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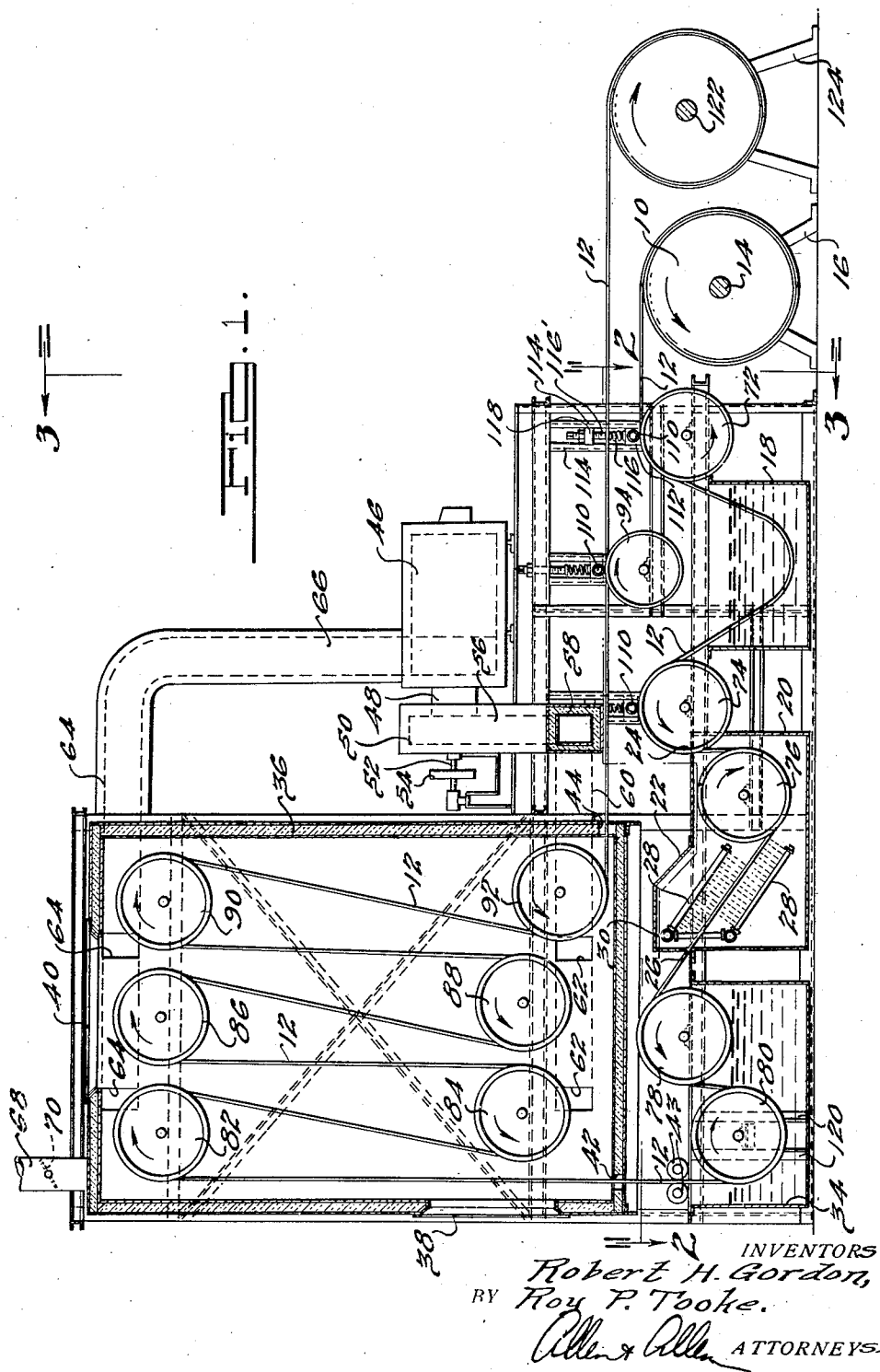
R. H. GORDON ET AL

