APPARATUS FOR HANDLING OPEN COILS OF STRIP METAL

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ABSTRACT OF THE DISCLOSURE

Apparatus for transferring and supporting open coils of strip metal especially in connection with the heat treat-
ing of a coil in an annealing furnace. The parallel lift bars of the coil transfer carriage and the coil supporting structure in the furnace plenum chamber have provision for supporting beneath the coil one or more support bars extending transversely of the lift bars. The support bars help support those arcuate portions of the coil con-
volutions which would otherwise be unsupported during charging and removal. The support bars are moved as a pallet along the with coil being transferred so that some means of support is provided for the coil in one or more zones extending transversely of the direction of travel of the coil into and out of the annealing furnace. An improved grid construction for supporting the coil above the furnace plenum chamber is also provided.

BACKGROUND OF THE INVENTION

This invention relates to the annealing or other heat treating of metal strip and more particularly to the trans-
fer of coils of the metal strip between a supply or storage location and an annealing furnace.

Coils of metal strip in either tight wound or open form are commonly annealed or otherwise subjected to treat-
ment requiring heating of the coils, by supporting a coil in a furnace chamber and repeatedly circulating around and over the exposed surfaces of a tight coil or through the convolutions of an open coil (an open coil having spaces between the laps or convolutions), heated atmos-
phere of the proper and desired composition. It will be understood hereinafter that the term "anneal" is used herein, it is used in a broad sense to include not only the technical annealing but also any other processing procedure which involves heating of the coils. Various types of furnaces may be employed to carry out the heating operation, for example, furnaces of the general type disclosed in the Lee Wilson and Paul R. Barenbok U.S. Patent No. 3,275,309.

According to more recent practice, a plurality of sep-
ate heating furnaces are utilized in such a manner that open coils of metal strip may be charged into and re-
moved therefrom by means of charging equipment which is readily adapted to an automated or programmed operation. Equipment adapted to this purpose is shown in the copending U.S. patent application Ser. No. 464,113 filed June 15, 1965, by Lee Wilson and John Arnold. The charging equipment includes a charging car having a transfer carriage mounted thereon with lift bars adapted to support an open coil of metal strip. The coils are transported on the charging car from a supply platform onto a supporting structure or bed within a furnace and subsequently, after the annealing or other heat treat-
ment is complete, back to an exit platform. The coil supporting lift bars of the transfer carriage extend parallel to one another and are inserted into parallel open slots or channels formed in the supply platform, for the pur-
pose of engaging the bottom of the coil and lifting it above the platform surface to facilitate removal. The lift bars must also be adapted for insertion into parallel open slots or channels formed in the coil supporting structure within the furnace.

Since the type of annealing furnace to which the present invention relates uses circulating atmosphere to effect the annealing, a plenum chamber is provided normally, below the coil supporting surface, to permit the atmosphere to pass uniformly through the open coil and be recirculated by suitable fans, etc. The supporting sur-
face is generally defined by a grid which permits heated air to pass therethrough to the plenum chamber below. The grid elements must be supported by structural mem-
bers which define both the parallel open slots or channels for the transfer carriage lift bars and the passages through the plenum chamber for the circulating atmosphere.

A related problem is that of providing support for each convolution of the open coils of metal strip at points suf-
ciently closely spaced. Otherwise unsupported arcuate spans of the coil convolutions may sag, twist or bend, etc, with resulting damage to the strip and interference with proper annealing. The problem of support is partic-
ularly critical while an open coil is being carried by the fingers of the transfer carriage.

Since the lift bars of the transfer carriage must be substantial and parallel and must be insertable into the open slots or channels formed in the supply and exit platforms and also into the open slots or channels formed in the supporting structure and grid of the plenum chamber of the furnace, prior to the present invention it has not been proposed to provide supporting members on the transfer carriage extending laterally or transversely of the lift bars. Accordingly, relatively long arcuate spans of the coil convolutions having their cords extending parallel to the fingers, frequently have had insufficient support. This is particularly true of those arcuate portions bisected by the radial centerline of the coil extending perpendicular to the direction of travel of the coil into and out of the fur-
nace.

The present invention substantially reduces the prob-
lems indicated above and affords other features and advantages not obtainable from the prior art.

