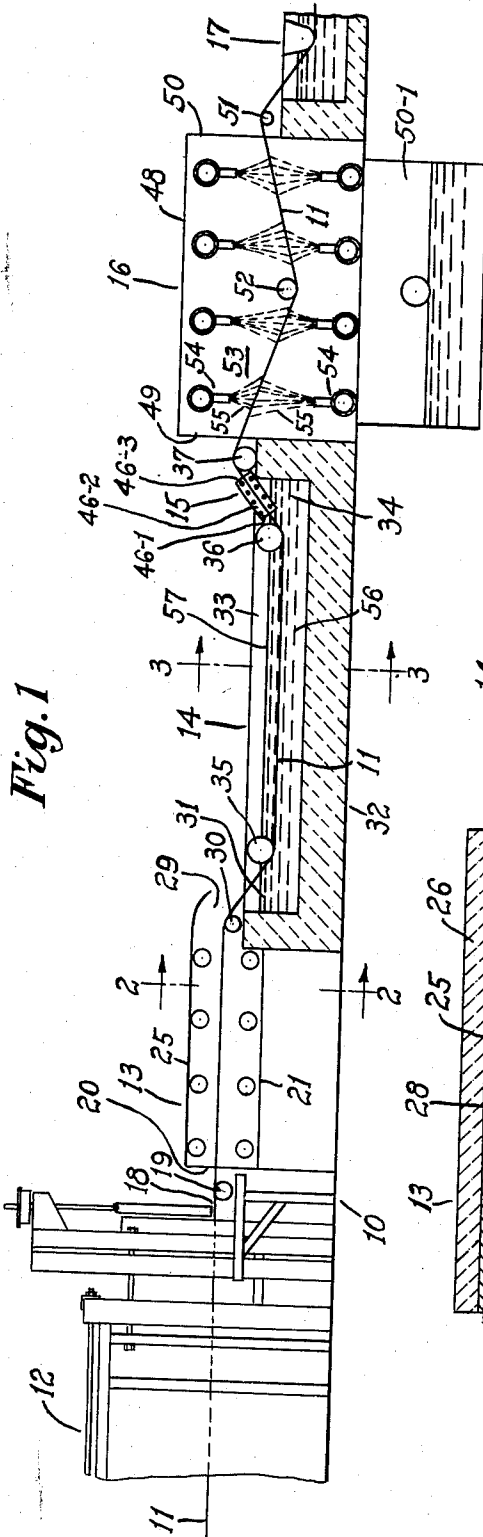
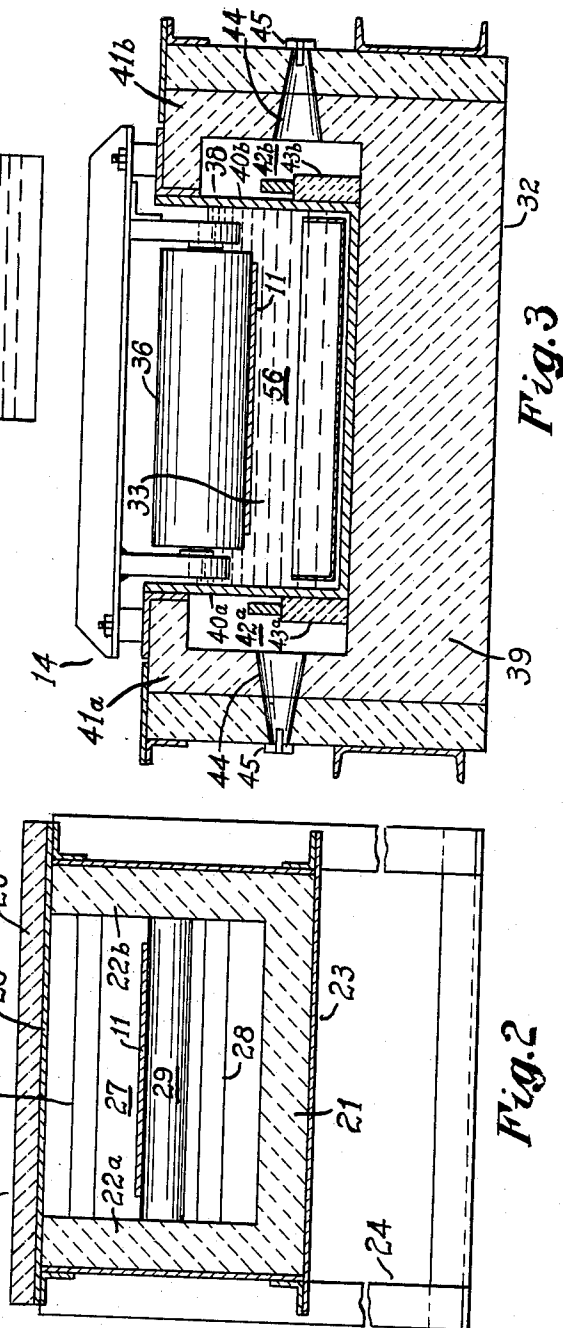


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METAL DESCALING METHODS

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METAL DESCALING METHODS

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The invention relates to methods for the descaling of metal by subjecting the metal having scale or oxides on its surfaces to a molten bath which removes oxygen from the oxides, and leaves an ashy substance that may be readily removed or washed off.