2,311,616

APPARATUS FOR TREATING METAL STRIPS

Filed Feb. 15, 1940

3 Sheets-Sheet 1



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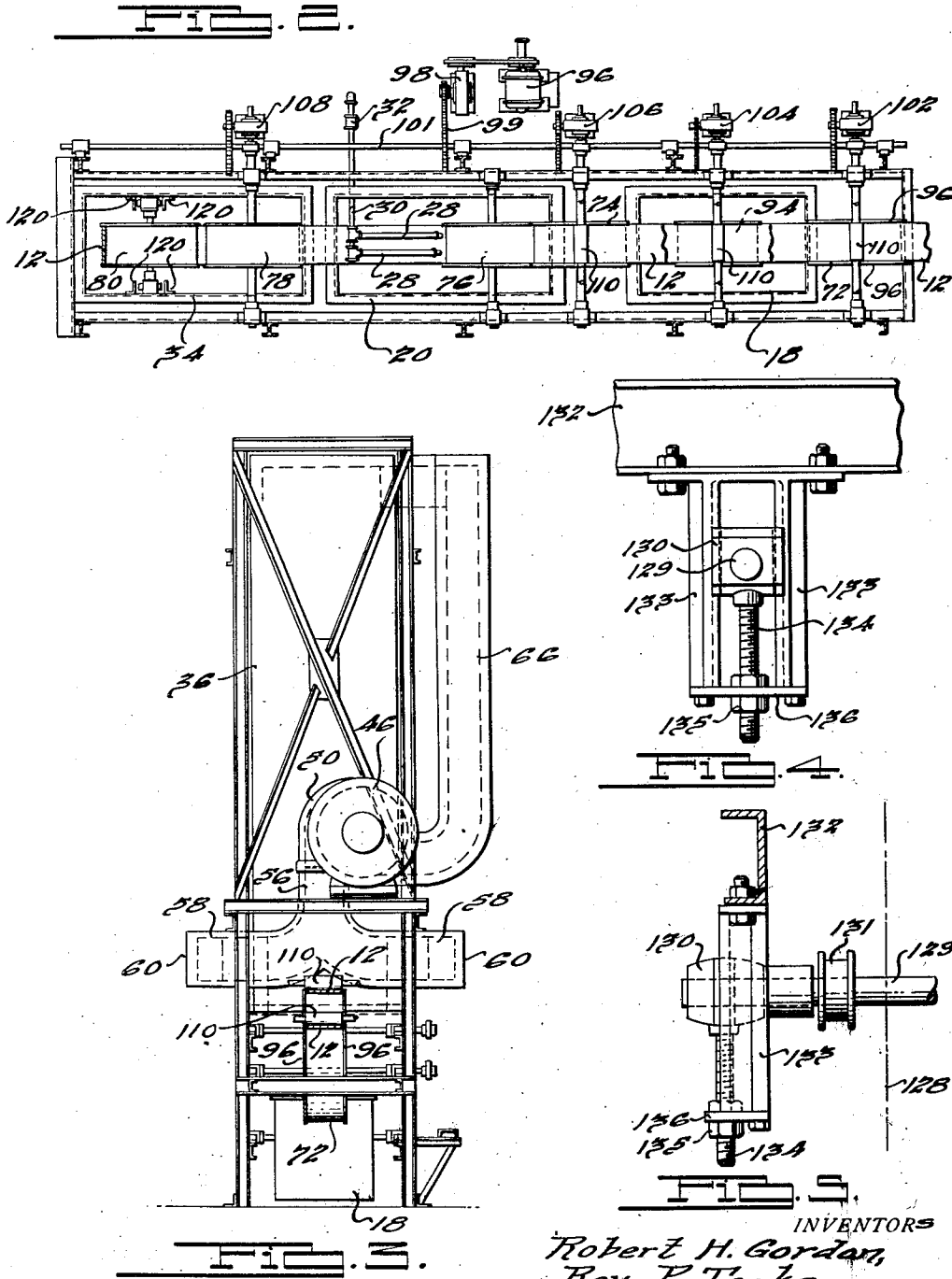
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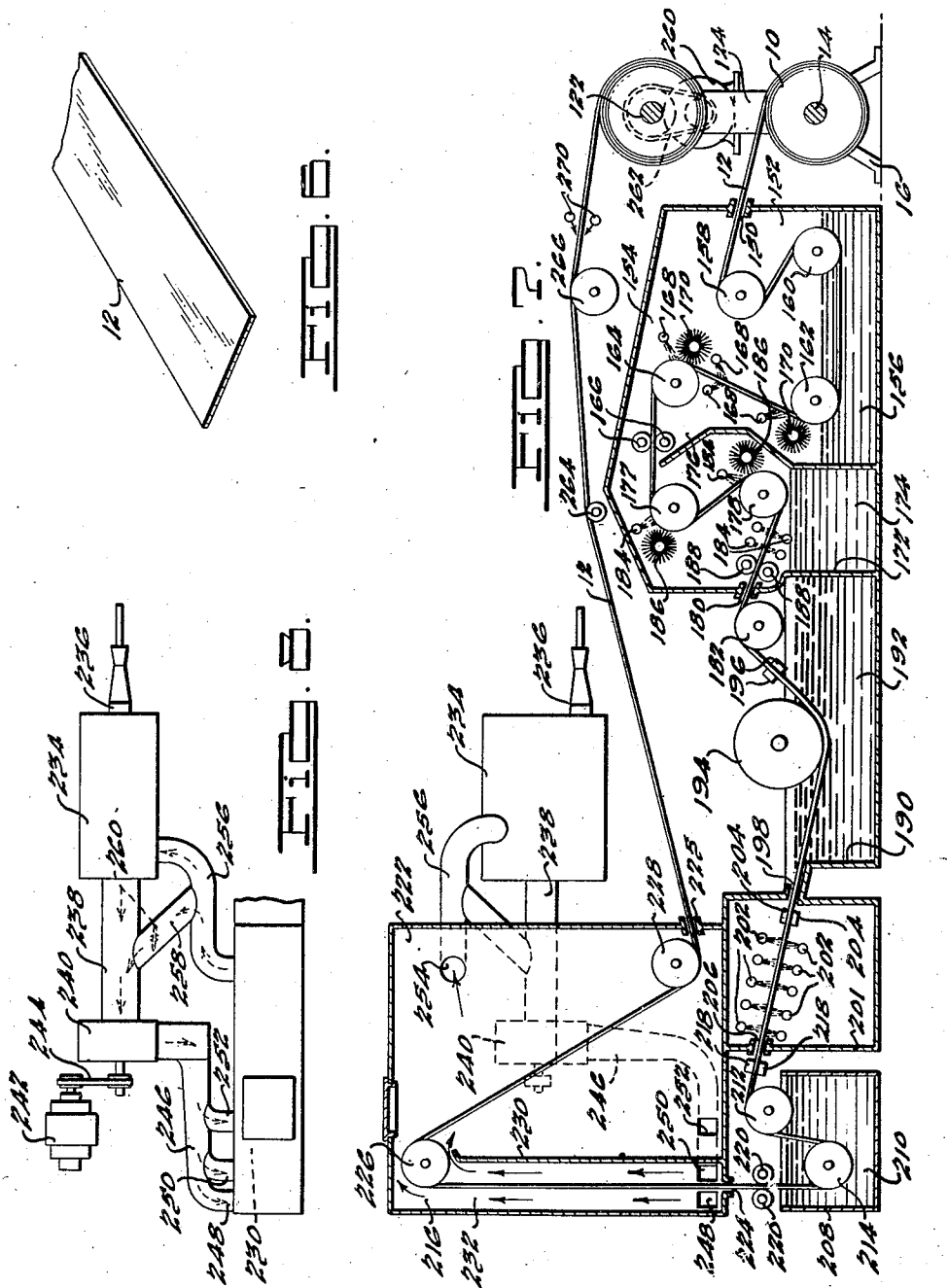
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APPARATUS FOR TREATING METAL STRIPS