SUMMARY OF THE INVENTION

It is among the objects of the invention to support the convolutions of a coil of metal strip being carried on the parallel lift bars of a transfer carriage, at locations where support cannot be provided by the lift bars them-
selves.

Another object of the invention is to support the con-
volutions of a coil of metal strip being heat treated in a circulating atmosphere type annealing furnace, at lo-
cations where support cannot be provided by the fixed elements of the coil supporting grid located above the fur-
nace plenum chamber.

Still another object of the invention is to support the arcuate portions of the convolutions of an open coil of metal strip in a zone or zones extending transversely of the direction of movement of the coil into and out of an annealing furnace.

A further object of the invention is to provide a grid con-
struction for supporting an open coil of metal strip above the plenum chamber of a circulating atmosphere type annealing furnace, which provides improved sup-
port for the coil within the limitations imposed by the re-
quirements of atmosphere circulation through the open coils, by the supporting structure of the grid within the plenum chamber, and by the necessity for providing access to the plenum chamber for the lift bars of a charging car.
According to a preferred form of the invention, the foregoing and other objects and advantages are accomplished by the combination of a charging car for handling coils of metal strip and an atmosphere circulating annealing furnace for heat treating the coils, both the charging car and the annealing furnace being adapted to hold one or more transverse coil support members. The charging car includes a coil transfer carriage having a plurality of spaced coil supporting lift bars adapted for movement in a direction parallel to the bars. The transverse coil support members are adapted to be removably carried by the lift bars in a transverse position relative to the lift bars and in supporting engagement with a coil carried by the transfer carriage. The lift bars are movable vertically between an upper coil supporting position with the transverse support members above the coil supporting surface in the furnace and a lower coil discharging position with the lift bars below the transverse support members are supported by structure within the furnace. The atmosphere circulating annealing furnace includes coil supporting grid elements located above the plenum chamber of the furnace and carried by a supporting structure located in the plenum chamber. The supporting structure defines parallel open channels for receiving the lift bars during charging and removal of coils and includes one or more transverse troughs for locating and supporting the transverse coil support members in a position transversely of the channels and below a coil located on the grid.

The transfer carriage is operable to transport a coil and the transverse support members on the lift bars into and out of the furnace. It is provided with a means for receiving the lift bars from the supporting structure. According to another aspect of the invention, the grid defined by the coil supporting elements is circular in form and comprises quadrants defined by a first radial grid centerline parallel to the channels in the plenum chamber and a second radial grid centerline perpendicular to the channels. The elements in each quadrant are parallel to one another and parallel to a radial line in the quadrant forming an angle of from about 20° to about 40° with the second radial centerline. Also, the elements in each quadrant are arranged in parallel rows, each row being located between two adjacent parallel channels.

Other objects, uses and advantages of the invention will appear from the following detailed description and drawings which illustrate one embodiment of the invention.

**Brief description of the drawings**

FIGURE 1 is an illustrative plan view showing a coil charging car carrying an open coil of metal strip and an annealing furnace (shown in horizontal section) having a grid for supporting an open coil to be annealed and rails for receiving the transfer carriage of the charging car;

FIGURE 2 is an elevational view showing the charging car of FIGURE 1 and the interior of an annealing furnace (shown in vertical section through the longitudinal centerline);

FIGURE 3 is an elevational view similar to FIGURE 1 showing an open coil positioned by the transfer car within the furnace chamber and still supported above the grid by the lift bars;

FIGURE 4 is an enlarged plan view with parts broken away and shown in section, of the coil supporting grid of the annealing furnace of FIGURE 1, showing the transverse support members located in the lateral channels in the furnace plenum;

FIGURE 5 is an enlarged sectional view taken on line 5—5 of FIGURE 4 showing an open coil located on the supporting grid above the furnace plenum chamber and the lift bars of the transfer carriage lowered to a position providing clearance for removal of the lift bars from the furnace plenum chamber;

FIGURE 6 is an enlarged sectional view taken on line 6—6 of FIGURE 4 showing the wheels of the transfer carriage supported on the rails within the plenum chamber of the annealing furnace;

FIGURE 7 is a perspective view showing the arrangement of the elements of the coil supporting grid in the annealing furnace; and

FIGURE 8 is a fragmentary plan view showing an alternate arrangement for the grid elements located adjacent the centerline extending from front to rear of the furnace.

