EXHIBIT 18 (Part 3)

CLAIMS

What is claimed is:

1. A method 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 coils of steel in the furnace, and

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

2. The method of claim 1 where the coils are placed on its circumferential surface within a retaining element.

3. The method of claim 1 where the reducing atmosphere comprises at least one inert gas and at least one polyolefin gas.

4. The method of claim 3 where the at least one inert gas is nitrogen.

5. The method of claim 3 where the at least one polyolefin gas is propylene.

6. The method of claim 1 where the reducing atmosphere comprises 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%.

7. The method of claim 1 where the annealing of the hot rolled steel coil provides a cycle time of less than 75 hours at a temperature range from about 1200 °F to about 1650 °F.

8. 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 the 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 the 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.

9. The furnace of claim 8 where the retaining element is configured such that each of the hot rolled steel coils is capable of resting on circumferential surface of the coils.

10. The furnace of claim 8 where the furnace is capable of providing annealing of the hot rolled steel coil in a cycle time of less than 75 hours at a temperature range between about 1200 °F and about 1650 °F.

11. The furnace of claim 8 where the system capable of establishing a reducing atmosphere comprises at least one inert gas and at least one polyolefin gas.

12. The furnace of claim 11 where the at least one inert gas is nitrogen.

13. The furnace of claim 11 where the at least one polyolefin gas is propylene.

14. The furnace of claim 11 where the system is capable of further providing hydrogen gas in the reducing atmosphere.

15. The furnace of claim 8 where the system capable of establishing a reducing atmosphere comprises nitrogen gas in an amount greater than 90%, hydrogen gas ranging from about 5% to about 7%, and propylene gas in an amount less than 1%.

16. The furnace of claim 10 where the annealing process has a cycle time in a range from about 40 hours to about 60 hours at a temperature in the range from about 1,200 °F to about 1600 °F.

17. The furnace of claim 10 where the annealing of the hot rolled steel coils is a batch process.

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(54) **Insulating heat retention system and method.**

(57) An insulating heat re-radiation - retention and infiltration air free system and method is provided for processing heated articles, including upper and lower heat shields (24,26) to form, in combination with spaced apart rollers (22) employed to support the articles, a substantial infiltration air-free enclosure, each of the heat shields (24,26) are made-up of substantially high purity 100% ceramic fibre which is relatively non-porous and gap free and having fibre hot faces, the fibre of the heat shields (24,26) being compressed and maintained in a high density condition, the fibre of the lower heat shield (26) being formed to contact the circumferences of the rollers (22) in a manner to prevent air from passing into the enclosure, the upper and lower heat shields (24,26) being maintained in close proximity with the heated articles.

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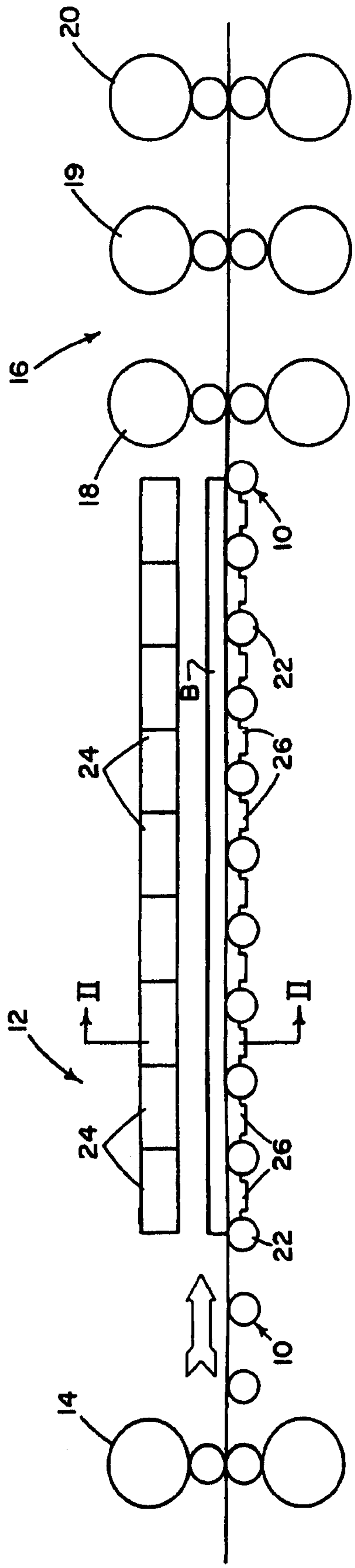

FIG. 1

It has long been recognised that the operation of hot strip rolling mills, and particularly that of the finishing train thereof, as well as the quality of the rolled product produced thereby can be improved by the employment of a means or system for controlling certain aspects of the temperature of the hot transfer bar. As used herein, the term "hot transfer bar" is meant to refer to the semi-rolled workpiece as it exits from the universal slab breakdown mill and before it is introduced into the finishing mill. An early U.S. Patent on the general subject may be found in Patent No. 1,676,176 dated July 3, 1928, while several later U.S. Patents, which relate more specifically to some of the problems to which the present invention is addressed, are found in Patent Nos. 3,344,648, 4,343,168, 4,463,585, 4,595,358 and 4,680,010 that issued between the years 1967 and 1987.

The more recent patents disclose the use of thermal insulating re-radiation heat shields which employ in combination with insulating fibre, metal hot faces designed to be arranged opposite the hot faces of the hot transfer bars. These patents attempt to utilize the heat shields to control the temperature and heat loss of the transfer bar prior to it being introduced into the finishing stand, two of the most important objectives being sought are the improvement in end-to-end gauge off the finishing mill and in the metallurgical properties of the rolled strip.

It has been found that heat shields and methods of their use of the above types and others do not acceptably function as intended and do not provide for maximum thermal effectiveness, nor are they cost effective. While there are other deficiencies in the known heat shields and methods, four of the most important are identified as follows: (1) reliance on the use of metallic hot faces that act as unfavourable heat sinks; (2) inability to provide a minimal air infiltration enclosure for the transfer bars, particularly as to the sides of the heat shields and the spaces between the driven rollers of the approach table arranged at the entry end of the first finishing stand for supporting and conveying the transfer bars; (3) inability to successfully protect the insulation of the lower heat shields from the water used to cool the bearings of the rollers; and (4) inability to provide a way to reduce heat build up in the rollers and heat transfer losses from the transfer bars. Another failure of prior heat shield systems employed in combination with hot strip rolling mill approach tables is the inability to provide an effective system for rolling grain oriented silicon steels where to obtain optimum results the entry temperatures of the transfer bars not only must be maintained at a very high temperature but the end to end temperatures of the bars must be maintained at a minimum differential temperature.

It is an object of the present invention to provide an insulating heat retention - re-radiation and infiltration air free system made up entirely of a high purity type substantial 100% ceramic fibre for use with heated articles such as hot metallic elongated workpieces, the system being characterised by having maximum ceramic fibre impact resistance and integrity on both sides of the hot workpiece with minimal heat storage capacity and minimal heat loss and having a fibre-faced hot side.

In one aspect, the invention provides a thermal re-radiation and retention system for influencing the temperature of hot metal articles positioned to radiate their heat toward the system, in which the articles have hot faces, said system being characterised by comprising heat shield means arranged at least adjacent to a portion of the article and having a support means, said heat shield means comprising a plurality of refractory fibre blanket modules carried by said support means; said blanket modules formed of a plurality of layers of refractory fibre arranged perpendicular to the hot face of the article and forming a substantially even elongated fibre hot face made up of the ends of folds of portions of said refractory fibre blanket; said blanket modules being in a substantially predetermined compressed state to create a substantially high density condition of a degree substantially impervious to room air; means for maintaining said modules in said compressed state in said support means; and means for maintaining said hot face of said heat shield means in a position of close proximity to said hot face of an article.

In another aspect, the invention also provides a method of controlling the temperature of a metal transfer bar while being rolled in a hot strip rolling mill characterised by, including a longitudinally arranged table having metal transfer bar support rollers positioned at the entry end of said mill for receiving heated transfer bars to be rolled by said mill, the transfer bars being supported horizontally and having top and bottom hot faces, said rollers of said table having support bearing means arranged at opposite ends thereof;

the steps of:

forming a thermal re-radiation - retention and infiltration air free enclosure system at said entry end of said mill for enclosing at least a part of said table;

positioning the transfer bar in said enclosure system,

forming said enclosure system by:

(a) positioning upper heat shield means co-extensive with the length and width of the transfer bar and comprising a plurality of refractory fibre blanket modules made up substantially entirely of ceramic; forming a substantially even elongated fibre hot face made up of ends of folds of portions of the fibre blankets of each module;

maintaining said modules 28 in a substantially predetermined compressed state to create a substantially high density condition; and

maintaining said hot face of said upper heat shield means in a position of close proximity to said top hot face of the transfer bar;

(b) positioning lower heat shield means in the form of a number of discrete sections, each arranged directly below and generally co-extensive with the width of the transfer bar, a different section being located between different adjacent pairs of said rollers of said table, in which the aggregate length of said sections is generally co-extensive with the length of the transfer bar;

forming each said section of a plurality of refractory fibre blanket members made up substantially entirely of a high purity ceramic and arranged in vertical side-by-side fashion relative to the transfer bar, the portions of said blanket members most adjacent the transfer bar forming a substantially even elongated fibre hot face;

maintaining said blanket members in a substantially predetermined compressed state to create a substantially high density substantially non-porous condition;

conforming end portions of said blanket members to correspond to adjacent circumferential portions of said table rollers and arranging said blanket members in close proximity with said rollers in a manner to substantially eliminate air space between said end portions and the adjacent associated portions of said rollers;

maintaining said hot face of said blanket members in a position of close proximity with the bottom hot face of the transfer bar in a manner to substantially reduce infiltration of free air into said enclosure system from between said blanket members and said bottom hot face; and

(c) applying coolant fluid to said bearing means by directing coolant fluid to the roller bearing means in a manner to maintain said blanket members substantially free of said coolant fluid.