Such descaling has been accomplished in a batch type operation by subjecting a metal piece having oxide coatings on its surfaces to a molten salt bath including sodium hydride. Metal descaling processes by the use of sodium hydride in batch type operations have been carried out for example by two prior processes.

In the case of one process, a sodium hydroxide bath is maintained at a temperature of 700–750° F. and metallic sodium and hydrogen are added to build up in the bath a sodium hydride content of 1.5% to 2%.

In the other process the salt bath contains all the necessary elements without additions, and includes sodium hydroxide, and the bath is operated at a temperature of 900° F.

The batch type operations used heretofore in both of these sodium hydride metal descaling processes in which pieces of metal are separately subject to the action of the baths are relatively slow, and attempts heretofore made to adapt these sodium hydride descaling processes to continuous operations have been unsuccessful, properly descaled metal being unobtainable excepting at speeds which are too slow for the mass production manufacturing operations required in either a peacetime economy or a wartime economy.

In a peacetime economy, overall high speed mass production operations are necessary to produce a profit. In a wartime economy, overall high speed mass production operations are necessary, even under controlled prices and fixed profits, in order to fulfill the production requirements of warfare.

In a high speed mass production line, any component process must have a speed of operation coordinated with the speeds of operations of the other component processes, and consequently the slowness of the prior sodium hydride descaling processes, whether batch or continuous, renders them unsuited for inclusion in the high speed mass production of steel sheets or continuous strips as practiced in 1946, particularly stainless steel sheets and strips.

As above indicated, the molten salt baths of both the prior sodium hydride descaling processes include sodium hydroxide. In each case the bath is maintained molten by externally applied heat. Molten sodium hydroxide baths have long been used for treating metals in various specific manners, in many instances the bath being electrolyzed, and in some instances the article being treated being a part of the electrolytic circuit.

By using an externally heated molten salt bath as in two prior processes, the necessity for electrical equipment is eliminated.

The nature of the present invention may be stated in general terms as including methods including successive sequential steps, by which a continuous strip of moving metal and particularly stainless steel may be sub-

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ject generally to a molten bath treatment which is adequate at a speed of 30 to 100 feet per minute or more of the strip, and particularly to a molten descaling bath treatment, the bath preferably containing sodium hydride.

As compared with an acid bath, in a molten descaling bath treatment in which the bath contains sodium hydride in molten sodium hydroxide, the sodium hydride acts on oxides only, whereas an acid bath attacks both oxides and the parent metal.

By way of example, embodiments of apparatus for carrying out the method of the present invention, and parts thereof, are illustrated in the accompanying drawing forming a part hereof, and in which

Figure 1 is a diagrammatic view, partly in vertical elevation, and partly in vertical section showing one form of apparatus adapted for carrying out the improved methods hereof;

Fig. 2 is an enlarged transverse sectional view thereof as on line 2—2, Fig. 1, with details added and distant parts removed; and

Fig. 3 is another enlarged transverse sectional view thereof as on line 3—3, Fig. 1, with details added and distant parts removed.

Similar numerals refer to similar parts throughout the drawing.

The apparatus for metal treatment, and particularly for metal descaling, is indicated generally by 10 in Fig. 1, and the apparatus 10 as shown is part of a continuous annealing, descaling, and pickling line for an elongated metal piece 11 as shown a metal strip, and particularly a stainless steel strip. The elongated metal strip 11 is moved longitudinally sequentially through each component apparatus of the entire line, in a usual manner as from coils not shown beyond the left side of Fig. 1 to coils not shown beyond the right side of Fig. 1.

The improved apparatus 10 includes, from left to right as shown in Fig. 1, a plurality of sub-apparatuses or metal treating means, through each of which the metal strip 11 is moved. These sub-apparatuses or metal strip or piece treating means include from left to right in Fig. 1, an annealing furnace indicated generally by 12, first radiant heating means indicated generally by 13, immersing bath means indicated generally by 14, second radiant heating means indicated generally by 15, and liquid spray means indicated generally by 16. From the liquid spray means 16 the strip 11 passes into a pickling tank indicated generally by 17 which may be of any usual type.