**Description of the preferred embodiment**

Referring more particularly to the drawings, there is shown a charging car A which is adapted to receive and remove an open coil B of metal strip, positioned with its axis vertical, into and from the heating chamber of an annealing furnace C. This equipment is particularly adapted for use in connection with a double row, multi-furnace annealing line of the type shown in U.S. application Ser. No. 464,113 referred to above. The charging car A rides on main charging car tracks 10 which extend between two parallel rows of furnaces (not shown). The car A is adapted to lift coils from a supply platform, carry them to a position adjacent the particular furnace to be charged, and then transfer them into the heating chamber of the furnace. After the coil is annealed the charging car is used to remove it from the furnace and convey it to an exit platform preparatory to further processing.

The charging car A includes a main frame structure 11, an intermediate turntable carriage 12 having wheeled support on cross tracks 13 carried by the main frame structure 11, and an upper coil transfer carriage 14 having wheeled support on transfer tracks 15 on the turntable carriage 12.

The main frame structure 11 includes a rectangular platform having end members 16 and 17 extending parallel to the tracks 10 and transverse members 18 and 19. The end members 16 and 17 are of generally inverted channel form and each serves to pivotally support and house wheel carrying yoke members 20 and 21 on suitable pivots or trunnions 22 and 23. The yoke members 20 and 21 in turn each pivotally support pairs of wheel housings 24 and 25 at the opposite ends of the yoke. Each housing 24 and 25 carries on suitable bearings, a pair of wheels 26, a sufficient number of wheels being provided to spread the load of the charging car A and coil evenly over the tracks 10.

Mounted on the transverse members 18 and 19 are the turntable carriage tracks 13 which support the turntable carriage 12 for travel on the main frame structure 11 transversely of the path of movement of the charging car A as a unit on the tracks 10. Charging car drive motors 27 are carried by the main frame structure 11 and have driving connection with the wheels 26. The motors 27 are reversible and are effective to drive the charging car A in either direction on the tracks 10.

The turntable carriage 12 is carried on wheels 28 supported on the tracks 13 on the main frame 11. The carriage 12 includes a base portion comprising a pair of spaced wheel carrying channels 29 connected by a central box structure 30. The box structure 30 carries a turntable carriage drive motor 31 which has a drive pinion 32 mounted on its shaft in engagement with a transversely extending rack 33 which is supported on the transverse member 19 of the main frame structure 11.

Mounted on the top of the box structure 30 of the turntable carriage 12 is a rotatable turntable carrying a ring gear 34 on its outer periphery. The ring gear 34 is engaged by the pinion of a turntable drive motor (not shown) which in turn is mounted on the central box frame structure 30.

Secured to and supported on top of the turntable is a platform structure made up of six parallel transfer car track supporting beams 35, 36, 37, 38, 39 and 40 and
transverse interconnecting beams 41 and 42. The track supporting beams 35–40 are mounted on the beams 41 and 42 and, with the intermediate transverse carriage 12 in the charging or unloading position, extend in a direction normal to the direction of travel of the car A on the tracks 10 as shown in FIGURES 3 and 5. The ends of the track supporting beams 35–40 engage and are supported on blocks 43 mounted on an I-beam 44 formed as part of the furnace base structure. The blocks 43 have sloping surfaces which mate with sloping shoulders 45 formed in the beams 35–40.

The upper coil transfer carriage 14 comprises a wheeled frame made up of a transverse portion 50 and six parallel transfer fingers 51, 52, 53, 54, 55 and 56. Each of these fingers 51–56 supports a plurality of flanged wheels 57 which in turn are supported on the transfer tracks 15 of the turntable carriage 12. When the transfer carriage 14 is extended to deposit or pick up a coil the wheels 57 also engage and are supported on the rails 103–108 in the bottom of the annealing furnace plenum chamber as shown in FIGURES 3 and 5. Each of the fingers 51–56 of the transfer carriage 14 also supports a plurality of cam rollers 58 which are rotatably mounted between the wheels 57. The tops of the rollers 58 are disposed above the tops of the fingers 51–56 and are adapted to engage and support six coil lift bars 68, 61, 62, 63, 64 and 65. Each of the lift bars 60–65 has an upper coil engaging surface and is notched or serrated on its underside to provide a plurality of inclined cam faces 66 which are adapted to engage and coat with the cam rollers 58 in the lifting and lowering of the lift bars 60–65 as will be more fully explained below.