A preferred embodiment of the invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a schematic elevational view of a portion of a hot strip rolling mill, and more particularly of the reversing slab breakdown mill and showing three of the multiple finishing mill stands with the approach table arranged therebetween, with which an insulating heat retention system constructed in accordance with the present invention is associated,

Figure 2 is a sectional view taken on line II - II of Figure 1 illustrating one of the heat shields of the heat retention system shown in Figure 1 in combination with the approach table,

Figure 3 is a partial plan view of one of the upper heat shields of the heat retention system shown in Figure 1,

Figure 4 is a perspective view of one of the insulating modules shown in Figures 2 and 3,

Figure 5 is an enlarged elevational view of one of the fasteners employed to secure an associated insulating module shown in Figure 4 in its assembled position,

Figure 6 is a plan view of one of the lower heat shields of the heat retention system shown in Figure 1, with portions broken away,

Figure 7 is a sectional view taken on line VII - VII of Figure 6, and

Figure 8 is an enlarged view of a portion of the table roller shown in Figure 2 illustrating a portion of the cooling system for one of the rollers.

With reference to Figure 1 there is schematically illustrated the area of the approach table 10 of a hot strip rolling mill 16. The approach table 10 is positioned between a reversing slab breakdown mill 14, arranged upstream of the table and the hot strip mill 16, located downstream, of which three tandemly arranged stands 18, 19 and 20 are only shown.

The table and mills follow well known designs, many characteristics of which are illustrated in the aforesaid U.S. Patents. The stands, as illustrated, are of the 4 Hi-type, and the table is made up of a number of spaced apart driven steel rollers 22 for receiving hot transfer bars from the mill 14 and delivering them to the first finishing stand 18, as indicated by the arrow shown in Figure 1. The arrows provided in the other figures are meant to indicate the same path of travel of the transfer bars. The table 10 is made long enough to accommodate the longest transfer bar rolled by the mill 14. Also in the usual manner, the table includes stationary side guards, not shown in Figure 1, but which are partially illustrated in Figure 2, which guards will be later identified and described.

In Figure 1 the hot transfer bars, B, may range generally from 0.75" to 1.5" (1.90 to 3.81 cm) thick, 20" to 50" (50.8 to 127 cm) wide, and 60' to 120' (18 to 37 m) long, may be formed of carbon, silicon or stainless steels, and may weigh between 5,000 to 30,000 pounds (2268 to 13605 kg). Depending on desired rolling and metallurgical property criteria, the bars may range in temperature between approximately 1900°F. and 2300°F. (1038°C. to 1260°C.). The transfer bar is generally described as having upper and lower hot faces.

As noted in the aforesaid U.S. Patents, in order to attempt to control the temperature level and lengthwise temperature gradient of the hot transfer bars, a series of heat shields in certain mill applications may be arranged above and below the transfer bars when resting on the approach table. The upper heat shields may be raised or lowered relative to each other to prevent damage to the shields by contact with a bowed-up portion of a transfer bar or for maintenance of the shields. The operational level of the heat shields are maintained as close to the top heat face of the transfer bar as dictated by the bowed up condition of the transfer bars.

In Figure 1 there is illustrated a heat shield system 12 constructed in accordance with the present invention consisting generally of a series of upper and lower heat shields 24 and 26, respectively, the shields of each series being identically constructed. With reference to Figures 2 and 3 in referring first to the upper heat shields 24, when viewed in a transverse direction as one views Figure 1, each shield is made up of a series of blanket modules 28 which in the illustrated form number five, the modules extending the entire length of the shield as shown in Figure 3. Since the shields are identical in construction only one will be described. The type of material, the assembled density, the character of the hot face of the modules and the closeness to the hot face of the transfer bar are considered important features of the upper shield.

The material employed for the modules, each of which take the form of continuous or discontinuous folded uniform sections of ten folds of 1" (2.54 cm) thick refractory fibre blankets, each arranged in accordion or corrugated fashion, are made up, for example, of a dry high purity ceramic fibre of the type sold by Sohio Carborundum Company of Niagara Falls, New York. This material is of a porous fibre type having the capacity of being able to be compressed from an original needled blanket state of approximately 8 lbs. per cu.ft. (128 kg/m³) density to 13.8 lbs. per cu.ft. (221 kg/m³) compressed density, when assembled in a banded module form. In this compressed condition all gaps between the adjacent folds are eliminated due to the high density compactness of the ceramic fibre and air flow tightness. In its original state, the fibre itself is porous, so that hot air can flow through the fibre and through construction cracks around the modules. The significant heat retention ability of the disclosed system has raised the current trailing end temperature of transfer bars, for example, 2139°F. (1171°C.), to a temperature greater than the former leading end temperature of the transfer bars, for example, 2110°F. (1154°C.). The heat conservation ability of the disclosed system in retaining the heat of the bars is equal to that formerly only accomplished by fired furnace type heat input panels arranged over a conveyor. Thus, the disclosed heat retention enclosure system is a "passive" system that retains and re-radiates the heat of the transfer bar and excludes infiltration of air to an extent that very high entry rolling temperatures are achievable, such 2200°F. (1222°C.) and higher, with the end to end rolling temperature differential of the transfer bars being greatly reduced.

The pre-assembled modules transversely viewed in Figure 2 consist of folded 1" (2.54 cm) high purity, 2400°F. (1333°C.) non-porous type fibre temperature material compressed from 10 layers 12" (30 cm) wide at 8 lbs. per cu.ft. (128 kg/m³) to form an aggregate of 20 assembled layers 11.6" (29.5 cm) wide at between 8 to 13.8 lbs. per cu.ft. (128 to 221 kg/m³) compressed density. The use of the term "high purity" refers to a currently available fibre of 99.5% or greater of alumina and silica containing only traces of tramp oxides, such as iron oxides or titania, one form of which is known by the tradename "Fiberfax Durablanket HP-S" as manufactured by the Sohio Carborundum Co. In employing a non-porous fibre, the fibres are sufficiently packed together in a random pattern to be impervious to room air flow. The modules as shown in Figures 2 and 3 are preferably arranged with the folds of the blanket parallel to the longitudinal axis of the transfer bar. The modules may also be arranged with the folds essentially perpendicular to the rolling direction. The height of the modules as one views Figure 5, which are arranged to form uniform top and bottom surfaces measure approximately 4" (10.2cm), the lower surface forming a continuous flat hot face. The height factor is important in order to assure a firm impact - resistant module of sufficient strength to resist the occasional upward thrust of a moving transfer bar without major damage to the fibre, in the event the transfer bar being rolled is upwardly distorted sufficient to contact the module surface. It will be appreciated that one of the important considerations of the present invention is to provide a heat shield that will successfully function in the harsh environment of a hot strip rolling mill.

It will be noted that according to the teaching of the present invention, the modules of the upper heat shield are not provided with a metallic fasteners or sheathing employed for a hot face but instead the hot face is formed by the highly compressed folds of the ceramic fibre to provide a uniform maximum re-radiation surface. It has been found that the ceramic fibre modules built in accordance with the present invention are superior to heat shields employing metal hot faces in terms of less heat storage capacity, heat losses and rapid re-radiation qualities. While others have previously recommended the virtue of employing stainless steel skin for the hot face, it has been found not only unnecessary but also to act as a detrimental heat sink. Ceramic fibre alone is inherently more efficient in heat energy conservation, due to its much lower heat capacity. When compressed, as taught by the present invention, the heat storage capacity and minimal heat loss characteristics are utilized to their fullest advantage. The elimination of a stainless steel skin over the module folds reduces the initial cost and repetitive steel skin replacement costs.

In addition to creating an assembled desired and predetermined compressed density of the modules of the heat shield in the transverse direction, it is also important that the modules described above be compressed to a predetermined degree when in their assembled state in the longitudinal direction, i.e. end to end as distinguished from side to side. The desired degree of compression and hence additional degree of added net density is obtained by compressing the 20 1" (2.54 cm) layers an additional one inch (2.54

cm) in the assembled state. In the illustrated form of the assembled modules, each module is compressed to a 4" (10.2 cm) high x 11.6" (29.5 cm) x 11" (27.9 cm) modules giving a final density of approximately 10 to 15 lbs. per cu.ft. (160 to 240 kg/m³). While one form and type of insulating material has been referenced several other commercially available corrugated or accordion folded refractory materials may be used, such as the type known as Inswool manufactured by A.P. Green Refractories, or a material known as high purity Kaowool (T.M.) sold by Thermal Ceramics.

With reference to the support structure of the upper heat shield 24, one of the important features of the present invention is a substantial infiltration air free enclosure for the hot transfer bars as can be best seen in comparing Figures 2 and 7. The enclosure includes insulating walls which are mounted in close proximity to the high temperature metallic transfer bar with short side re-radiation ceramic fibre extending downward to reflect heat shield side radiation and transfer bar edge radiation and at the same time excluding infiltrated air. In this way fresh air is prevented from being exposed continuously to the hot transfer bar whereby lesser amount of scale is formed on the bar and more uniform and predictable control of the heat losses are achievable.

Figure 2 illustrates the end of the upper heat shield 24, in which a series of modules 28 are aligned close to and in a transverse direction relative to the transfer bar B. The modules in the aforesaid compressed condition are contained in a frame 30 consisting of three parallel longitudinal angle beams 34 and five transverse angle beams 36, two outer beams of each set forming the four sides of the rectangular frame 30 which supports the modules in the desired compressed state. Extending downwardly from the end beams 34 are opposed inwardly open channel beams 40, best shown in Figure 2, that extend the entire length of the heat shield and in which each receive compressed ceramic fibre folds 42 that form part of the enclosure. the beams 34, 36 and 40 form an integral rigid unit and to the bottom of the common surfaces of the beams 34 and 36 there is secured by spot welding an expanded stainless steel mesh screen 43 shown in Figure 3, the mesh providing an expeditious manner of securing the individual modules 28 to the screen and hence the frame 30. The ceramic folds 42 are made up of two layers of the same type of ceramic material described above, which as shown in Figure 2 are received in the openings of the channel beams 40, and secured in the desired compressed condition therein by the compressing forces of the modules 28 acting against the folds 42 along the entire lengths of their upper outside portions. The channel beams 40 are carried by parallel extending end supports 32 forming part of the upper heat shield 24. To retain the two end rows of modules longitudinally in the frame 30 at the opposite ends thereof downwardly extending keeper plates 45 are provided.