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3 Sheets-Sheet 3



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2,311,616

APPARATUS FOR TREATING METAL STRIPS

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Application February 15, 1940, Serial No. 319,114

4 Claims. (Cl. 266—3)

The present invention relates to improved apparatus for processing strip steel, and particularly relates to improved apparatus for applying rust-proofing solution to such strip steel.

It has been the practice in strip steel mills to store the strips in the form of coils outside of the mills where such coils are exposed to the elements with the result that they become rusted.

One of the primary objects of the present invention is to treat the surface of strip steel so that it may be stored outside in coils and will not rust when exposed to the elements.

Another object of the invention is to provide an apparatus by which strip steel may be continuously cleaned and thereafter treated to produce coatings on the surfaces thereof to render such surfaces rust-proof.

Another object is to provide an improved drying oven whereby the strip steel may be efficiently subjected to heat after the rust-proofing solution has been applied thereto in order to quickly dry the same.

Another object of the invention is to provide an improved arrangement of a cleaning bath, a rinse, a bath of rust-proofing solutions, a drying oven and means for continuously carrying a strip of steel through these elements so that the surfaces of the strip may be rapidly and economically rust-proofed.

Another object of the invention is to provide an improved arrangement of a cleaning bath, a rinse, a pretreating or flash bath, a rinse, a bath of rust-proofing solution, a drying oven and means for continuously carrying a strip of steel through these elements so that the surfaces of the strip may be rapidly and economically rust-proofed.

Another object of the invention is to provide a machine for carrying out a coating process of the nature above discussed, in which the successive operations are carried out upon the strip automatically and continuously without the intervention of human hands.

Another object of the invention is the provision of an apparatus as above outlined in which the different variable factors involved, such as the treatment times in the various successive steps, may be closely controlled, to the end of producing a perfectly coated strip.

Another object of the invention is to provide an arrangement, whereby excess pretreating solution is rinsed off the strip immediately upon its emergence from the pretreating bath in order to avoid drying of such excess solution upon the strip.

A further object of the invention involves the

provision of means for keeping the strip moist until it enters the coating bath, whereby it is insured that the coating will be evenly distributed over the strip.

5 Another object of the invention is the provision of mechanism which insures that the strip, upon its emergence from the coating bath, will not carry along an excess of the coating fluid, whereby streaking and unevenness in the thickness of the coating is eliminated.

10 Another object of the invention is the provision of means whereby the rust-proof coating solution on the strip is dried as rapidly as possible and prior to contact of the strip (after leaving the coating solution and after excess solution is removed) with any conveying means.

A further object of the invention resides in the arrangement of the elements whereby the strip, after it issues from the last bath, is dried before it is engaged by any of the conveying means within a baking oven, whereby the coating is not injured in any way by such engagement.

20 Another object of the invention is the provision of means whereby the processed strip is treated prior to its coiling so that such strip and the coating thereon will not become injured by the subsequent coiling operation.

A further object of the invention is the provision of cooling means so located that as the relatively hot strip issues from the baking oven, it is cooled to such a temperature that it may be coiled without any danger of injury thereto.

30 Other objects of the invention will become apparent from the following specification, the drawings relating thereto, and from the claims hereinafter set forth.

In the drawings, in which like numerals are used to designate like parts in the several views throughout:

40 Figure 1 is a side elevational view of an apparatus according to the present invention in which parts are shown in cross-section in order to more clearly illustrate the structure and to show the manner of treatment;

45 Fig. 2 is a plan view taken substantially along the line 2—2 of Fig. 1;

Fig. 3 is a side elevational view taken in the direction of the arrows 3—3 in Fig. 1;

50 Fig. 4 is a detail, partial elevational view of a bearing mounting for one of the conveying rolls in the baking oven, taken axially of the roll;

Fig. 5 is an elevational view taken from the right of Fig. 4;

Fig. 6 is a fragmentary perspective view of a

portion of the strip steel which is processed by the apparatus illustrated in Figs. 1 to 3;

Fig. 7 is a view similar to Fig. 1, illustrating a modified, preferred form of the present invention; and,

Fig. 8 is a top plan view of the oven and heating means illustrated in Fig. 7.

According to one embodiment of the present invention, a coil of strip steel is disposed adjacent the processing apparatus, and the leading end thereof is first carried through a pre-treatment container which has a suitable cleaner therein for the purpose of removing any grease or dirt on the surfaces of the strip. The strip is then carried through a cold water rinse so as to wash any of the cleaning solution on the surfaces of the strip therefrom and then into a tank or container having the rust-proofing solution therein. The strip is then carried through a drying oven and passes from the drying oven onto a spool where it is re-wound into a coil.

