of the low carbon steel produces the growth of larger grains within the steel which ultimately yields improved magnetic properties. These improvements include lower core loss, which is a reduction in the loss of magnetic field as the magnetic fields are alternated, and higher permeability of the steel that allows more of the magnetic field to permeate it. Another benefit of the hot roll annealing of the low carbon steel is that it softens the steel to promote a more efficient cold rolling process.

[0032] Based on the foregoing disclosure, it should be apparent that the furnace used for annealing hot rolled steel coils of the present invention will achieve the objectives set forth above. It is therefore understood that any evident variations will fall within the scope of the claimed invention. Thus, alternate specific component elements can be selected without departing from the spirit of the invention disclosed and described therein.

ABSTRACT

Disclosed is a high temperature annealing furnace for hot rolled steel coils. The furnace of the present invention pivotably rotates about a pivot member between an opened and closed position. Prior to the annealing step, the hot rolled steel coils are placed within the housing of the furnace. The hot rolled steel coils are supported on a retaining element secured to a base portion located within the housing of the furnace. The hot rolled steel coils may be positioned on the base portion such that the axial opening of each coil is generally horizontal with the base portion.

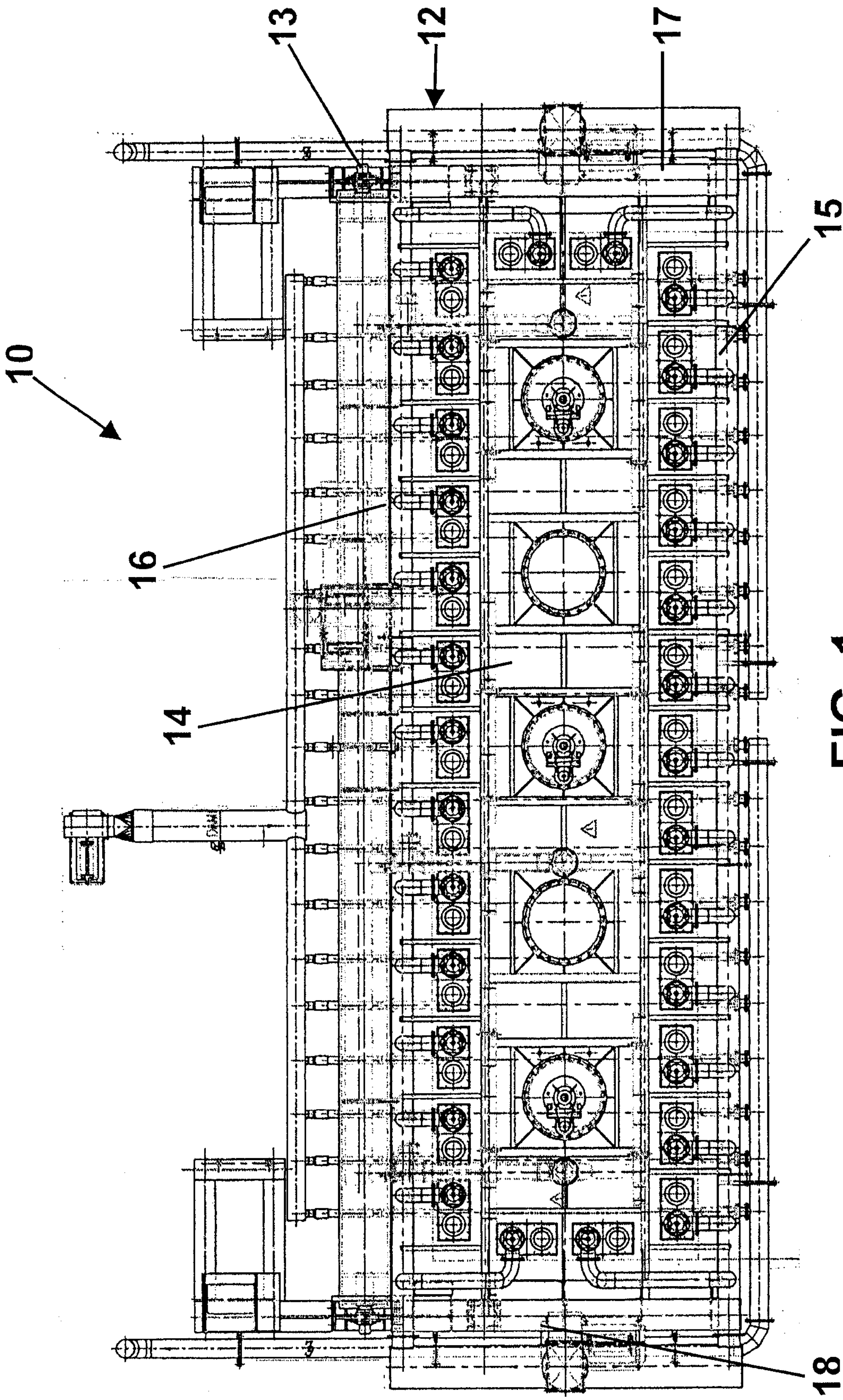

FIG. 1

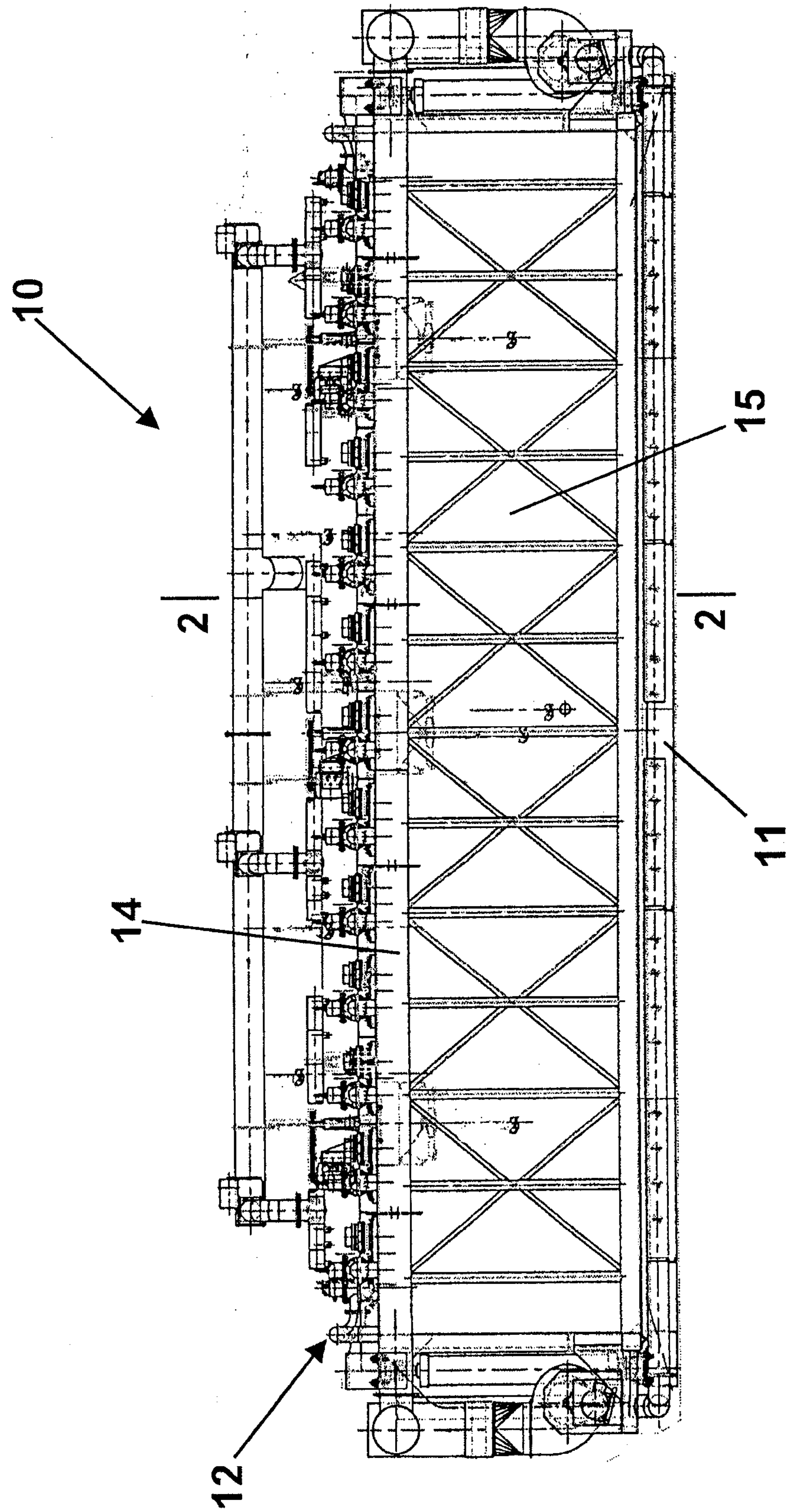

FIG. 2