The lift bars 60–65 are connected together at their inner ends (left hand as seen in FIGURES 1–3) by an interconnecting plate structure 67 so that in effect the lift bars 60–65 and the plate structure 67 form an integral unitary fork structure supported on the cam rollers 58.

Mounted on the transverse base portion 50 of the wheeled frame structure of the transfer carriage 14 is a horizontal axis electric drive motor 68 which is connected through suitable gearing to drive a transverse shaft 69. Supported along the shaft 69 on the base portion 50 are a plurality of screw jack units 70. The screw jack units 70 have threaded screw members 71 which when the motor 68 is operated, are advanced or retracted relative to the base 50. At the ends of the screw units 71 there are rollers 72 which are disposed in vertical slots 73 formed in the inner end portions of the lift bars 60–65.

As the fork structure or lift bar assembly of the transfer carriage 14 is supported on the rollers or cam members 58 driving is free to move thereon relative to the wheelbase 50. At the ends of the screws 71 are rollers 72 which when the drive motor 68 is actuated to cause the screws 71 to move the rollers 72 to the left (as seen in FIGURES 2 and 3) relative to the base 60, movement will necessarily take place between the base 50 and the lift bars 60–65. As will be more fully described later in this movement will cause the lift bars 60–65 to be raised or lowered between upper coil supporting and lower coil discharging positions and will enable the coil B which is supported thereon to be positioned on or removed from the coil supporting grid of the annealing furnace C.

In order to effect movement of the coil transfer carriage 14 on the tracks 15 between the advanced or extended position seen in FIGURE 3 and the withdrawn or retracted position as seen in FIGURES 1 and 2, a drive motor 74 is mounted on the lift bar interconnecting plate 67 and connected through suitable gearing to drive a transverse shaft 75. The shaft 75 extends between boxes 71 and 77 from which vertical shafts 78 and 79 extend downwardly. The gear connections from the shaft 75 to the shafts 78 and 79 preferably are interchangeable so that the lift bars 60–65 cannot move longitudinally relative to the turntable carriage 12 except by operation of the motor 74. The shafts 78 and 79 carry pinions 80 and 81 which mesh with longitudinally extending racks 82 and 83 mounted on the supporting beams 35 and 40, respectively, of the turntable carriage 12. Accordingly, when the motor 74 is driven to rotate the pinions 80 and 81, the turntable carriage 14 will be moved on its supporting tracks 15 on the turntable carriage 12 between a fully extended position as shown in FIGURE 3 and a fully retracted position as seen in FIGURE 1.

As previously noted the transfer carriage 14 is illustrated in FIGURES 3 and 5 in its fully extended position. In order to return the carriage 14 to its retracted or centered position as seen in FIGURES 1 and 2, the drive motor 74 of the transfer carriage 14 is operated to drive the pinions 80 and 81 in a direction such that their engagement with the racks 82 and 83 on the turntable carriage 12 will cause the carriage 14 to move to the left. This movement is continued until the lift bars 60–65 are centered above the turntable. Subsequently to this movement of the transfer carriage 14 the turntable carriage 12 is moved to the left by operating the turntable carriage drive motor 31 in the direction such that the engagement of the pinion 52 with the rack 33 on the main frame structure 11 will cause the turntable carriage 12 to move the carriage 14 to move to the left. This movement is continued until the turntable carriage 12 and 14 of the charging car A will be in their centered positions and may be rotated by the turntable to service furnaces on the opposite side of tracks 10 and the car may be traversed on the tracks 10 to any of its several stations at coil supporting platforms or furnaces.

Formed in the lift bars 60–65 along a line perpendicular to the bars, and corresponding to a radial centerline of the coil B carried thereon, are upwardly open notches 85 which are adapted to receive two transverse support bars 86 with their upper surface substantially in the same horizontal plane with the upper surfaces of the lift bars 60–65 and in engagement with the bottom of the coil B to help support the spaced convolutions of the coil B while it is being carried on the lift bars. The transverse support bars 86 are not secured to the lift bars 60–65 but are adapted to be moved along with the coil B from its location on a supply platform and into and out of the annealing furnace C. The bars 86 remain in the annealing furnace below the coil during the annealing process and it will be understood that, if desired, additional transverse support bars may be carried by the lift bars 60–65 and parallel to the bars 86.

