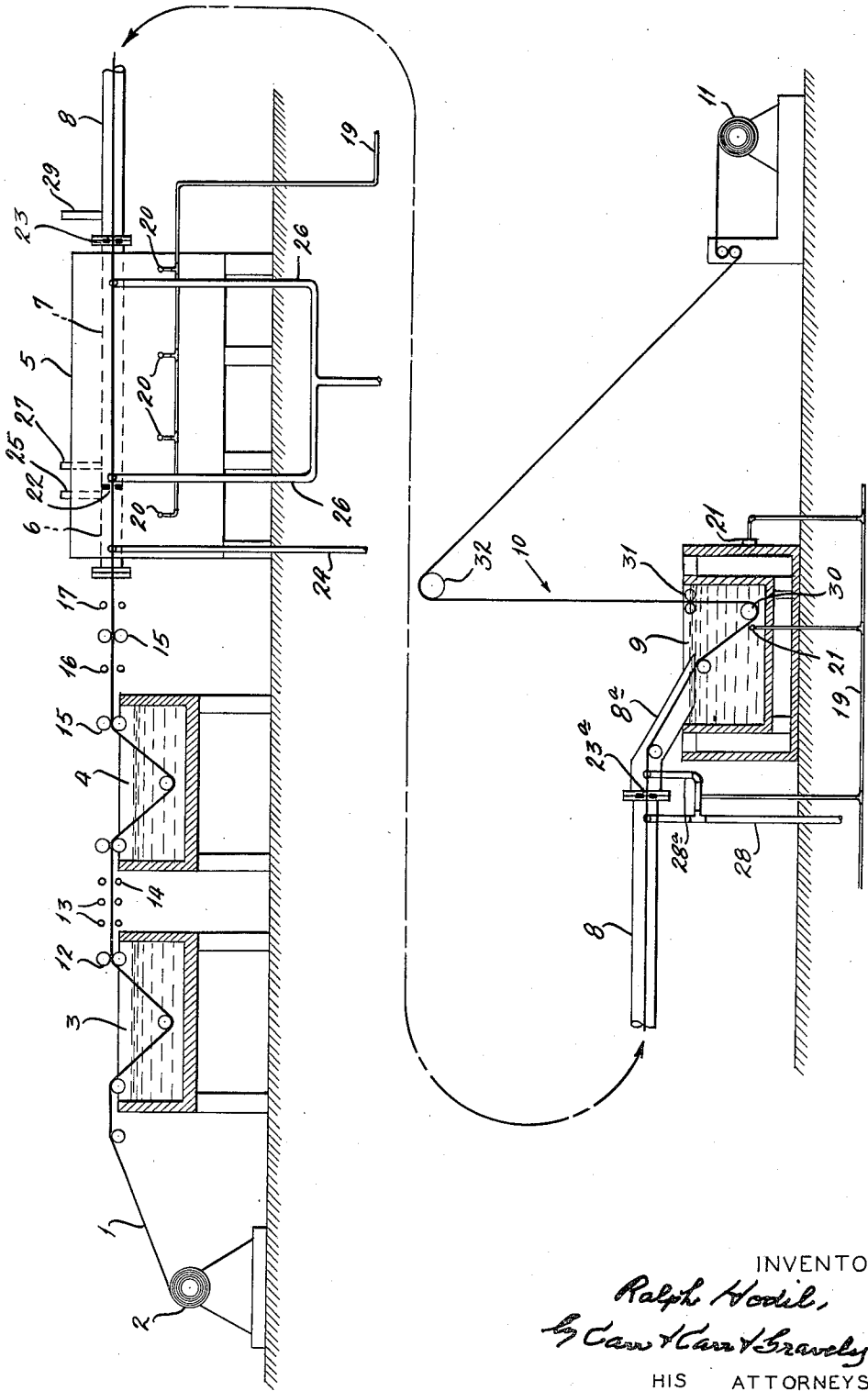


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CONTINUOUS PROCESS OF PREPARING  
AND METAL COATING ROLLED STEEL  
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CONTINUOUS PROCESS OF PREPARING AND  
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6 Claims. (Cl. 117—51)

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This invention relates to the manufacture of metal coated hot or cold rolled strip or sheet steel and has for its principal object to devise a simple, economical and rapid process of continuously producing material of the above type having a coating that is superior in adherence, continuity, workability and appearance to previous coatings. The invention consists principally in the process of preparing the steel for the reception of the metal coating and it also consists in the hereinafter described and claimed process of continuously preparing and coating the steel.