The annealing furnace 12 may be of usual construction, and within its compartment the strip 11 is subject to contact with one or more hot gases, as is usual in an annealing furnace. The annealing furnace 12 has an exit opening 18 from which the strip 11 emerges and passes over a level roll 19 into the entrance opening 20 of the first radiant heating means 13.

The first radiant heating means 13 is illustrated in greater detail in Fig. 2, and includes a horizontally extending rectangular tube having a bottom wall 21, and side walls 22a and 22d of refractory material, carried in a sheet or plate steel case indicated generally by 23, and being supported by suitable structural steel framework 24. The top wall of the rectangular tube of the first radiant heating means 13 as shown includes a lower heat resistant metal plate 25 upon which lies an upper layer of refractory material 26.

The rectangular tube of the first radiant heating means 13 formed by the walls 21, 22a, 22b and 25 encloses a horizontally extending open ended passageway 27 through which the strip 11 moves. The strip 11 as shown and preferably is laterally horizontal, and within the tube passageway 27 above the strip 11, a set of laterally extending preferably horizontal and parallel straight radiant

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heating elements 28 are located, each heating element 28 extending between and having its ends supported in, as shown, the first radiant heater side walls 22a and 22b.

Similarly, below the strip 11 in the passageway 27 of the first radiant heating means 13, another set of radiant heating element 28 is located. Each of the radiant heating elements 28 may be a tube of radiant heat resistant metal alloy which is heated to radiant heat by an internal flame, or when desired each of the radiant heating elements 28 may be an electric resistance radiant heating element which is maintained at radiant heat by being located in series with a source of electric power. Such an internally flame heated tubular radiant heating element, or such an electric resistance radiant heating element, is of usual construction and operation, and any other desired form of radiant heating element may be utilized, such as a metal member brought to radiant temperature by electric induction heating.

The first radiant heating means 13 has an exit opening 29 from which the strip 11 emerges, preferably passing over a level and guide roller 30 above the entrance end 31 of the immersing bath means 14.

The immersing bath means 14 includes an elongated upwardly opening tank indicated generally by 32 and having an upwardly opening elongated compartment 33 extending from the entrance end 31 to the exit end 34. A level and guide roll 35 extends laterally in the compartment 33 between side walls of the tank 32 at the entrance end 31, and the roll 35 is longitudinally spaced from and below the level and guide roller 30. Similarly within the compartment 33 of the tank 32 at the exit end 34, a level and guide roll 36 extends between said walls of the tank, and longitudinally spaced from the roll 36 and above the exit end 34 of the immersing bath means, there is located a level, guide, and heater roll 37.

The strip 11 extends downwardly from the roll 30 into the entrance end 31 of the compartment 33 of the tank or container 32 of the immersing bath means 14. The strip 11 then extends under the roll 35 and longitudinally through the compartment 33 to and under the roll 36 and upwardly therefrom to and over the roll 37. The tank 33 is filled with the desired liquid metal treating material to a level above the portion of the strip 11 extending between the rolls 35 and 36.

The immersing bath means 14 may have details of construction shown in Fig. 3 in which inner walls of the tank 32 are steel walls indicated generally by 38 resting in a trough formed in outer refractory walls indicated generally by 39. The tank steel walls 38 as shown include side walls 40a and 40b, and the tank outer refractory walls include side walls 41a and 41b alongside the tank steel walls 40a and 40b, and the refractory side walls 41a and 41b having longitudinally extending side opening channels 42a and 42b formed therein, the channels opening towards the steel side walls 40a and 40b.

Longitudinally extending baffle means 43a and 43b are located in the channels 42a and 42b, and each side wall 41a and 41b has a plurality of inwardly flaring burner openings 44 formed therein at the outer smaller end of each of which is located the tip end of a gas burner nozzle 45, the flame from which in operation impinges the opposite baffle wall 43a or 43b, whereby the tank inner steel walls 38 are heated to the desired temperature for transmission to the liquid or molten material in the compartment 33 of the tank or container 32.

The second radiant heating means 15 is interposed between the rolls 36 and 37, and is of a construction generally similar to the first radiant heating means 13, with suitable dimensional changes. In the second radiant heating means 15, the strip 11 passes into a lower entrance end opening 46-1 and upwardly through the passageway 46-2 of the second radiant heating means 15 and out the exit end opening 46-3 thereof and over the roll 37.