The annealing furnace C includes a heating chamber 90 provided with circulating atmosphere inlet opening 91 and a circulating atmosphere outlet opening 92. A blower 93 delivers atmosphere into the chamber 90 through the atmosphere inlet opening 91. Radiant heating tubes 94 or other suitable heating means are positioned at the top of the furnace chamber 90 and the circulating atmosphere which is delivered by blower 93 into the furnace chamber through the opening 91 is directed over the heating tubes 94 and is heated thereby. After passing through and over the coil B which is supported in the atmosphere passes into a plenum chamber 97 which is located below the grid 96 and connected to atmosphere outlet opening 92 whereby the atmosphere is returned to the blower 93 and recirculated.

A furnace door 98 is supported for vertical movement by vertical guide posts 99 having slots 100 formed therein which receive guide rollers 101 rotatably mounted on the sides of the door. As seen in FIGURES 1, 2 and 3 the door 98 is in its lifted or open position. When it is desired to lower the door it is lowered so that the rollers 101 guide the door 98 downwardly in the slots 100 and then inwardly at the lower end of the slots 100 until the door reaches a sealing position. It is essential that the door provide an air tight seal so that no ambient air can leak into the chamber of the furnace.

FIGURES 4–7 show in greater detail the structure with-
in the furnace for supporting the coil B of metal strip. The plenum chamber 96 is essential in order that the reduced pressure provided therein will cause the heated atmosphere to be drawn downwardly through the spaces between the convolutions of the coil and then be recirculated by the blower 93. Accordingly, the coil must be supported above the base plate 102 of the furnace chamber 90 both to permit space for the plenum chamber 97 to permit space for the movement of the transfer fingers 51-56 and lift bars 60-65 into and out of the furnace during the charging and unloading of a coil. The base plate 102 is best shown in FIGURES 4 and 5 and has mounted thereon six parallel rails 103, 104, 105, 106, 107 and 108 which support the wheels 57 of the transfer carriage 14 as the transfer fingers 51-56 move into and out of the furnace heating chamber 90.

Mounted on the base plate 102 between the rails 103-108 are upstanding corrugated grid support strips 109 which carry elongated plates 110 that in turn support the various elements of the coil supporting grid 95. The corrugated strips 109 are braced by vertical triangular plates 111 secured to the base plate 102 (see FIGURE 6). The corrugated grid support strips 109 are a center plate 112, a rearward circumferential plate 113 and arcuate segments 114, 115, 116 and 117 spaced around the perimeter of the grid 96 between the open spaces above the rails. The arcuate perimeter segments 114-117 define, with the rearward circumferential plate 113, a flat annular ring around the grid 96. The grid itself is defined by the various elements 118 as best shown in FIGURE 4. The elements 118 provide, with the corrugated support strips 109, open channels adapted to receive the parallel transfer fingers 51-56 of the transfer carriage 14 and also the lift bars 60-65 carried thereby. This permits the lift bars 60-65 to extend above the supporting surface defined by the grid 96 while the coil B is being moved into the furnace C and also when the coil is being removed.

Mounted in the corrugated grid support strips 109 along the centerline of the grid and extending perpendicular to the rails 103-108 are channel members 119 that are adapted to support the transverse support bars 86 when a coil is positioned on the grid 96. The support bars 86 extend as shown in FIGURE 4 from near the edge of the center plate 112 to the outer edge of the grid 96. It will be seen from FIGURES 1 and 4 that when a coil is carried on the lift bars 60-65 the transverse bars 86 serve to support those arcuate portions of the convolutions of the coil which have their cords extending parallel to the lift bars and which would otherwise have radial long circumferential portions un supported. This arrangement effectively prevents distortion or drooping of the strip during heating of the coil B while providing access for the coil transporting lift bars 60-65.

FIGURE 8 shows an alternate arrangement for the portion of the grid adjacent the grid centerline that extends from front to rear of the furnace. The elements 120 of the rows located adjacent the centerline and on opposite sides thereof extend across the centerline and into the opposite row. Also the rows with the elements 120 are staggered as shown to permit the interlocking of the inward ends of the elements 120 on opposite sides of the centerline. This arrangement provides improved support for the coil B and is preferable for some applications.