Referring to Figs. 1 through 6 of the drawings for a more detailed description of one embodiment of the invention, the coil 10 of strip steel 12 is supported on a spool 14 having a standard 16. The strip 12 is preferably a coil of strip steel which has been cold reduced, box annealed, and finally temper rolled. The parts forming the processing apparatus may be suitably mounted on a suitable framework, and such apparatus includes a pre-treatment tank or container 18 which may be lead lined or constructed of stainless steel, or other acid resistant material for pre-treating the strip prior to its treatment in the rust-proofing bath.

A housing 20, having a cover 22 associated therewith and provided with an inlet 24 and an outlet 26, is disposed adjacent the tank 18 at substantially the same level. Cold water rinsing means, including oppositely disposed pairs of spray pipes 28, are disposed within the housing 20 and are upwardly inclined toward the outlet 26 for a purpose to be hereinafter described. The pipes 28 are suitably connected to a header 30 which, in turn, is connected through a suitable valve 32 to a source of cold water under pressure (not shown). The outlet openings of the spray pipes 28 are directed toward each other so that the sprays issuing therefrom are directed toward the middle so that the issuing jets of cold water impinge on opposite sides of the strip steel as it is passed between the pairs of pipes to wash any pre-treating solution carried by the surfaces of the strips therefrom. The water is collected in the bottom of the housing 20 and may be drained therefrom in any suitable way.

Another tank or container 34 is disposed adjacent the container 20 at substantially the same level and is adapted to contain therein the rust-proofing solution. The rust-proofing solution may be such as that disclosed in the McDonald Patent No. 2,030,601, February 11, 1936, and is such that a corrosion resistant, paint holding coating is formed on the surfaces of the strip of steel as it is passed through the oven. The solution may be maintained at substantially room temperature. If it is desired to raise the temperature, this may be done in any suitable way such as by the immersion of steam or hot water pipes in the bath.

The pre-treatment tank 18, the rinsing means 20, and the rust-proofing tank 34, are at substantially the same level and are aligned in a substantially straight line so that the strip of steel may be conveyed into and through each

of the parts by conveying means to be described in detail hereinafter.

A drying oven 36 is supported on suitable framework above the rust-proofing tank 34 and includes insulated walls forming the oven enclosure. Suitable doors 38 and 40 may be provided in order to provide access to the interior of the oven.

A transversely elongated inlet opening 42 is provided through the bottom wall of the oven 36 immediately above the tank 34 adjacent one side of the oven; and a transversely elongated outlet opening 44 is provided through the opposite wall adjacent the bottom thereof.

As the strip leaves the rust-proofing tank 34, it passes between a pair of idle rollers 46. The purpose of such rollers is to provide for the even distribution of the coating solution on the strip and to insure that excess solution on the strip is not carried into the baking oven. It is a characteristic of the present process that the coating must be thoroughly dried on the strip before it touches any conveying mechanism in order to avoid marking of the strip. Likewise, excess solution carried along with the strip tends to run and cause streaking.

According to the broader aspects of the present invention, smooth surface rollers have been found to be satisfactory, but it has been found that for best results such rollers should have a roughened surface such as that disclosed and claimed in the copending application of John E. Eckert, Serial No. 319,115, filed concurrently herewith. These rollers engage the strip and serve to control the amount and distribution of the rust-proofing solution thereon immediately prior to the entrance of the strip into the oven, so that the strip is in proper condition for the baking treatment it receives in the oven. A rust-proofing coating of substantial and uniform thickness is thereby ensured.

Heating means are associated with the oven and such means include a gas fired air heater 48 which may be supported on the apparatus framework above the level of tanks 18 and 34. An outlet conduit 50 communicates with the interior of the heater 48 and communicates with the interior of a fan housing 52. The fan housing 52 is adapted to have a centrifugal fan mounted therein on a drive shaft 54. The drive shaft 54 may be mounted in suitable bearings, and has a drive pulley 56 associated therewith which may be connected to a source of power for driving the centrifugal fan.

A tangentially disposed outlet or discharge conduit 58 is associated with the housing 52 so that the air discharged by the fan is conducted by the conduit 58 to branch conduits 60. The branch conduits 60 extend to the sides of the oven 36 and communicate with longitudinally disposed inlet conduits 62 at each side of the oven, respectively. The conduits 62 extend along the sides of the oven adjacent the bottom thereof and communicate with the interior of the oven through longitudinally spaced inlet openings 64. The hot gases are thus introduced into the oven 36 adjacent the bottom thereof, at each side, and at longitudinally spaced points.

Outlet openings are provided through one side wall of the oven 36 adjacent the top thereof at longitudinally spaced points and communicate with a longitudinally extending conduit 66 having a downwardly extending portion 68 which communicates with the interior of the heater 48. The hot gases may thus be re-circulated through

the gas heater 46, thereby increasing the efficiency of the heating system.

A ventilating conduit 68 is disposed in the top wall of the oven 38 and communicates with the interior thereof so that the hot gases may be vented from the oven if desired. A damper 70 is associated with the conduit 68 so as to provide a control for the hot gases exhausted from the oven. The oven is maintained at a temperature of approximately 650° F., for example, and the re-circulating conduits, together with the ventilating conduit 68, provide an effective and efficient means for controlling the oven temperature along with the controls for the gas heater 46. The inlet and outlet conduits and the heater 46 with the housing 50 are suitably insulated.