Figure 4 and 5 illustrates features of each module for securing it to the frame 30. Figure 4 shows that each module is provided with a pair of internal parallel cross bars 41 which pass through the module at the upper side thereof, and are held in the modules by two clips 46a arranged in the fibre and end pop rivet flanges 44. To the cross bars are integrally attached a plate 46 having a centre opening 49. Figure 5 shows a bolt 47 provided to secure each module to the mesh screen 43 of the frame 30, in which the upper end of the bolt 47 is threadedly connected to a washer-nut assembly 47a on the outer side of the plate 46. The other end of the bolt 47 is secured to the module by a washer-bolt head 47b.

The entire heat shield for certain operational conditions and for maintenance reasons is adapted to be raised from an operative position shown in hard lines in Figure 2 to an inoperative position shown in dash lines in the same figure. This movement is accomplished by a piston cylinder assembly 48 against a counterweight 50 about a pivot 51. It will be observed in Figure 8 that the lower ends of the channel beams 40 are arranged in general vertical alignment with opposed stationary side guards 54 that form part of the approach table 10, thereby serving as part of the continuous side walls of the enclosure to prevent, in the region involved, outside air from passing into the enclosure. The length of the side guards extend the entire length of the table 10 which in Figure 2 is shown carried by spaced apart I - beams 56.

In order to complete the enclosure and accomplish the objectives of the present invention of providing an effective heat retention system for the hot transfer bars, special attention is given to the effect the required employment of the table rollers 22 and the problem presented by the necessary spaces provided by the rollers have on realising the objectives and to protect the insulation from the water required for operating the rollers. This involves several important features of the present invention, namely, of eliminating the air space between the lower hot face of the transfer bar and the heat shield, of constructing the lower heat shield to cooperate with the upper heat shield to complete the insulating enclosure, of eliminating air from passing into the enclosure from clearances between the rollers and the heat shield, of preventing water used to cool the bearings of the rollers from contacting the ceramic fibre of the lower heat shield and of reducing the heat loss effect the rollers have on the heat retention system.

In regard to these features reference will be made to Figures 2, 6 and 7. Figure 7 illustrates one of the lower heat shields 26 arranged between two of the rollers 22 of the approach table 10. As in the case of the upper heat shields, each lower heat shield is identical in function and construction, and only one will be described. The lower heat shield is formed of a number of longitudinally arranged highly compacted stack-bonded blanket layers 58 of ceramic fibre of the type described above, but in the form of individual sections and not in an accordion form as employed in the upper heat shields. The ends of the ceramic fibre are cut to closely fit the contour of the rollers. In addition, the fibre is cut so that when layers are stackbonded, the top of the heat shield is at the passline of the transfer bar. Although the actual height of the bottom ceramic fibre may be reduced by either a scraping or tamping action of the transfer bars to slightly below the passline, the air space between the fibre and bottom surface of the transfer bar is essentially eliminated. However, since the fibre is highly compressed to about 10 lbs. per cu.ft. (160 kg/m^3) density, it does not become dislocated.

The advantages of this design are numerous. The surface area of a highly effective heat shield with very low heat capacity is maximized. In operation, the surface of the shield glows instantaneously when a 2200°F. (1222°C.) transfer bar enters the shield. This, of course, is the visual effect of a minimal amount of heat being transferred to the shield from the transfer bar until the shield re-radiates. This effect begins with the first transfer bar to come across the table. Heat transferred to the rollers is minimized as a substantial part of the roller surfaces are shielded by the fibre. This not only is a benefit for the transfer bar but also for the rollers which are subject to less heat. The amount of oxygen surrounding the transfer bar is minimized. Of equal importance is the advantage of having a method of operating a hot strip rolling mill which permits the entry rolling temperature of the transfer bar to be maintained at a predetermined high temperature, and to maintain the bar at this high temperature level with greatly reduced end to end temperature drop during rolling. Such temperature control is extremely important for some steels, such as grain oriented silicon steels.

It should be noted this improved heat shield design could not be obtained if a metal hot face cover were used as suggested in some of the aforesaid U.S. Patents wherein the metal hot face inherently requires an air space or clearance be maintained between the rollers and the transfer bar. Further, the curved fibre pieces of the blankets cut to conform to the table roller diameters may be cut oversized to insure that close positive contact is made with the rollers. In such case, the rotation of the rollers will grind the fibres to exactly conform to the roller's diameters. This close ceramic fibre fit prevents external room air from entering the interior of the re-radiating heat shield enclosure from beneath the roller table 10.

Figure 7 illustrates the air sealing contact of the fibre layers 58 and two adjacent rollers 22. The layers of the fibre 58 are compressed in a transverse direction to create a rigid high density unit having a density of the order of approximately 15 lbs. per cu.ft. (160 to 240 kg/m^3) Figure 6 shows that the lower heat shield includes a stainless steel expanded wire mesh screen 60 arranged to support the lower surface of the layers 58 as best shown in Figure 7, the screen being made upon three similar sections. The screen is received in a base pan or tray 64 having four upright sides for receiving the lower portions of the layers and for retaining them in the desired compressed condition, in both the longitudinal and transverse directions relative to the path of travel of the transfer bar. Below the pan is provided a base member 62 which is supported by an I beam 66.

With reference to Figure 2, in addition to Figure 8 where the system for preventing water used to cool the rollers 22 is best illustrated, the rollers in the usual manner are provided with end bearings, not shown, which are carried in stationary bearing caps 68. It is customary in operating a hot strip rolling mill to cool the rollers and bearings by directing water to the outer surfaces of the rollers and the bearing caps by a splashing technique. When lower fibre heat shields are employed it has been found that the water inevitably contacts and saturates the fibre which results in a permanently and substantially reduced insulating effectiveness of the fibre.

The present invention provides a system for eliminating this drawback by providing a direct piping system that avoids water coming into contact with the ceramic fibre layers 58. As shown in Figures 2 and 8 the bearing caps 68 on each end of the rollers are provided with inclined drilled holes 70 on the top of the bearing caps into which water delivery pipes 72 are arranged having their output ends close to the inside casing of the bearings, not shown. In this manner water under a controlled pressure without splashing is directed to the stub shafts of the rollers 22 immediately adjacent the bearings, while the opposite ends of the pipes are connected to supply conduits 74, shown only in Figure 2. By this arrangement, water is delivered in a controlled non-splashing manner to the bearings; the need to subject the rollers to water for cooling is substantially eliminated, and the fibre layers are prevented from contacting the water.

The thermal passive re-radiation and retention system 12 allows the operation of a hot strip mill to realise substantial benefits in rolling all types of steels, such as carbon, stainless and silicon, both in the ability to utilise the mill to its optimum capacity, to improve control of the strip and in the case of grain oriented silicon steel, improve its electrical properties. For all these steels, by way of example only, the ability to maintain a desired top and bottom surface temperatures of the transfer bars, to efficiently and effectively obtain the desired entry temperature of the transfer bars entering the first finishing stand, and to maintain the end-to-end temperature differential of the bars as low as possible entering the first finishing stand is the direct result of employing the enclosure

30, in combination with the employment of the table roller cooling system of Figure 8. The ability of the enclosure to exclude infiltrating air, reduce heat losses of the transfer bars while in the enclosure and reduce the adverse affect of the table rollers from acting as heat sinks, allow the obtaining of the above enumerated advantages. In rolling grain oriented silicon electrical steel strip, the thermal re-radiation - retention and air infiltration free system allows optimum high entry rolling temperatures to be obtained in the transfer bars at the finishing mill and minimal end-to-end bar rolling temperature variation thereby allowing the mill to consistently produce premium quality grain oriented silicon electrical steel strip. For example, the well recognised desired rolling temperatures of this steel of the order of 2100°F. (1166°C.) and above and rolling with an end-to-end temperature range of no greater than 100°F. (55°C.) below the entry rolling temperature is consistently obtainable by the thermal re-radiation - retention and infiltration air free system disclosed.

Although preferred embodiments of a thermal re-radiation system and method of use of the present invention has been described, it will be apparent to one skilled in the art that changes can be made thereto without departing from the scope of the invention.

Claims

1. A thermal re-radiation and retention system for influencing the temperature of hot metal articles positioned to radiate their heat toward the system, in which the articles have hot faces, said system being characterised by comprising:
   heat shield means (24,26) arranged at least adjacent to a portion of the article and having a support means;
   said heat shield means comprising a plurality of refractory fibre blanket modules (28,58) carried by said support means;
   said blanket modules (28,58) formed of a plurality of layers of refractory fibre arranged perpendicular to the hot face of the article and forming a substantially even elongated fibre hot face made up of the ends of folds of portions of said refractory fibre blanket;
   said blanket modules (28,58) being in a substantially predetermined compressed state to create a substantially high density condition of a degree substantially impervious to room air;
   means (30) for maintaining said modules (28,58) in said compressed state in said support means; and
   means for maintaining said hot face of said heat shield means (24,26) in a position of close proximity to said hot face of an article.

2. A system according to claim 1 characterised in that said refractory fibre is of a high purity type ceramic and comprises substantially one hundred per cent (100%) of said fibre.

3. A system according to claim 1 or 2, characterised in that said refractory fibre is folded in alternating directions to form the plurality of layers.