**Operation**

In the operation of the embodiment of the invention shown an open coil B of metal strip, located with its axis vertical on a supply platform (not shown but generally as illustrated in copending U.S. patent application Ser. No. 464,113) with the transverse support bars 86 in the supporting position in transverse slots below the bottom of the coil, is selected for annealing in a particular furnace. The transfer carriage 14 of the charging car A is then operated to move the transfer fingers 51-56 and lift bars 60-65 thereof through open channels in the supply platform to a position beneath the coil B. The lift bars 60-65 are then operated to lift both the coil B and the transverse support bars 86 (positioned in the notches 85) above the surface of the platform and the transfer carriage 14 is then operated to transfer the coil B from the platform to a centered position on the turntable carriage 12 of the charging car A. The charging car A is then propelled along the tracks 10 to carry the coil B to a position adjacent the selected annealing furnace A which has its door 98 in the open position (FIGURE 2). Where the annealing furnace is located on the opposite side of the tracks 10 from the supply platform the turntable carriage 12 may be operated to turn the transfer carriage 14 through 180° to a position for movement in the opposite direction.

The turntable carriage 12 is then moved laterally on the rails 13 so as to position shoulders 45 of the transfer car supporting beams 35-40 on the blocks 43 and the rails 15 for the wheels 57 of the transfer fingers 51-56. The transfer car is moved in close proximity to the corresponding rails 103-108 mounted on the base plate 102 of the furnace C. The drive motor 74 for the transfer carriage 14 is next operated to move the transfer fingers 51-56 and the coil lift bars 60-65 into the furnace plenum chamber 97 with the wheels 57 rolling onto the rails 103-108. During this movement the transfer carriage 14 of the coil B is supported on the lift bars 60-65 and the transverse support bars 86, and the bottom of the coil is held above the top surface of grid 96. Once the coil is in position over the grid 96 and the lateral support bars are positioned above the channel members 119, the motor 68 is operated to move the transfer fingers 51-56 forward relative to the coil lift bars 60-65 so that the cam faces 66 will ride downward on the cam rollers 58 to lower the lift bars 60-65 vertically to the position shown in FIGURE 5. In this position the coil supporting surfaces of the lift bars 60-65 are below the transverse support bars 86 which are deposited in the channel members 119.

The transfer carriage 14 is then operated to withdraw the transfer fingers 51-56 and the coil lift bars 60-65 from the furnace plenum chamber 97. Once the transfer carriage 14 has been completely removed the furnace door 98 is closed and sealed and the annealing operation in the furnace is commenced. When the annealing is complete the coil B of metal strip is permitted to cool to a predetermined degree before ambient air is permitted to enter the furnace chamber. In order to cool the metal more quickly a unit containing cooling coils may be retractedly positioned in the path of travel of the atmosphere from the furnace blower so that once the heating tubes 94 are turned off the cooling unit can be used to cool the circulating atmosphere. This provides for faster dissipation of the heat in the coil.
When the coil reaches a sufficiently reduced temperature the furnace door 98 is opened and the charging car A is again positioned adjacent the furnace C and the turntable carriage 12 is moved laterally so that the rails 15 are in close proximity to the rails 103-105 mounted on the furnace base plate 102. The turntable carriage is then moved to the right momentarily to move the transfer fingers 51-56 and the coil lift bars 60-65, which are in their lowermost position as shown in FIGURE 5, into the furnace plenum chamber 97. The drive motor 69 is then operated to move the lift bars 60-65 upward into engagement with the transverse support bars 86 and the bottom surface of the coil B. Additional vertical movement of the lift bars carries the coil and the lift bars 86 upward to a position above the surface of the coil supporting grid 96 (FIGURE 3). The turntable carriage drive motor 74 is then operated to move the turntable carriage 14 and the coil B and support bars 86 out of the furnace and onto the turntable carriage 12. The turntable carriage drive motor 31 (FIGURE 1) is then operated to center the turntable on the charging car A and the charging car may be propelled along the rails 10 to transport the annealed coil B to a new position such as an exit platform for a coiling station where the open coil may be rewound into a tight coil.

Although only one embodiment of the invention is illustrated and described it will be understood that variations in the manipulations may be made in the form and arrangement of the several parts or elements thereof without departing from the spirit of the invention. The invention therefore is not to be limited to the particular structures and mechanisms herein shown and described nor in any manner inconsistent with the extent to which the progress in this art has been advanced by the invention.