Conveying means are provided for continuously carrying the strip of steel through the apparatus so that the intended processing may be effected and are so operated that the proper time interval for treatment at each stage is possible. Such conveying means includes a plurality of drums or rolls 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, and 94. The drums are mounted on shafts which, in turn, are journaled in bearings on the framework, or, in the case of the oven rolls on framework associated with the walls of the oven. Certain of the rolls are driving rolls and others idle rolls, as will be pointed out hereinafter. The rolls are all constructed with annular flanges 96 at the sides thereof, and the space between the flanges is of substantially the same width as the width of the strip steel 12. The flanges 96 prevent displacement of the strips from the rollers and insure alignment of the strip as it is passed through the various stages of the process. Rolls 72, 74, 78, and 94 are driven rollers, while the remaining rolls are idle guide rolls arranged in a particular manner to be described hereinafter.

In connection with the arrangement of the rolls above described and shown in the drawings, it is pointed out that one of the important features of this arrangement resides in the position of the roll 82 with respect to the inlet to the oven. As mentioned above, it is important that the rust-proofing solution on the strip be dried before it contacts or engages any of the conveying elements disposed within the oven. It will thus be seen that roll 82, which is the first of the conveying elements engaged by the strip, is disposed at a position remote from the inlet 42. The roll is thus so arranged that the strip travels a substantial distance within the oven before it engages any of the conveying means, and by the time the strip reaches roll 82, the rust-proofing solution is dried sufficiently that it will not be injured by its engagement with the roll.

In the above description, it will be noted that the conveying rolls or drums are provided with flanges 96 in order to prevent displacement of the strips from the rollers and to ensure alignment of the strip as it is passed through the various stages of the process. It has been found, however, that the preferred means for attaining this end, that is, the proper alignment of the strip and the prevention of displacement of the strip from the rolls, is that disclosed in Figs. 4 and 5. This is accomplished by tilting certain of the conveyor rolls transversely of the strip. Preferably, the tiltable rolls will be the first and last rolls contacted by the strip during its course through the baking oven. The tilting of the rolls is accomplished by mounting the rolls in the manner described and claimed in the copending applica-

tion of Grant A. Pettit, Serial No. 319,116, filed concurrently herewith.

When the tiltable mounting for the rolls, disclosed in Figs. 4 and 5, is used the rolls having flanges thereon may be used, or smooth rolls without flanges may be used, as desired.

Referring to Figs. 4 and 5 for a description of this construction, an exemplary mounting for the bearing at one end of the roll 82 is illustrated. The wall of the oven is indicated in broken lines at 128 and the shaft 129 of the roll 82 projects through the oven wall as illustrated. The end of shaft 129 has its bearing in an adjustable element 130, and a seat collar 131 is provided adjacent each end of the shaft to prevent axial movement thereof. A portion of a frame structure is indicated at 132, to which are fixed guide rails 133, in which the element 130 is mounted for sliding movement. Fixed to the element 130 is a threaded member 134 which passes through a nut 135 mounted in a cross bar 136 fixed to the bottoms of the guide rails 133. It will thus be clear that as the nut 135 is turned, the slide 130 slides with respect to the guideways 133 and thereby vertically shifts that end of shaft 129.

The bearing at the other end of the shaft may be fixed and, since the ultimate in upward and downward movement of the bearing 130 will amount to approximately one-half inch, it is sufficient to prevent binding if the fit of element 130 and the guide rails 133 is relatively loose. The bearing at the fixed end of the shaft may be given adequate clearance to allow for this small tilting movement. It is to be understood, however, that the bearings at each end of the shaft may be of the self-aligning type or may be mounted in swiveling mountings.

The driving means for the rolls includes a prime mover 96 suitably connected by a belt and pulley to a speed reducer 98. The speed reducer 98 is connected through a sprocket chain 99 to a sprocket on a drive shaft 101. The shaft 101 extends longitudinally of the apparatus and may be journaled in suitable bearings at spaced points therealong. Shaft 101 is operatively connected through suitable gear mechanism to feed reduction transmission mechanisms 102, 104, 106, and 108. The mechanisms 102, 104, 106, and 108 are operatively connected to the drive shafts for drums 72, 94, 74, and 78, respectively.

The strip 12 is disposed over the drums 72, 74, and 94; and so that the strip is frictionally urged against the drums and may be frictionally driven thereby, a pressure roller 110 is associated with each one of these drum and engages the upper surface of the strip 12 at the top of each drum. Each friction roller 110 is adapted to be mounted to a vertically movable slide member 112 which is slidably disposed within vertical guides 114. A spiral spring 116 engages the top of the slide 112 and is telescopically received over the lower end of an adjustable screw 116' which is threadably received within a threaded mounting member 118. The member 118 may be fixed to the guideways 114. By adjusting the screws 116' the pressure exerted by the rollers 110 may be varied.

The strip of steel 12 passes over the top of drum 72 and drops into the pre-treating bath within container 18. The strip then passes upwardly out of the bath so that a good portion of the pre-treating solution may drain back into the bath, and then passes upwardly over roll 74 and downwardly and under guide roll 76. Roll 78 is disposed at a level above roll 76 so that the

strip 12 passes through the outlet 26 over roll 78 at an angle upwardly disposed towards the outlet and in so passing within the housing 20 passes between the jets of cold water issuing from the pipe 28. The jets of cold water impinge against opposite sides of the strip 12 and wash any of the pre-treating solution remaining thereon from the surfaces of the strip. Due to the inclination of the strip, any water carried on the surfaces of the strip will drain back into the housing.

The strip 12 is then passed downwardly under guide roll 80 into and through the rust-proofing bath within the container 34. The roller 80 is journaled in bearings which are slidably mounted within guide members 120. By vertically adjusting the position of these bearings, the tautness of the strip 12 may be effectively controlled, and also the interval of time it remains in the rust-proofing solution.