4. A system according to any one of claims 1 to 3 characterised in that said modules are compressed in a first direction relative to the article to a density of no less than 8 lbs. per cu.ft. (128 kg/m^3) and compressed in a second direction generally perpendicular to said first direction relative to the article to create a total density of no less than 10 lbs. per cu.ft. (160 kg/m^3).

5. A system according to claim 4, characterised in that said modules are compressed in a first direction relative to the article to a density of substantially 13 lbs per cu.ft. (208 kg/m^3) and compressed in a second direction generally perpendicular to said first direction relative to the article to create a total density of substantially 15 lbs per cu.ft. (240 kg/m^3).

6. A system according to claim 5, characterised in that said first direction is transverse to a longitudinal axis of the article and said second direction is parallel to said longitudinal axis of the article.

7. A system according to any one of the preceding claims characterised in that said folds of said modules (28) are formed from continuous side-by-side folds, in which a portion of each fold between its ends creates a portion of the hot face of the modules.

8. A system according to any one of the preceding claims, characterised in that said modules (28) have a height in a direction perpendicular to said hot face of the article of approximately 4 inches (10.16 cm).

9. A system according to any one of the preceding claims characterised in that a plurality of spaced apart roller means (22) are provided to support the hot metal articles.

10. A system according to claim 9, characterised in that said roller means has supporting bearing means arranged at opposite ends thereof,
    cooling means for introducing coolant fluid to the said bearing means,
    said cooling means including coolant fluid directing means constructed and arranged relative to said bearing means to effectively direct

coolant to said bearing means in a manner to maintain said blanket sections substantially free of said coolant fluid.

11. A system according to claim 10, characterised in that the roller means (22) have supporting bearing means arranged at opposite ends thereof and each said roller bearing means includes bearing caps (68); and

openings (70) formed in said bearing caps (68) arranged to receive coolant means for directing coolant to at least portions of said roller bearing means.

12. A system according to any one of the preceding claims characterised in that the system comprises upper and lower heat shields (24,26).

13. A system according to claim 12 characterised in that the end portions of the refractory fibre blankets of the lower heat shield (26) are arranged in an air excluding relationship with adjacent pairs of said rollers means (22).

14. A system according to claim 12 or 13, characterised in that said upper heat shield (24) includes opposed parallel extending side members (34,36);

said side members having a portion (40) that extends downwardly from the support means to form at least part of the side wall means of the heat shield (24) and being co-extensive in length therewith;

fibre folds (42) carried by said side members on the inside of the heat shield (24) and having fibre hot faces arranged to be subject to the thermal radiation of side portions of the article bar; and

said fibre folds (42) being at least co-extensive with the lengths of said side members.

15. A system according to any one of claims 9 to 14, characterised in that said roller means (22) constitutes part of a support table (10) for the articles, said table including opposed upright side guard means (54), a different one extending parallel to the longitudinal opposite sides of the article bar;

said side guard means (54) having upright portions that cooperate with said upper heat shield (24) to form at least part of an external air excluding opposed sides of said enclosure.

16. A system according to any one of the preceding claims, wherein the support means include expanded stainless steel wire mesh screen means (43,60) for supporting said modules (28,58) on the side of the support means opposite the hot faces of said modules (28,58).

17. A method of controlling the temperature of a metal transfer bar while being rolled in a hot strip rolling mill characterised by, including a longitudinally arranged table (10) having metal transfer bar support rollers (22) positioned at the entry end of said mill for receiving heated transfer bars (B) to be rolled by said mill, the transfer bars (B) being supported horizontally and having top and bottom hot faces, said rollers (22) of said table (10) having support bearing means arranged at opposite ends thereof;

the steps of:

forming a thermal re-radiation - retention and infiltration air free enclosure system at said entry end of said mill for enclosing at least a part of said table;

positioning the transfer bar (B) in said enclosure system,

forming said enclosure system by:

(a) positioning upper heat shield means (24) co-extensive with the length and width of the transfer bar (B) and comprising a plurality of refractory fibre blanket modules (28) made up substantially entirely of ceramic;

forming a substantially even elongated fibre hot face made up of ends of folds of portions of the fibre blankets of each module (28);

maintaining said modules (28) in a substantially predetermined compressed state to create a substantially high density condition; and

maintaining said hot face of said upper heat shield means (24) in a position of close proximity to said top hot face of the transfer bar (B);

(b) positioning lower heat shield means (26) in the form of a number of discrete sections, each arranged directly below and generally co-extensive with the width of the transfer bar (B), a different section being located between different adjacent pairs of said rollers (22) of said table, in which the aggregate length of said sections is generally co-extensive with the length of the transfer bar (B);

forming each said section of a plurality of refractory fibre blanket members (58) made up substantially entirely of a high purity ceramic and arranged in vertical side-by-side fashion relative to the transfer bar, the portions of said blanket members (58) most adjacent the transfer bar (B) forming a substantially even elongated fibre hot face;

maintaining said blanket members (58) in a substantially predetermined compressed state to create a substantially high density substantially non-porous condition;

conforming end portions of said blanket members (58) to correspond to adjacent circumferential portions of said table rollers (22) and arranging said blanket members (58) in close proximity with said rollers (22) in a manner to substantially eliminate air space between said end portions and the adjacent associated portions of said rollers (22);

maintaining said hot face of said blanket members (58) in a position of close proximity with the bottom hot face of the transfer bar (B) in a manner to substantially reduce infiltration of free air into said enclosure system from between said blanket members (58) and said bottom hot face; and

(c) applying coolant fluid to said bearing means by directing coolant fluid to the roller bearing means in a manner to maintain said blanket members (58) substantially free of said coolant fluid.

18. A method according to claim 17, characterised by comprising the additional step of maintaining said hot face of said blanket members (58) in contact or near contact with said bottom hot face of the transfer bar (B).

19. A method according to claim 17 or 18 characterised by comprising the additional steps of during the time the transfer bar (B) is in said enclosure maintaining the temperature of the transfer bar (B) at a desired entry rolling temperature for said mill and at the same time substantially reducing the front end to back end differential temperature of the heated transfer bar (B).

20. A method according to any one of claims 17 to 19, characterised by comprising the additional steps of passing the transfer bar (B) through said enclosure system;

operating said enclosure system as a passive system by retaining and re-radiating the heat of the transfer bar (B) while in said enclosure system and excluding infiltration of air into said enclosure system;

delivering the transfer bar (B) to said enclosure system at a desired entry rolling temperature for said mill;

controlling the amount of time the transfer bar (B) is in said enclosure system in relation to the heat retention capacity of said enclosure system to maintain said desired entry rolling temperature for the transfer bar (B) entering said mill and at the same time substantially reducing the front end to back end rolling temperatures for the transfer bar (B) when exiting from said enclosure system.

21. A method according to claim 20 characterised in that the metal of the transfer bar (B) comprises a grain oriented silicon steel and the steps include maintaining said entry rolling temperature at approximately 2100°F. (1167°C.) and higher and said end-to-end temperatures at temperatures of no greater difference than approximately 100°F. (56°C.).

22. A method according to any one of claims 17 to 21, characterised in that further temperature controlling includes the steps of:

reducing heat losses from the sides of the transfer bar (B) by arranging side heat shields (24,26) adjacent the opposite sides of the transfer bar (B) co-extensive with its length in a manner to reduce heat losses from the opposite sides of the transfer bar (B) and in reducing infiltrated air from entering said system.