We claim:

1. Apparatus for charging, supporting and removing coiled strip metal, in and from a furnace including a charging car comprising a coil turntable carriage having a plurality of spaced coil supporting lift bars, said carriage being supported for movement in a direction parallel to said bars, a transverse coil supporting member adapted to be removed after passing through the intermediate ends of said bars transversely thereof and in supporting engagement with a coil carried by said turntable carriage, means for lifting and lowering said lift bars and said transverse supporting member between upper coil supporting and lower coil discharging positions, an atmosphere circulating furnace for heating coils of strip metal including coil supporting elements, means defining a plenum chamber below said elements, element supporting structure defining with said elements parallel open-top channels for receiving said lift bars during charging and removal of coils into and from said furnace, and trough means in said supporting structure for removably locating and supporting said transverse coil supporting member in a position transversely of said channels below a coil supported on said elements, said charging car being operable to transport a coil and said transverse coil supporting member on said lift bars into said furnace over said elements, lower said coil onto said elements and said lift bars below said elements, deposit said transverse coil supporting member in said trough means, and then withdraw said lift bars from said channels.

2. Apparatus as defined in claim 1 including a plurality of said transverse coil supporting members located transversely of said lift bars.

3. Apparatus as defined in claim 1 wherein said lift bars are provided with upwardly open notches located in a line extending transversely of said lift bars, said notches being adapted to receive said transverse support member and locate said member in supporting engagement with a coil being carried on said lift bars, the vertical travel of said lift bars being sufficient to support said transverse members above said coil supporting elements of said furnace when said lift bars are in their upper coil supporting position and to lower said lift bars below said transverse coil supporting member supported in said trough means when said lift bars are in their lower coil discharging position.

4. In combination, a coil charging car having a plurality of vertically movable coil transporting lift bars, and means for lifting and lowering said bars, a furnace for heating open coils of strip metal having coil supporting elements defining a grid, means defining a plenum chamber below said elements, structure in said plenum defining parallel open-top channels in said grid adapted to provide for entry and exit of said parallel coil transporting lift bars, and a transverse coil supporting member adapted to be carried into and out of said furnace by said lift bars while in supporting engagement with an open coil carried by said lift bars, said plenum having a groove in its upper surface extending transversely of said channels and adapted to receive and support said transverse member, said lift bar lifting and lowering means being adapted to lower said bars to a position below said groove and below said transverse member when supported therein whereby said lift bars may be longitudinally withdrawn from said channels.

5. A furnace as defined in claim 4 wherein said structure in said plenum chamber includes parallel elongated element supporting plates, at least two plates being located longitudinally between adjacent channels and where-in said grid defined by said coil supporting elements is generally circular and comprises quadrants defined by a first grid centerline parallel to said plates and a second grid centerline perpendicular to said plates, the elements in each quadrant being parallel to one another and to a radial line in said quadrant forming an angle of from 20 to 40 degrees with said second centerline and arranged in parallel rows, each row being supported by the plates between two adjacent channels.

6. In a furnace for heat treating open coils of metal strip including means defining a plenum located below a coil positioned in said furnace for treatment, structure in said plenum defining parallel, open-top channels and supporting plates mounted on said structure, at least two of said plates extending longitudinally of and between adjacent channels, the improvement which comprises coil supporting elements defining a generally circular grid having quadrants defined by a first grid centerline and a second grid centerline perpendicular to said first grid centerline, each quadrant having elements parallel to one another and to a radial line in said quadrant oblique to said centerlines.

7. Apparatus as defined in claim 6 wherein said radial line subtends an angle of from about 20° to 40° with said second grid centerline.

8. Apparatus as defined in claim 6 wherein the elements of each quadrant are arranged in parallel rows, each row being supported by the plates between two adjacent channels.

9. Apparatus as defined in claim 8 wherein the elements of the adjacent rows located on opposite sides of the grid centerline extending parallel to said channels, extend across said centerline, whereby the ends of the elements on opposite sides of said centerline are interlaced with respect to one another.

10. Apparatus as defined in claim 6 including means defined by said structure for removably supporting and locating at least one support transversely of said channels and below the supporting surface defined by said grid.

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