The accompanying drawing, which forms part of this specification and wherein like symbols refer to like parts wherever they occur, is a diagrammatic part side elevational and part vertical sectional view illustrating an apparatus for carrying out my process.

In continuously preparing and metal coating hot or cold rolled strip steel according to my process, the coiled strip steel 1 is drawn from a suitable uncoiler 2 through a cleaning tank 3 containing any common proprietary alkaline or acid cleaner, thence through a tank 4 containing nitric acid, thence through a heating furnace 5 having a first heating chamber 6 and a longer second heating chamber 7, each containing an atmosphere which is preponderantly nitrogen, thence through a relatively long cooling chamber 8 containing an atmosphere which is also preponderantly nitrogen, thence through a heated tank or pot 9 containing a melt or bath of molten coating metal, such as zinc, terne metal, lead or aluminum, with or without alloy additions, and thence through a cooling zone 10 or tower to a take-up reel 11 for coiling the finished metal coated strip steel. As shown in the drawing, the cooling chamber 8 has a downwardly inclined discharge end portion 8a which opens into the coating tank 9 below the level of the molten coating metal therein. In coating sheet steel, the sheets are passed successively through the apparatus in the same manner as the continuous strip steel without using the uncoiler 2 and the take-up reel 11.

In traveling from the cleaner tank 3 to the acid tank 4, the strip passes between wringer rolls 12, water sprays 13 and compressed air jets 14 to remove the residual cleaner from the strip. In traveling from the acid tank 4 to the first heating chamber or zone 6 of the furnace 5, the strip passes between wringer rolls 15, water sprays 16 and compressed air jets 17 to remove the nitric

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acid from the strip and dry the surface thereof as completely as possible.

The two heating chambers 6 and 7 of the furnace 5 are preferably heated with gas supplied through a pipe 19 to a plurality of burners 20 located in said furnace. The coating tank 9 is also heated to a specified coating temperature by gas burners 21 that are supplied with gas through the pipe 19. The first heating chamber or zone 6 is preferably maintained at a temperature which will heat the strip of steel passing through it to a temperature of about 1000 deg. F. and the second heating chamber or zone 7 is preferably maintained at a temperature that will heat the strip passing therethrough to a temperature of from 1300 to 1350 deg. F.

The first heating zone 6, the second heating zone 7 and the cooling zone 8 each contains an atmosphere which is preponderantly nitrogen and to which are preferably added small quantities of hydrogen and water vapor which are combined with dry nitrogen to form a gaseous atmospheric solution. Preferably, the atmosphere in the first heating zone 6 contains 5% to 8% of hydrogen and .01% to .03% of water vapor, the atmosphere in the second heating zone contains 10% to 18% of hydrogen and 4% to 6% of water vapor, and the atmosphere in the cooling chamber 8 and the delivery end portion 8a thereof contains 5% to 20% of hydrogen and .005% to .01% of water vapor. The steel passes through a restricted passageway or slot 22 between the first heating chamber 6 and the second heating chamber 7 and through similar slots or passageways 23 and 23a located respectively between said heating chamber and the cooling chamber 8 and between the main portion of said cooling chamber and the downwardly inclined delivery end portion 8a thereof.