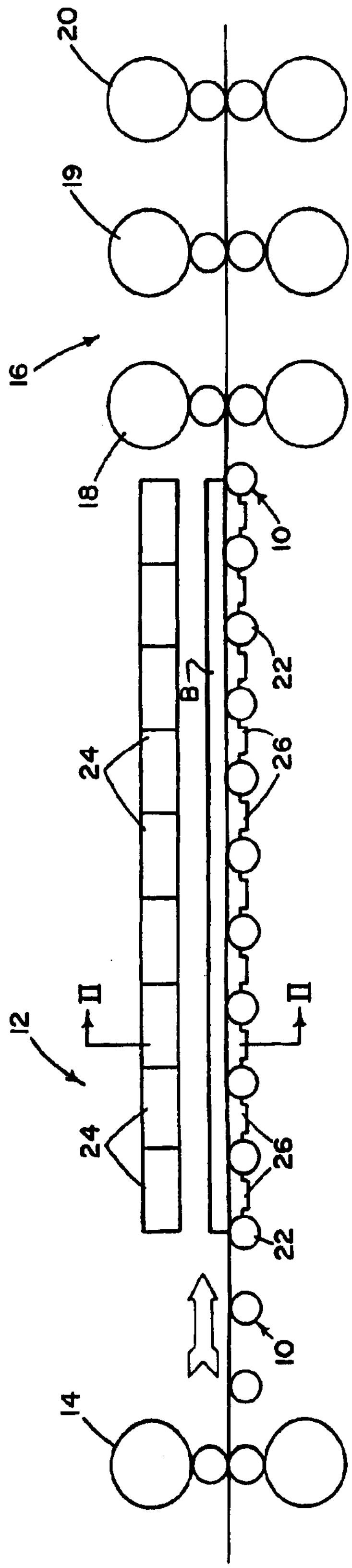

FIG. 1

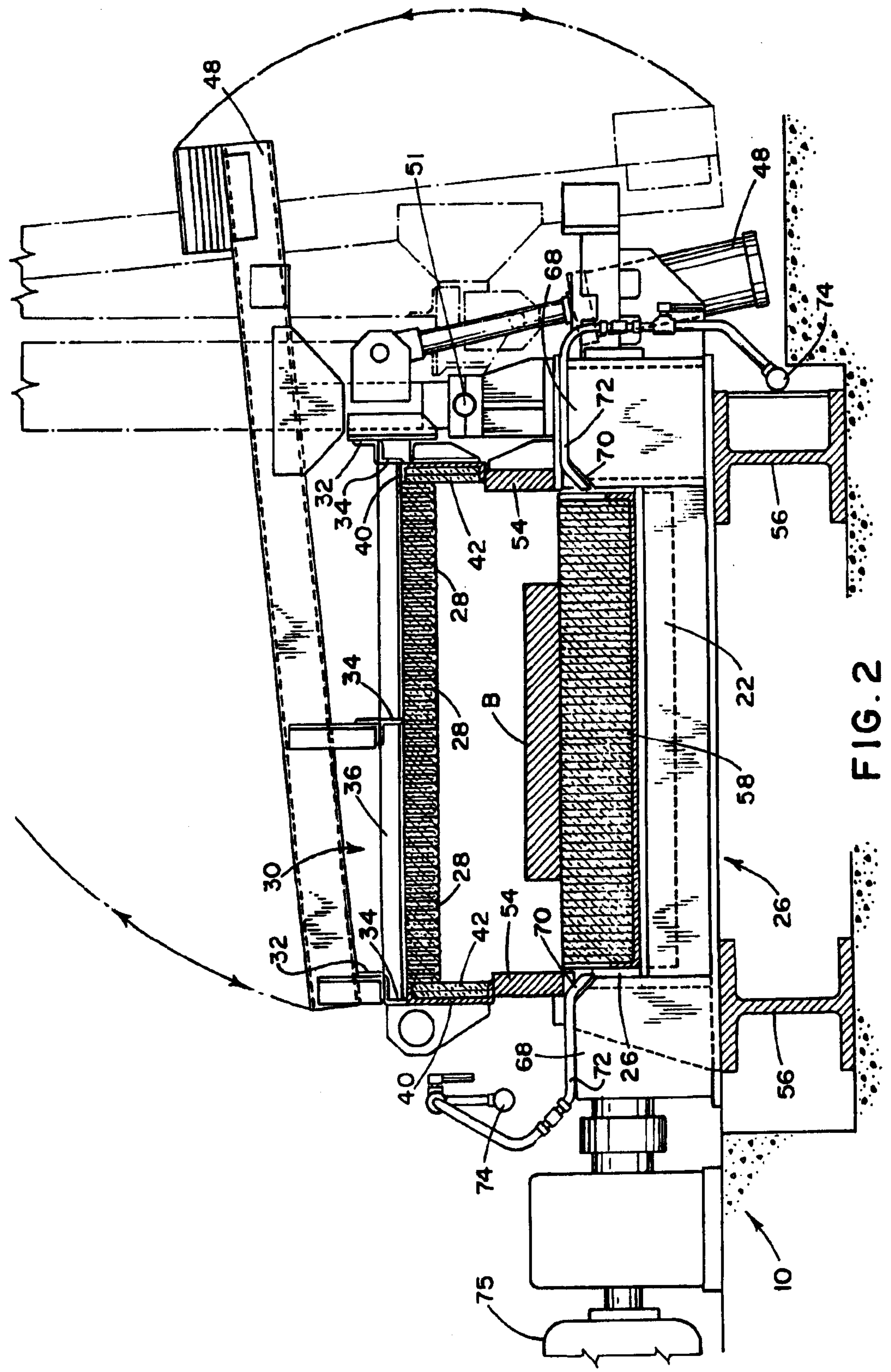

FIG. 2

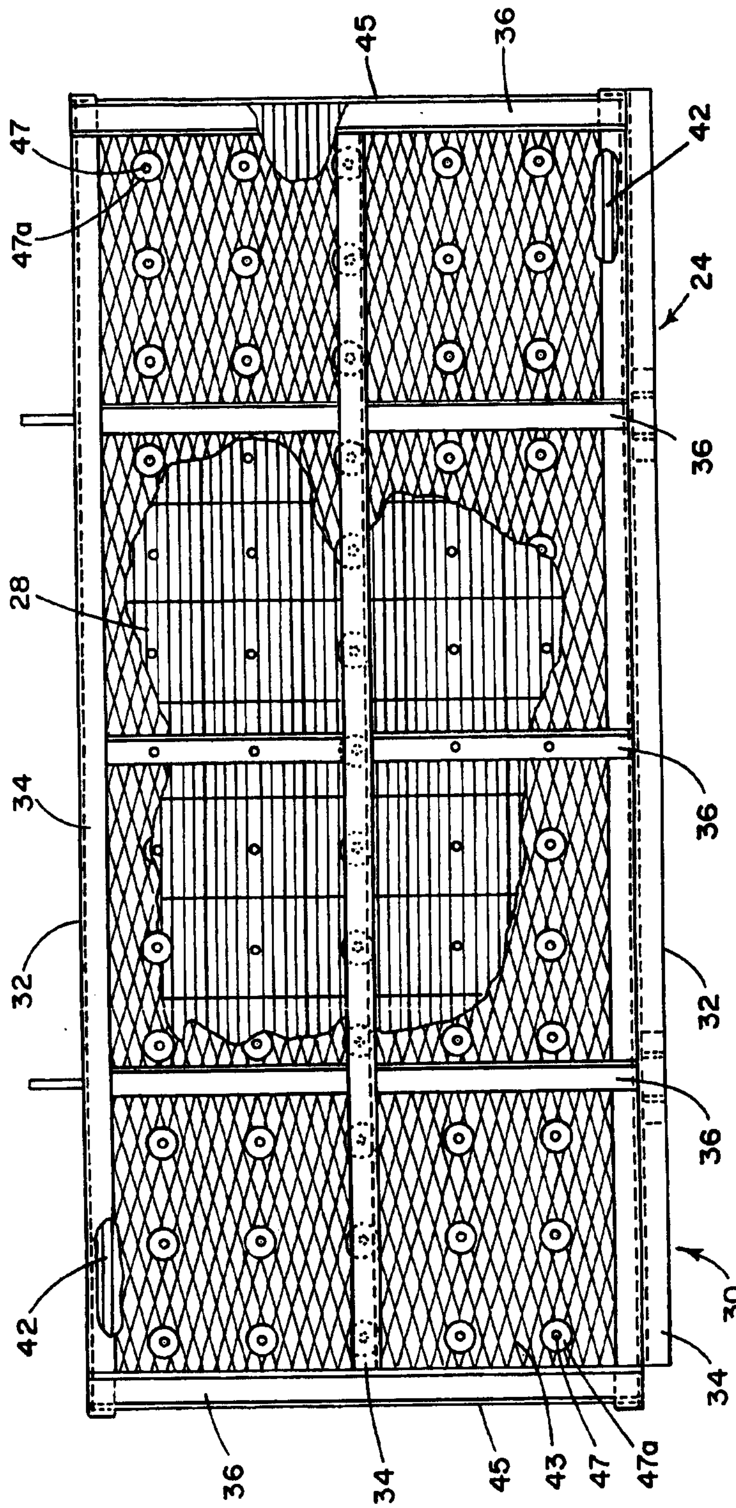

FIG. 3

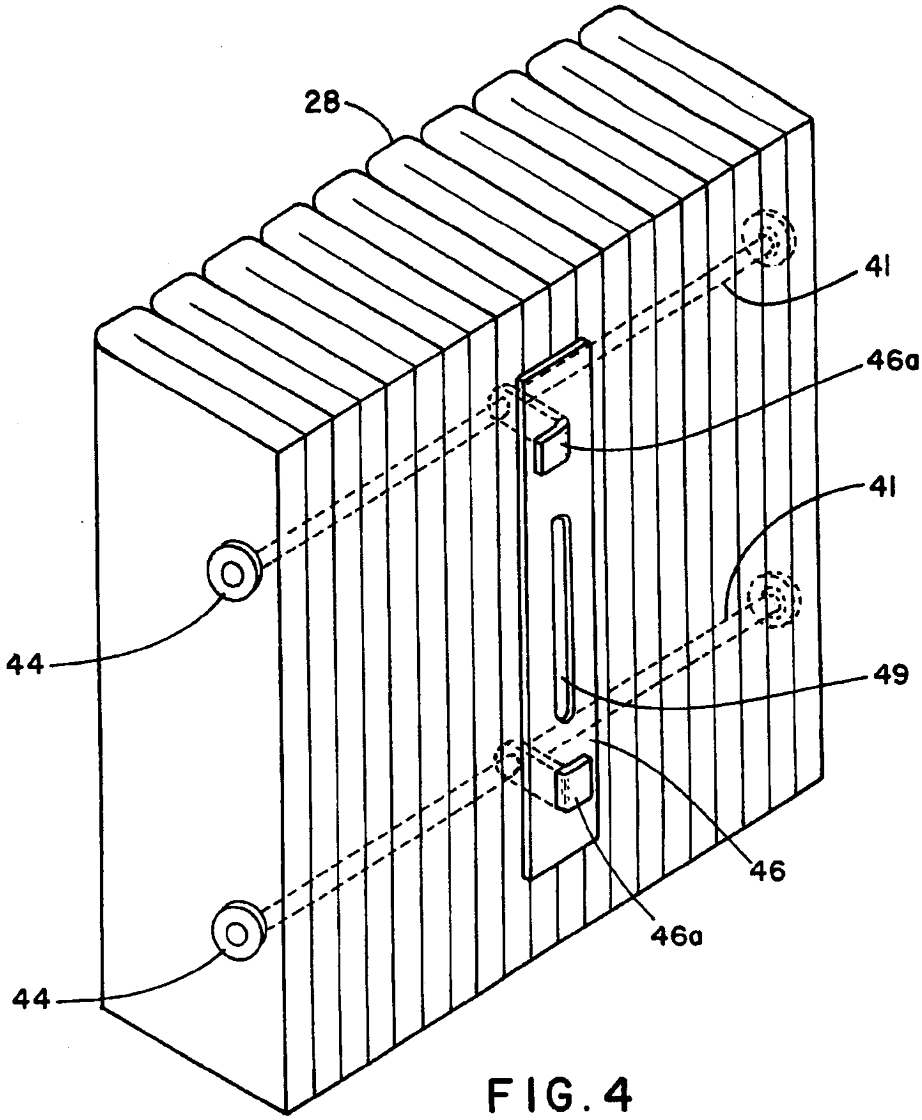

FIG. 4

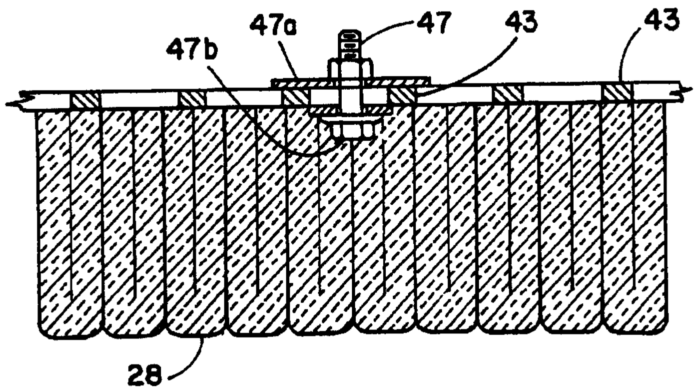

FIG. 5

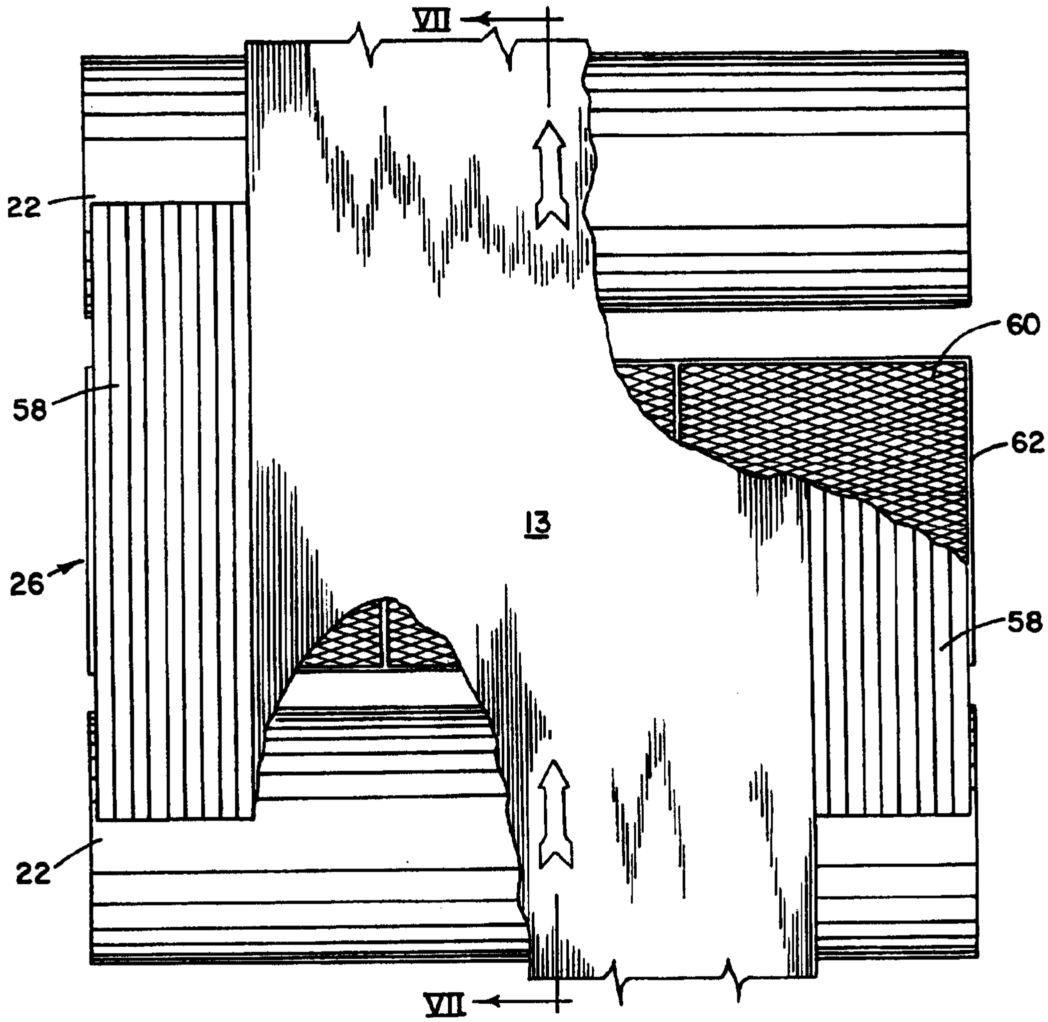

FIG.6

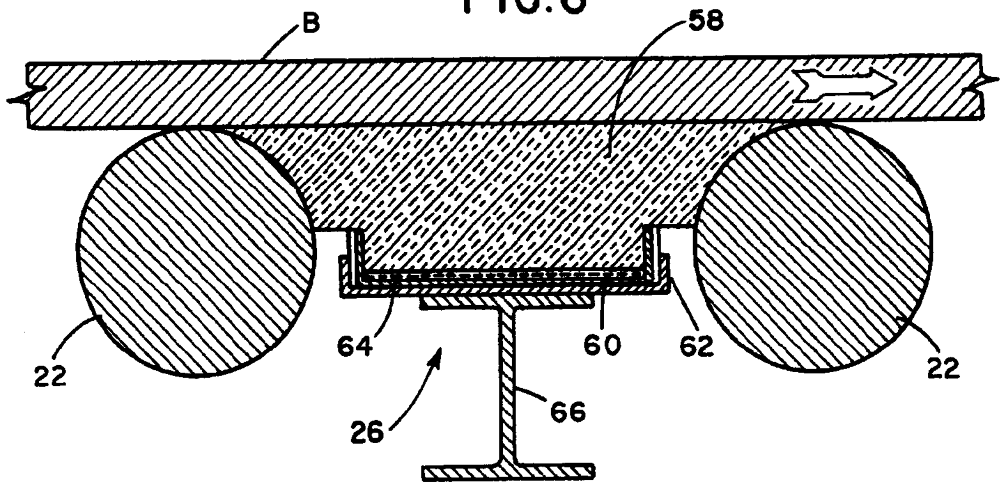

FIG.7

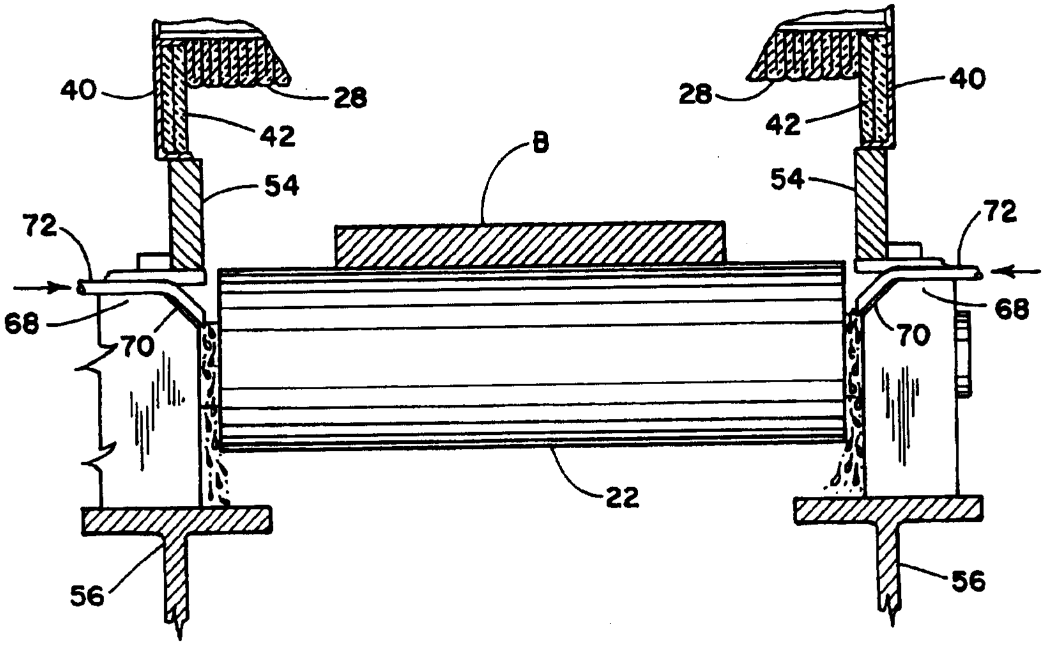

FIG.8

⑲ 日本国特許庁（JP）　⑪ 特許出願公開

⑫ 公開特許公報（A）　昭61－60829

⑤Int.Cl.⁴	識別記号	庁内整理番号	㊸公開 昭和61年(1986) 3月28日
C 21 D 9/52	101	7371－4K	
9/68		7371－4K	
// C 21 D 1/26		7730－4K	審査請求 未請求 発明の数 1 （全5頁）

㊹発明の名称　コイル焼鈍方法

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㉒出　願　昭59(1984) 9月3日

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明　細　書

1. 発明の名称

コイル焼鈍方法

2. 特許請求の範囲

複数のホットコイルを、各コイルの穴の中心線が同一の垂直面内にあり、かつ各コイルの端面が相互に近接するように、水平配置することによつて各隣接コイルが急速に冷却することを相互に防止するようにすると共に、コイル搬送機器の一部を含む、複数コイルの周囲を保温カバーでおおうことにより、コイル自身のもつ自己保有熱によつてコイルの焼鈍を行なうことを特徴とするコイル焼鈍方法。

3. 発明の詳細な説明

〔産業上の利用分野〕

本発明はコイル焼鈍方法に関し、特に熱間帯鋼圧延ラインにおけるホットコイルの自己焼鈍方法に関する。本発明の方法は、上記以外の一般のコイル搬送設備等に有利に応用することができる。