The strip 12 then passes between the rolls 43, through the inlet 42 into the oven 36, and in being carried upwardly out of the bath within the container 34 the excess rust-proofing solution will drain back into tank 34 below rolls 43.

The strip 12 is then trained over the guide rollers 82, 84, 86, 88, 90, and 92, so that the strip follows a tortuous path within the oven 36 and is thereby subjected to a complete drying operation. Roller 82 is disposed adjacent the outlet opening 44 so that the strip 12 is passed through the opening 44 and engages roller 94 with its associated pressure roller 110 to convey the strip from the oven. The strip is then coiled on a suitable spool 122 mounted on standards 124 and at the completion of the process such coil may be stored out of doors. Suitable means may be provided for turning the spool 122 in order to coil the strip.

Referring to Figs. 7 and 8 of the drawings, the preferred embodiment of the present invention is illustrated. It has been found that the strip of steel 12, to be treated according to the present invention, is not free of dust, grease, dirt, or other foreign material so that it must be cleaned prior to treatment in order to accomplish the best results. According to this embodiment of the invention the strip is first cleaned by passing it through an alkali bath, then thoroughly scrubbing and rinsing the strip before it is passed through the pre-treatment and final treatment baths. Although the alkali bath provides the preferable and most satisfactory cleaning means, other cleaners would be satisfactory. For example, vapor de-greasing means, or an acid cleaner could be used, although it has been found that good results are obtained with the alkali bath mentioned above.

Also, the material is dried at relatively high temperatures. The particular oven temperature used, in order to obtain the particular strip temperature desired depends upon a number of variable factors, such as gauge and width of the strip, the coating desired, the coating solution used, and the length of baking time. The strip travels some distance after leaving the oven before it is re-coiled, but with strips of certain widths and thicknesses there is not a sufficient reduction in temperature between the time the strip leaves the furnace and the time it reaches the re-coil reel. It has also been found that when the strip is coiled at temperatures exceeding approximately 300° F., there is grave danger in injuring the coating thereon as the strip is coiled. Means are, therefore provided

according to the present invention, adjacent the coiling means to cool the strip in order to bring its temperature below such a point that it can be coiled without the danger mentioned above.

The coil 10 is mounted on a suitable pay-off reel or standard and the leading end of the strip 12 is passed through an inlet opening 150 into an enclosed chamber comprising a bottom tank 152 with a cover portion 154. The tank 152 is adapted to contain an alkali bath 156 which is preferably maintained at a temperature of 160 degrees to 170 degrees F.

A roll 158 is suitably mounted within the chamber above the bath and the strip 12 is adapted to be passed thereover. Rolls 160 and 162 are suitably mounted and are disposed so that the bottoms thereof extend within the bath 156. The strip 12 is then trained around rolls 160 and 162 so that it passes through the bath 156.

Another roll 164 is mounted above the bath and is located at a level above the roll 158, and the strip 12 is passed therearound and passes between a pair of wringer rolls 166 which engage the surface of the strip for a reason to be pointed out hereinafter. Spray means 168 extend transversely of the strip 12 and are disposed above the bath 156 between and adjacent the rolls 162 and 164. Such means 168 may be in the form of tubes having a plurality of small apertures formed in the wall thereof and may be connected to the bath 156 through suitable conduits with a pumping means associated therewith so that the alkali of the bath is pumped into the spray means 168 and is projected against both sides of the strip, the alkali then dropping back into the bath. Scrubbing brushes 170 are disposed on opposite sides of the strip 12 and are generally cylindrical in form. Such brushes have driving means suitably associated therewith so that they may be rotated at high speeds and engage both sides of the strip in order to effect a scrubbing action thereon to insure removal of any of the grease or dirt carried by the strip.

The strip 12 leaves the roll 164 and passes into a wash chamber above a wash tank 172 which is adapted to contain a water bath 174 therein. The water in the bath 174 is preferably maintained at a temperature of approximately 200 degrees F. The cover 154 extends over the bath 174 and the chamber above the alkali bath 156 and the chamber above the water bath 174 are separated from each other by means of a baffle or wall 176 which extends between the sides of the chamber enclosing such tanks.

It will be seen that the rolls 166 are disposed on that side of the baffle or wall 176 above the bath 156. The rolls 166 are suitably mounted for rotation about substantially horizontal axes and serve as wringer rolls in order to remove any of the excess alkali carried by the strip in its passage to the chamber above the water bath.

Rolls 177 and 178 are mounted within the chamber above the water bath 174 for rotation about a substantially horizontal axis. The roll 177 is located at substantially the same level as the roll 164, and roll 178 is located therebelow. The strip 12 is trained about rolls 177 and 178 and is passed through an outlet 180 and over a horizontal roll 182.

The strip 12 is washed and scrubbed within the chamber above the bath 174 by means of sprays and rotating brushes. The sprays may be in the form of tubular members 184 which are

connected to the bath 174 through suitable conduits and have a pumping means associated therewith so that the water in the bath 174 is sprayed against both sides of the strip 12. Rotatable brushes 186, which are similar in construction to the brushes 170, are mounted for rotation within the chamber above the bath 174 and engage both sides of the strip so that such brushes scrub the strip in order to thoroughly remove any of the dirt or alkali which may be thereon.

Wringer rolls 188 are mounted for rotation about horizontal axes adjacent the outlet 180 and engage opposite sides of the strip 12 just as it leaves the chamber above the water bath so that any excess water is removed from the surfaces of the strip.