The atmospheric solution for the first heating zone 6 is supplied thereto through a pipe 24 which opens into said zone near the receiving end thereof and escapes from said zone through a pipe 25 leading therefrom near the discharge end thereof. The atmospheric solution for the second, longer heating chamber 7 is supplied thereto through a pipe 26 having branches that open into said chamber adjacent to opposite ends thereof, the atmospheric solution escaping from this chamber through an outlet pipe 27 communicating therewith near the receiving end thereof. The atmospheric solution for the cooling chamber 8 is supplied thereto through a pipe 28 which opens into said chamber near the downwardly in-

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clined discharge end portion 8a thereof and has a branch 28a which opens into said delivery portion near the receiving end thereof, the atmospheric solution escaping through an outlet pipe 29 near the receiving end of said chamber. The steel strip passes downwardly from the inclined discharge end portion 8a of the cooling chamber 8 into the molten coating metal in the heated coating tank 9, thence upwardly around a guide roller 30 in the bottom thereof, thence upwardly between wringer rolls 31, which are preferably located in said tank at the surface of the coating metal and remove the surplus coating material from the strip, thence preferably over a guide roll 32 located above the tank and thence downwardly to the take-up reel 11, so as to permit the coating to cool and harden before reaching the take-up reel 11.

By the arrangement described, the rolling oils are removed from the strip or sheet steel material during the passage thereof through the cleaning tank 3, and the residual cleaner is removed from the surface of said material by the wringer rolls 12, water sprays 13 and compressed air jets 14. The material next passes through the tank 4 containing the nitric acid which attacks the steel in the grain boundaries, thus exposing undesirable material, such as carbon and/or carbides, which is precipitated at these points during solidification, heating and rolling of the steel. As the rolled strip or sheet steel material has a normally scale-free surface, the nitric acid bath is not for the purpose of removing oxide from said surface, but is for the purpose of attacking the steel to open the grain boundaries thereof, as distinguished from other reagents which may etch the steel but do not open the grain boundaries for purification in subsequent steps of the present process. After the nitric acid bath, the material passes between the wringer rolls 15, water sprays 16 and compressed air jets 17 to remove the nitric acid from the surface of said material and to dry said surface.

The strip or sheet steel material thence passes into the first heating zone 6 of the furnace 5 wherein the preponderantly nitrogenous atmospheric solution permits and assists the volatilization from the surface of the strip of the last traces of rolling oils, metal salts and other contamination from previous processing and, at the same time, protects the surface from oxidation at the temperature reached by the strip in this chamber. The material thence passes through the restriction or slot 22 into the second heating chamber 7 of the furnace 5. This second heating chamber, which is substantially twice as long as the first heating chamber, also contains an atmosphere which is preponderantly nitrogen with a different percentage of hydrogen and water vapor. This different gaseous solution operates to actively and speedily remove undesirable material from the grain boundaries opened up by the previous step of the process and, at the same time, protects the surface from oxidation at the higher temperature reached by the strip in the second heating chamber. Thus, the material reaches the end of the second heating zone or chamber 7 with the surface in perfect condition for the reception of the metal coating.

The strip or sheet steel material thence passes from the second heating chamber 7 into the cooling zone 8 wherein the material is cooled to the temperature desired for introduction into the coating bath. This cooling zone also contains an atmosphere which is predominantly nitrogen

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and which serves to protect the previously prepared surface of the material while the material is cooling down to prevent oxidation of the surface of the coating bath. The atmosphere in the cooling zone is substantially non-reactive with the steel surface and with the molten coating metal between the temperatures of 1400 deg. F. and 450 deg. F. The cooling zone may contain any atmosphere which will perform these functions at temperatures down to 450 deg. F. However, as stated above, I prefer to use in the cooling chamber an atmosphere of nitrogen containing 5% to 20% of hydrogen and .005 to .01% of water vapor.