〔従来の技術〕

従来、熱間帯鋼圧延ラインにおいて、コイル状に巻取りされたホットコイル（熱間圧延したままのコイルを、コイルの温度とは無関係にこのように呼ぶ）のうち、その材質上、そのまま冷間圧延するには硬度が高過ぎて冷間圧延不能であつたり、又そのままで冷間圧延が可能であつたとしても、冷間圧延後に必要とする材質特性（じん性、深絞り特性等）が得られなかつたりするものは、一般に冷間圧延される前にコイル焼鈍炉によつて焼鈍されていた。焼鈍されるホットコイルは、従来、熱間圧延ラインよりコイル搬送ラインおよびコイルストックヤード、コイル酸洗ヤードを経由してコイル焼鈍炉に装入される為に、コイル自身の温度低下が大きく、従つてコイル焼鈍炉内において多大の燃料を消費してコイルの焼鈍が行なわれていた。

この欠点を除く目的で、熱間帯鋼圧延ラインにおいてコイルを高温状態で巻取ることによつて、コイル自身の持つ自己保有熱により、コイ

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ルを焼鈍する、いわゆる自己焼鈍の方法がすでに公知である（特許第246065号、特許第493331号等）。

〔発明が解決しようとする問題点〕

しかしながら、コイルの焼鈍を行なう為には、たとえ高温状態で巻取りを行なつたコイルにおいても、ある必要温度以上の温度をある必要時間（必要温度及び必要時間共にコイルの材質毎に異なる）、保持しておくことが必要であり、上記の公知技術に従つて高温状態で巻取りを行なつたコイルであつても自然放冷状態に放置したのでは、コイルの内、外周近傍およびエッジ近傍およびエッジ近傍共に急速に冷却してしまう為に、コイルを歩留り良く自己焼鈍することはできなかつた。

前記の高温状態で巻取りを行なつたコイルの必要温度を必要時間、保持する為の具体的かつ効率的な方法は未だ提案されておらず、従つてコイルを歩留り良く焼鈍する為には、依然としてコイル焼鈍炉によつて焼鈍を行なう工程、を省くことはできなかつた。

本発明は以上詳述した従来法の欠点を解消し、高温状態にて巻取つたコイルの自己保有熱を利用して、必要温度・必要時間保持しうるに加え歩留りの良いコイルの自己焼鈍方法を提供することを目的とする。

〔問題点を解決するための手段〕

本発明は、複数のホットコイルを、各コイルの穴の中心線が同一の垂直面内にあり、かつ各コイルの端面が相互に近接するように、水平配置することによつて各隣接コイルが急速に冷却することを相互に防止するようにすると共に、コイル搬送機器の一部を含む、複数コイルの周囲を保温カバーでおおうことにより、コイル自身のもつ自己保有熱によつてコイルの焼鈍を行なうことを特徴とするコイル焼鈍方法により、上記の目的を達成するものである。

そして、コイルの保温を行うには、コイラ出口のコイルが配置されている搬送器の外周部に、保温カバーを設けることによる。

本発明のコイル焼鈍方法は、熱間圧延ラインにおいて高温状態で巻取られたホットコイルを順次近接配置して保温カバーにより保温しつつ搬送することによつて、1個のコイル単独では長時間、保持しておくことが不可能なコイル温度を保持できるので、自己焼鈍が可能である。特に、自然放冷状態でもつとも冷却しやすいコイル部位であるエッジ部（コイル両端面）が、その両端面共に、相互にコイルを近接配置することによつて、急速に冷却することを、防止できる。尚、従来より、コイラ出側においてコイルを横置き状態でその穴中心が同一直線上にあるようにしてコイルを搬送する（コイル横置き縦搬送）方法、およびその装置は公知（ウオーキングビームおよびアイホリゾンタルコンベヤ等）であるが、仕様最大寸法のコイルが相互に干渉しないように、コイル間隔は可能な限り大きくとるようにコイル配置点が設定されている。

すなわち、コイルの配置点は、そのコイル巾方向（搬送方向）中心点が予め定められた一定位置（通常2400㎜より大で3000～3500㎜程度）に置かれるように設定されていた。従つて、コイル間隔は、コイル幅が大のものでは小さく例えば1000㎜程度であり、またコイル幅が小のものでは大きくなり、例えば2500㎜程度といつた具合に、コイル幅により変動していた。

そして従来のコイル搬送方法においては、一定のコイル搬送距離を効率的に（小さな力で速やかに）コイル搬送することがその主目的であり、従つて、コイルの配置ピッチはコイルの巻取り時間ピッチと、コイル搬送速度とのバランス及び特定の搬送中のコイルをワイヤとクレーンを使用して、抜取る時の作業性を考慮して、定められていた。すなわち、コイラによるコイル巻取ピッチを乱さないために、コイラ出側のコイル搬送は、可能な限り早急にコイルを払い出して、後方のラインへ送るように機能することが必要であつた。

従つて、従来のコイル搬送方式におけるコイ

ル間隔は500mm以上、通常1000～3000mm程度であつた。

これに対して本発明の方法は、コイルの巻取ピッチを乱さない範囲で、コイルを可能な限り長時間、コイラ出側のコイル搬送設備上に滞留させておくことを特徴とするものである。

このために、本発明の方法では、コイル横置き縦搬送において、搬送方向における前置コイルの後部端面を基準としてコイル間隔が一定値になるように後置コイルを配置する。すなわちコイル幅の大小に拘わらず、コイル間隔が一定値となるようにコイル配置する。

本発明の方法におけるコイル間隔は、コイルの保温の為の理論性能上は0mm（前置コイルと後置コイルが接触した状態）が望ましいが、コイル端面傷発生の防止の観点より300mm以下、好ましくは50～300mmとする。

このようにコイル間隔を一定値に設定する具体的方法としては、例えばコイル搬送台車上に、コイル端面検出器（例えばフォトセル等）を搬送方向に対し所期のコイル間隔に2個セットしておき、後方に位置する第2のコイル端面検出器にて後置コイルの前方端面を検知した位置で該後置コイルを受取り、次に搬送台車を前進させて、前方に位置する第1のコイル端面検出器が前置コイルの後端面を検知した位置で停止させ、後置コイルを置くと、両者のコイル間隔は所期の値となる。

さらに本発明方法におけるホットコイルの保温については、コイルの出側でコイルの搬送機器の近傍に、コイル保温カバーを設置することにより行い、従来このような保温カバーの設置は行われていなかつたものである。

以下図面により本発明を具体的に示す。

第1図および第2図は本発明の一実施態様を説明する図である。第1図は複数のコイル1（$1_1, 1_2 \cdots 1_4$）を、コイルの穴2の中心線X－Xが同一方向を向き、かつ互に近接して配置された状態を示しており図中aはコイル外周近傍エッジ部を、またbはコイル内周近傍エッジ部を示す。

第2図において、次段階にコイル1（$1_1, 1_2, \cdots 1_n$）を搬送するコイルスキッド3を配設したコイル搬送装置4上に、コイルの巻取軸5、クレイドルロール6および走行用シリンダ7を有し、走行レール8上を走行するコイルストリップカー9上に巻取られた高温のコイルが、順次（$1_1, 1_2 \cdots 1_n$）、コイル穴2の中心線X－Xが同一線上となるように近接配置されており、該複数個のコイル（$1_1 \cdots 1_n$）を覆うが如くに、保温カバー10が配置されている。なお11はコイラを示す。

このような本発明の方法を適用できる搬送装置としては、例えばウォーキングビーム式コイル搬送装置、アイホリゾンタル式コイルコンベア装置、固定スキッド付コイルカ等がある。

保温カバーは耐熱性を有し、断熱効果の大きい材質のものであればいずれのもので作成してもよい。又保温カバーは保温ボックス等の形をとるものでもよい。

本発明の方法は第1図および第2図に示すとおり、熱間圧延コイラ11によつて巻取られた直後の高温巻取コイル$1_1 \cdots 1_n$を横置き状態にてその両端面を極く近接させた状態で（又は互に接触させた状態で）コイラ出側に滞留させると共に、コイルの周囲を保温カバーで覆うことにより、コイルの急速冷却を防止し、コイル自身のもつ自己保有熱により、コイルの焼鈍を行うことができる。

〔作用〕

第3図に、コイルエッジ部の温度の経時変化を、従来のコイル焼鈍方法による場合と、本発明方法による場合とを比較して示す。第3図において、縦軸はコイル温度を、又横軸は経過時間を示し、その原点(0)はコイラ11の巻取軸5よりコイルストリップカー9によつてコイル1_nが抜取られた直後の時点を示す。この時点においてコイル外周近傍エッジ部aはストリップの巻取温度に近い高温Xを保持しているが、コイル内周近傍エッジ部bは低温体である巻取

軸5によつて冷却されると共に、コイル巻取中にコイル端面（エッジ面）から冷却される度合が、コイル外周近傍部aよりは大である為、ストリップの巻取温度（通常500～900℃）よりはかなり低い温度（通常300～500℃）となる。コイルの自己焼鈍を行なう為に必要なコイルの温度レベルYに対して従来のコイル搬送方法におけるコイル外周近傍エッジ部の温度変化(A')と内周近傍エッジ部の温度変化(B')を、又本発明方法を使用した場合の外周近傍エッジ部温度変化(A)、および内周近傍エッジ部の温度変化(B)を第3図グラフに示す。

又第3図において、コイル外周近傍エッジ部aはコイラ11の巻取軸5より抜取られた直後（0の時点）より自然放冷する為に、抜取直後の温度Xより、時間を経るに従つて冷却してゆくが、時間Fの時点において複数のコイルが相互に近接配置されるか否かによつて、自己焼鈍の為の必要温度以上の温度を保持している時間（即ちコイルが相互に近接配置されない従来のコイル搬送方法の場合の時間；$\overline{OH}$ に対して相互に近接配置された場合の時間；$\overline{OJ}$ ）が異なり、時間；$\overline{OH}$ はコイルの自己焼鈍を行なう為の温度保持時間としては短かすぎ又、時間；$\overline{OJ}$ は充分長いという特性がある。