The strip 12 is then passed through a pre-treatment or flash tank, indicated at 190. Such tank contains a solution 192 which will coat the steel strip. This preliminary coating may be an oxide coating, or other coating which, when treated with the final treatment solution, will give, after baking, a corrosion resistant, paint holding coating on the strip. A roll 194 is mounted for rotation about a substantially horizontal axis above the bath 192. The roll 194 is so positioned that the lower end thereof projects below the surface of the bath at such a location and to such a depth that the strip 12 is immersed in the bath 192 before it contacts roll 194. Both surfaces of the strip are, therefore, wet by the solution 192 before the strip contacts roll 194. The strip 12 is trained about the roll 182 and also about the roll 194 so that the strip passes into the bath 192 for the pre-treatment effected by this bath. Before the strip reaches the bath, transversely extending wiper elements 196 are mounted to suitable framework so that they press against opposite sides of the strip and serve to wipe the strip free of any excess water remaining thereon before the strip passes into the bath.

Such members 196 are formed of such material that they will perform a wiping action on the strip without in any way marring the surface thereof. For example, they may be constructed by wrapping a strong, rugged material, such as canvas, in a plurality of layers about a suitable supporting element, or they may be formed of a strong, rugged felt material.

The strip then passes from the tank 190 through an outlet 198 into a rinse chamber 201. Spraying means 202 in the form of tubular members having outlet apertures therein are disposed on opposite sides of the strip 12, transversely thereof, with the openings so positioned that sprays of water are directed against both sides of the strip. Such spray means are placed in communication through suitable conduits, with a source of water, which may be at room temperature, having a pumping means associated therewith so that the spray is in sufficient quantities and at high enough pressures to accomplish a thorough rinsing of the strip. Wiper members 204, similar in construction to the wiper members 196, are disposed adjacent the opening 198 and bear against opposite sides of the strip so as to wipe the major portion of the solution from bath 192 from the strip.

The strip is thoroughly rinsed in chamber 201 and it will be seen that it passes therethrough following an upwardly inclined path so that the water drains back into the chamber 201. The strip leaves the chamber through an outlet 206 and is then passed into and through the rust-

proofing tank 208. The tank 208 corresponds to the tank 34 above described and contains a rust-proofing bath 210, similar to the bath mentioned above in connection with tank 34, or other solution, which when applied over the preliminary coating will give a corrosion resistant, paint holding coating on the steel strip after baking. Rolls 212 and 214, corresponding to rolls 78 and 80 in the embodiment above described are mounted in a similar manner with respect to tank 34. The strip 12 is passed around these rolls into and through the bath 210 and passes upwardly therefrom into the baking oven 216.

So that the strip 12 is wiped free of any excess water which is carried thereon from the rinse chamber 201, wiper members 218, similar to wiping members 196, are disposed adjacent the outlet 206 in such position that they bear against the strip.

Rolls 220, similar to the rolls 43 described in the above embodiment, are disposed above the bath 210 in a position similar to that described above in connection with tank 34 and serve the same purposes described above. The rolls 158, 160, 162, 164, 177, 178, 182, 194, 212, 214, and 220 are all idle rollers and may be mounted on framework similar to the framework upon which the rolls such as 72, 94, 74, 76, 78 and 80 are mounted in the embodiment described above as shown in Fig. 1. The rotating brushes and the wipers, such as 196, may be suitably mounted on the same framework.

A drying oven 222, generally similar to the oven 36 above described, is supported on suitable framework above the rust-proofing tank 208 and includes insulated walls forming the oven enclosure. Suitable doors are provided in the oven walls for providing access to the interior thereof. The oven 222 includes an inlet 224, corresponding to the inlet 42, above described, which is disposed substantially vertically above the path between rolls 220. The oven also has an outlet 225 corresponding to the outlet 44 above described.

Conveyor rolls 226 and 228 are disposed within the oven and are preferably mounted therein in the same manner as rolls 82 and 92 described above in connection with Figs. 4 and 5. A wall member 230 is disposed within the oven 222 in spaced relation to the left hand wall thereof (viewing Fig. 7) which extends across the oven 222 to provide a vertical conduit 232 which forms an initial drying chamber.

Heating means are associated with the oven and such heating means include a gas fired heater 234 having a burner 236 associated therewith. An outlet conduit 238 communicates with the heater and communicates with a blower housing 240 which has a suitable blower mounted therein. The blower is connected to a suitable source of power 242 through a belt connection 244 so that the blower operates to force the heated air from the conduit 238 into a header conduit 246. The header conduit 246 is so shaped that the outlet end thereof is disposed adjacent the bottom of oven 222 and is in communication with a plurality of outlet conduits 248, 250 and 252.

Viewing Fig. 8, it will be seen that the outlet conduits 248 and 250 communicate with the drying chamber 232 of the oven on opposite sides of the strip 12. The outlet 252 communicates with the other portion of the oven to the right of wall 230 (viewing Fig. 8). An outlet for the oven is illustrated at 254 and communicates with

a return conduit 256. The return conduit returns to the heater 234 for re-circulation of the heated air.

For temperature control, a branch conduit 258 connects the return conduit 256 and the inlet conduit 238 and has an adjustable damper 260 associated therewith so that the returned air through the conduit 258 may be bypassed around the heater 234 in variable amounts directly into the conduit 238, thus affording a simple temperature control means.

From the above, it will be seen that the strip 12 passes directly into the vertical drying chamber 232 and is trained over the conveyor rolls 226 and 228 and then passes out through opening 225. The heated air enters the conduit 232 adjacent the bottom thereof and passes upwardly over roll 226 and into the main portion of the oven. This heated air is supplemented by the conduit 252 and all of the heated air then passes out of the oven through outlet 254.