As stated above, the first and second heating zones 6 and 7 and the cooling zone 8, all contain atmospheres which are predominantly nitrogen and to each of which are added different quantities of hydrogen and water vapor. The different atmospheric solutions are arranged in a definite sequence to produce the desired result. The atmosphere used in the second heating zone cannot be used in the first heating zone, because it will oxidize the surface at the steel strip temperature existing therein; the atmosphere used in the first heating zone cannot be used in the second heating zone, because it is not sufficiently active to produce the desired result; and the atmosphere used in the cooling zone cannot be used in either of the two heating zones for the same reason, while the atmospheres used in the heating zones cannot be used in the cooling zone, because they will not protect the surface at the temperature required in the cooling zone. The temperatures specified for the strip steel in the heating zones and the cooling zones are not critical to this process but are those used in normal processing for producing ordinary qualities in the basis strip or sheet. If other temperatures are required to produce special properties in the strip or sheet, the atmospheres may be adjusted to perform their functions at those temperatures. The use of the nitric acid bath places the surface of the steel material in perfect condition for the subsequent action of the preponderantly nitrogenous but different atmospheric solutions.

The hereinbefore described invention provides an easily controllable process of continuously producing high quality coated steel products; and it also provides an economical method of producing such products by dispensing with the operations of cleaning, pickling and annealing and the need for fluxing material. It also provides a rapid process of continuously coating the material, as distinguished from the prior coating processes that depend upon the slow reducing action of hydrogen; and the material produced by the present process has a coating which is superior in adherence, continuity, workability and appearance to coatings produced by previous processes.

What I claim is:

1. The continuous process of preparing and coating rolled strip or sheet steel with another metal which comprises passing the steel through a relatively dilute nitric acid bath which only opens the grain boundaries of the steel without destroying or removing the same and which exposes undesirable material precipitated therein during the solidification, heating and rolling thereof, thence through a plurality of heated zones, the first of said zones being a preheating zone to bring the temperature of said steel to up to approximately 1000° F. and consisting essentially of a nitrogenous non-oxidizing atmosphere

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containing a relatively small quantity of hydrogen and a relatively smaller quantity of water vapor, the amounts and proportions of hydrogen and water vapor being sufficient to aid in the removal of the undesirable material exposed by the nitric acid bath and any remaining rolling oils and other contaminations from previous steps of prior processing, another of said zones being an annealing zone and consisting essentially of a nitrogenous non-oxidizing atmosphere containing a relatively small quantity of hydrogen and a relatively smaller quantity of water vapor, the amounts and proportions of hydrogen and water vapor being sufficient to complete the removal of the contaminations, thus completing preparation of the surface without creating a new surface and protecting said surface from oxidation at the temperatures of said heated atmospheres, thence through a cooling zone consisting essentially of a nitrogenous non-oxidizing atmosphere containing a relatively small quantity of hydrogen and a relatively smaller quantity of water vapor, the amounts and proportions of hydrogen and water vapor being sufficient to completely protect and prevent oxidation of said prepared surface and thence immediately through a molten bath of such other coating metal to directly apply the same to said completely prepared surface.

2. The process of claim 1 wherein the hydrogen is present in said preheating zone in amounts ranging from 5% to 8% and the water vapor is present in said preheating zone in amounts ranging from .01% to .03%.

3. The process of claim 1 wherein the hydrogen

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is present in said annealing zone in amounts ranging from 10% to 18% and the water vapor is present in said annealing zone in amounts ranging from 4% to 6%.

4. The process of claim 1 wherein the hydrogen is present in said annealing zone in amounts ranging from 10% to 18%, the water vapor is present in said annealing zone in amounts ranging from 4% to 6% and the temperature is in the range of 1300° F. to 1350° F.

5. The process of claim 1 wherein the hydrogen is present in said cooling zone in amounts ranging from 5 to 20% and the water vapor is present in amounts ranging from .005% to .01%.

6. The process of claim 1 wherein the hydrogen is present in said preheating zone in amounts ranging from 5% to 8% and the water vapor is present in said preheating zone in amounts ranging from .01% to .03%, and in said annealing zone the hydrogen is present in amounts ranging from 10% to 18%, the water vapor is present in amounts ranging from 4% to 6% and the temperature is in the range of 1300° F. to 1350° F.

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