更に、コイル内周近傍エッジ部；bは、巻取軸5より抜取られた直後よりコイル内部の熱によつて復熱すると共に自然放冷する為に従来のコイル焼鈍方法の場合の温度の経時変化が(B')のようになるに比べ本発明方法による場合の温度の経時変化は(B)のようになる。コイル内周近傍エッジ部bにおいても、従来法(B')の温度変化では必要なコイル焼鈍温度Yに復熱するに至らないが、本発明の方法によれば、温度Y以上に復熱すると共にその温度保持時間 $\overline{GI}$ を自己焼鈍の必要温度保持時間以上に確保することができる。更にコイルの周囲を保温カバーで覆うことにより、コイル外周近傍の急速冷却を防止することができるため、コイルの全部位の急速冷却が防止できる。

例

本発明の方法においてコイル焼鈍に必要な、焼鈍必要温度T℃と、温度保持時間t分の間には、下記(1)式

$T = T_0 - C \cdot \ell_n t$ ℃ ……(1)

の関係がある。ここで T_0℃：材料毎に異なる温度定数

C ：一定数である。

例えば鋼種Mにおいて

外周近傍エッジ部の温度保持時間 t_A（第3図の $\overline{OJ}$ に相当）は、

T_0（第3図のY点温度に相当）が770℃の場合

t_A ＝ 5分間

また T_0 が750℃の場合

t_A ＝ 10分間　であつた。

内周近傍エッジ部の温度保持時間 t_B（第3図の $\overline{GI}$ に相当）は、

T_0 が770℃の場合

t_B ＝ 5分間

T_0 が750℃の場合

t_B ＝ 10分間　であつた。

ここで、第3図においては便宜上同一座標上にA，A'、BおよびB'の各曲線を表したが、これらは別々の座標上に記載されていてもよいので、t_A と t_B の大小関係は第3図により規定されるものではない。

〔発明の効果〕

本発明方法は、熱間帯鋼圧延後高温で巻取られたコイルが、コイル自身の保有する熱による自己焼鈍のために必要な温度にて、必要な時間、保持できるので、歩留りの良いコイルの自己焼鈍を実現できるに加え、従来法では依然として必要であつたコイル焼鈍炉を省けるため工程上エネルギー上さらに設備投資上、経済性の高い、有利な方法である。

4. 図面の簡単な説明

第1図は本発明方法において、コイルが同一軸上に、近接配置された状態を説明する図、

第2図は本発明の実施態様を説明する図、

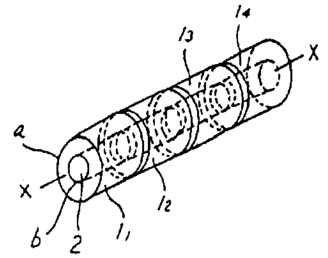
第3図は本発明方法および従来法による場合

の、それぞれの、コイル外周近傍エッジ部とコイル内周近傍エッジ部の温度の経時変化を示すグラフである。

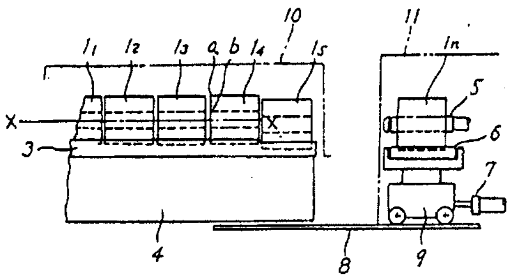
復代理人 内田 明

復代理人 萩原 亮一

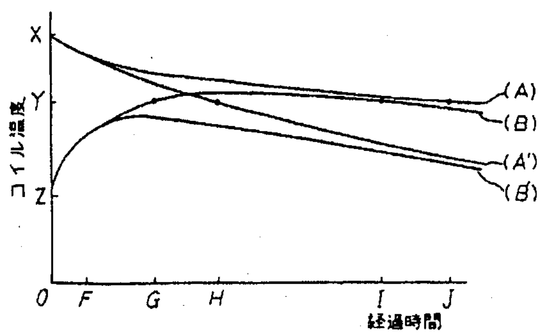
第1図



第2図



第3図



PATENT ABSTRACTS OF JAPAN

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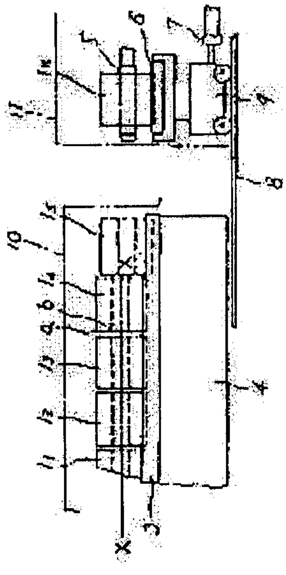
(72)Inventor : **OGI TAKEHIKO**

(54) COIL ANNEALING METHOD

(57)Abstract:
PURPOSE: To make a coil annealing furnace unnecessary by holding a coil wound at a high temperature after a hot band steel rolling, at a temperature required for self-annealing by heat held by the coil itself, for a necessary time.
CONSTITUTION: On a coil carrying device 4 provided with a coil skid 3 for carrying coils 11, 12W,1n to the next step, the coils 11, 12W,1n of a high tempera ture wound onto a coil strip car 9 having a winding shaft 5 of the coil, a cradle roll 6 and a running cylinder 7, and running on a running rail 8 are placed adjacently and successively so that the center line X-X becomes on the same line. A heat retaining cover 10 is placed so as to cover said coils. Therefore, the coils 11, 12W, 1n are annealed by self-retained heat held by the coil itself.



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(54) Title of the Invention Coil annealing method

(21) Application Filing No. S59-182770

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Specification

1. Title of the Invention

Coil annealing method

2. Claims

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 themselves have 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.

3. Detailed Explanation of the Invention

(Industrial Field of Application)

The present invention relates to a coil annealing method, and more particularly to a self-annealing method of a hot coil in a hot strip steel rolling line. The method of the present invention can be advantageously applied to general coil carrying equipment and the like other than the above-mentioned.

(Prior Art)

Formerly, in a hot strip steel rolling line, among hot coils (a coil hot rolled and left unchanged is referred to in this way without regard to the temperature of the coil) rolled up in a coil shape, those for which, in terms of the material thereof, the hardness is too hard for cold rolling as it is and cold rolling is impossible, or, even if cold rolling were possible as it is, after cold rolling, the material characteristics regarded as necessary (toughness, deep drawing characteristics and the like) are not obtained, generally, were annealed by means of a coil annealing furnace prior to cold rolling. Because an annealed hot coil, formerly, was charged to the coil annealing furnace by way of the coil carrying line from the hot rolling line, the coil stack yard, and the coil acid cleaning yard, the lowering of the temperature of the coil itself was great, consequently, in the coil annealing furnace, the annealing of the coil was carried out consuming a large amount of fuel.

For the purpose of eliminating this weak point, the so-called self-annealing method that anneals a coil by means of the self-possessed heat a coil itself has by means of rolling up a coil in a high temperature state in the hot strip steel rolling line is already well-known (patent number 246065, patent number 493331, and the like).

(Problems that the Invention is to Solve)

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)

$$T = T_0 - c \bullet l_n t \ ^\circ C \qquad (1)$$

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.

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SEP 06 2006

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Aktenzeichen/File No./No. du Dossier
RS 114155 GB

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Das Europäische Patentamt übermittelt hiermit den Standardrecherchenbericht zu dem unten bezeichneten Antrag; Kopien der im Recherchenbericht angeführten Schriften werden in der Anlage beigefügt.

The European Patent Office herewith transmits the Standard Search Report relating to the request indicated below; copies of the documents cited in the search report are enclosed.

L'Office Européen des Brevets à l'honneur de vous transmettre ci-joint le Rapport de Recherche concernant la demande désignée ci-dessous; des copies des documents cités sont jointes.

Zeichen und Datum des Antrages Applicant's reference and date Références et date de la demande	201141.00196
Dokument, Gegenstand der Recherche Document subject of the search Objet de la recherche	USA 27919206
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Beanspruchte Priorität Priority claimed Priorité revendiquée	

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S. Butler

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A07808

European Patent Office

STANDARD SEARCH REPORT

File
RS 114155
US 27919206

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	US 6 346 214 B1 (KNUDSEN ARNE-NILS ET AL) 12 February 2002 (2002-02-12) * the whole document * -----	1,8
A	US 6 358 337 B1 (ESTEBAN SANZ LUIS VIDAL ET AL) 19 March 2002 (2002-03-19) * column 1, line 66 - column 2, line 4 * -----	3-6, 12-15
A	US 5 788 483 A (DRIGANI ET AL) 4 August 1998 (1998-08-04) * figure 1 * -----	1,2,8,9
A	US 4 527 409 A (OUWERKERK ET AL) 9 July 1985 (1985-07-09) * figure 1 * -----	1,8
A	US 4 463 585 A (LAWS ET AL) 7 August 1984 (1984-08-07) * figures 6,7 * -----	1,8
A	EP 0 468 716 A (ALLEGHENY LUDLUM CORPORATION) 29 January 1992 (1992-01-29) * figure 2 * -----	1,8
A	PATENT ABSTRACTS OF JAPAN vol. 010, no. 226 (C-364), 7 August 1986 (1986-08-07) & JP 61 060829 A (MITSUBISHI HEAVY IND LTD), 28 March 1986 (1986-03-28) * the whole document * -----	1

TECHNICAL FIELDS SEARCHED (IPC)

C21D
F27B

The present search report has been drawn up for all claims

Date of completion of the search	Examiner
25 August 2006	Mollet, G

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C17)

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STANDARD SEARCH REPORT

File
RS 114155
US 27919206

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
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Date of completion of the search	Examiner
25 August 2006	Mollet, G

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