With this construction it will be evident that the hot gases envelop the strip as it first enters the oven so that the rust-proofing solution will be dried before it reaches the conveyor roll 226. This has the advantage pointed out above in detail.

The strip 12, after leaving the oven, is coiled on a suitable spool 122. The spool 122 is driven by suitable means such as a motor 260 connected to the spool 122 by suitable drive means 262. The spool 122, in the embodiment illustrated, is the only driven roller, the remaining rollers about which the strip is coiled merely being idle rollers.

In its passage from the outlet 225 of the oven to the spool 122, the strip 12 is preferably supported on suitable guide rollers 264 and 266 which may be mounted for rotation upon substantially horizontal axes on the framework above mentioned.

As mentioned above, with heavy gauge strips of wide width, there is not sufficient time between the time the strip leaves the oven until it reaches the spool 122 to cool down sufficiently so that it will not be injured during the coiling operation. To take care of such a contingency, suitable cooling means are disposed adjacent the coil and blow a cooling medium, such as air, against the strip so as to reduce its temperature to a proper coiling temperature. Such cooling means may also be in the form of a water or liquid spray disposed at any suitable point between the oven and the spool. One example is illustrated in the form of transversely extending tubular conduits 270, disposed on opposite sides of the strip and having apertures therein directed preferably in a direction opposite to that of the direction of movement of the strip. Such tubular members 270 may be connected to a suitable blower (not shown), so that air is directed against the strip. A plurality of such means may be provided along the strip with independent controls so that the cooling of the strip may be varied to the varied conditions resulting from different gauge and different width strips.

In an exemplary embodiment of the preferred apparatus described above, which is now in operation in one of the steel plants, the apparatus has been set to operate continuously on strip steel as wide as twenty inches and up to .050 gauge. In this particular apparatus, the strip is run at approximately fifteen feet per minute. Also, in this apparatus the strip is in the scrubber approximately three minutes, in the pretreatment solution approximately thirty seconds,

in the wash tank and spray approximately thirty seconds, and in the final coating solution approximately thirty seconds. The strip then passes through the oven in approximately two minutes, the oven temperature being between 600° and 650° F., so that the strip as it leaves the oven is at approximately 550° F. The immersion coating and baking times which we have given for our pilot installation have been found to be entirely satisfactory for the gauge and width strip which is being used.

The above-mentioned operation is merely exemplary, and it will be appreciated by those skilled in the art that wider strip steel of heavier gauges may be used and that the times, speeds, and temperatures may be varied within the scope of the present invention. The strip may be carried through the apparatus at a much faster rate and the tanks and other processing devices may be sized proportionately to give the desired treatment times.

It will be evident that by the various embodiments of the invention described above, simple and efficient means for rust-proofing strip steel is provided in which the surfaces of the strip may be rapidly and effectively treated. Also, the structures of the present invention afford means by which strips of varied gauge and width may be effectively treated.

Formal changes may be made in the specific embodiments of the invention described without departing from the spirit and substance of the invention, the scope of which is commensurate with the appended claims.

What is claimed is:

1. An apparatus for treating metal strip comprising a series of tanks containing treating fluids, means for conducting a strip in sequence into said tanks, a baking oven, means for conducting said strip through said baking oven and pulling means for acting upon the strip upon its emergence from said baking oven, said oven being arranged above the last tank of said series and said conducting means being so disposed therein that the strip passes from the last tank of said series into said oven in a vertical path, and traverses substantially the height of said oven before contacting said conducting means and is then generally led in a reverse direction to its path through said treating tanks and said pulling means being disposed in the vicinity of the entrance of the strip into the first tank of said series.

2. Apparatus for rust-proofing strip steel comprising a container adapted to contain a rust-proofing solution, an oven disposed above said container, said oven having a downwardly presented inlet opening therein, means for conveying a strip of steel through said container and through said inlet opening into said oven, said last named means including a roller element disposed within said oven adjacent the top thereof, said roller element being so arranged that said strip is drawn upwardly through said inlet opening and being arranged in a position remote from said inlet opening, means within said oven adjacent said inlet opening forming a drying chamber, heating means associated with said oven, and means conducting the heated gases from said heating means to said oven and introducing such gases into said chamber.

3. Apparatus for rust-proofing strip steel comprising a container adapted to contain a rust-proofing solution, an oven disposed above said container, said oven having a downwardly pre-

sented inlet opening therein, means for conveying a strip of steel through said container and through said inlet opening into said oven, said last named means including a roller element disposed within said oven adjacent the top thereof, 5 said roller element being so arranged that said strip is drawn upwardly through said inlet opening and being arranged in a position remote from said inlet opening, means within said oven adjacent said inlet opening forming a drying 10 chamber, heating means associated with said oven, and means conducting the heated gases from said heating means to said oven and introducing such gases into said chamber, said last named means entering said chamber adjacent 15 the lower end thereof so that said gases pass upwardly through said chamber in enveloping relationship to said strip.

4. Apparatus for rust-proofing strip steel comprising a plurality of in line containers adapted to contain treating solutions, a drying oven disposed adjacent the last of said containers, means supplying a heating medium to said oven, and conveying means so constructed and arranged as to convey a strip of steel through said containers and through said oven, said conveyor means including a coiling element about which 10 said strip of steel is coiled, said element being disposed at the outlet end of said oven, said coiling element being remotely disposed from the outlet so that said strip will cool down before reaching said element, and cooling means disposed adjacent said element for cooling said 15 strip.

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