The liquid spray means 16 includes upper walls form-

ing a tunnel 48 having an entrance end opening 49 and an exit end opening 50. The bottom of the tunnel 48 opens into an upwardly opening drain pit 50-1. Intermediate the ends of the tunnel 48 and between the side walls thereof, a level and guide roll 52 extends. The guide roll 37 is adjacent and outside of the tunnel entrance end opening 49, and adjacent and outside of the exit end opening 50 of the tunnel 48, a level and guide roll 51 is located. The strip 11 passes into the tunnel from the roll 37 downwardly beneath the roll 52 and upwardly over the roll 51 from which it passes into the usual pickling tank 17. Above the strip 11 within the tunnel passage 53 there is located one set of liquid spray nozzles each indicated by 54, the spray 55 of each of which is directed downwardly onto the top surface of the strip 11. Below the strip 11 in the tunnel passageway 53, another set of liquid spray nozzles each indicated by 54 each directs its spray 55 upwardly against the bottom surface of the strip 11.

The operation of the improved apparatus 10 for carrying out the improved methods hereof, preferably for pickling a stainless steel strip 11, is as follows: The compartment 33 of the tank or container 32 of the immersion bath means 14 is filled with a bath 56 of desired metal treating material which may be either liquid or molten, but for the purposes of descaling stainless steel may preferably be a molten sodium hydroxide bath containing metallic sodium and hydrogen as in the first above described batch sodium hydride descaling process. The bath 56 has its upper surface 57 at a level substantially above the portion of the strip 11 extending between the rolls 35 and 36, and the temperature of the bath 56 is maintained at the desired temperature of 700-750° F. in the first above described batch process, by operation of the gas burners 45. The interior temperature of the compartment of the annealing furnace 12 containing one or more gases is maintained at a usual annealing temperature. The temperature within the passageway 27 of the first radiant heating means 13 is maintained preferably at least equal to and preferably above the temperature of the bath 56 of molten material. Likewise, the temperature in the passageway 46-2 of the second radiant heating means 15 is maintained at a temperature at least equal to or above the temperature of the bath 56 of molten material.

The heating capacity of the first radiant heating means 13 is sufficient to bring up and maintain the temperature of the portions of the strip or metal piece 11 passing therethrough somewhat above the temperature of the bath of molten material 56, so that none of the heat of the bath 56 is required to heat the metal strip or piece 11 as it passes therethrough. The temperature of the strip 11 as it passes through the second radiant heating means 15 is likewise maintained above the temperature of the bath 56 of molten material so that the adhering salt mixture on the metal strip 11 is maintained fluid preventing solidification of the salt on the strip 11 which otherwise would cause marks or scratches on the finished or partly finished surfaces of the strip 11, and which also would result in excessive carry out of the salts of the bath 56.

The tunnel or box 48 of the liquid spray means 16 is provided with suitable shielding means at its entrance end opening 49 and at its exit end opening 50. Each spray nozzle 54 is served with water at a relatively high pressure of upwards of 500 pounds per square inch, and the high pressure liquid spray means 16 serves to thoroughly remove adhering salt and descaling residue from the surfaces of the strip 11. Adhering salt otherwise would reduce the acid concentration in the pickling tank 17, usually containing nitric acid.

The level guide and heater roll 37 is maintained by internal heating means at a temperature of upwards of 700° F. or more to further maintain the temperature of

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the strip 11 as it passes out of the second radiant heating means 15.

The strip 11 is passed in sequence through the annealing furnace 12, the first radiant heating means 13, the immersing bath means 14, the second radiant heating means 15, the liquid spray means 16, and the pickling tank 17, and subsequent sub-apparatuses by usual means such as tension rolls located at the right of the parts illustrated in Fig. 1.

By reason of the improved relation of the steps of the improved methods hereof and the apparatus parts for carrying out the improved method steps, satisfactory descaling may be attained when using the sodium hydroxide and sodium hydride descaling molten material in the bath 56 at a speed of the moving metal strip or piece 11 of 30 to 100 feet per minute.

In the treatment of the elongated metal piece 11 by operation of the improved apparatus 10 to carry out the improved methods hereof, the treatment of the elongated metal piece 11 may otherwise be described as including method steps including moving the elongated metal piece 11 longitudinally in one direction (from left to right in Fig. 1) and successively subjecting portions of the metal piece 11 to a plurality of different actions in sequence, each action taking place in one of the component sub-apparatuses or metal treating means 12, 13, 14, 15, and 16, as above described.

The embodiments of the present improvements illustrated and described herein are by way of example, and the scope of the present invention is not limited to the same or to the particular details thereof but is commensurate with any and all subject matter contained herein which may at any time properly under the U. S. patent laws be set forth in the claims hereof or originating herein, and the elements of any such claims are intended to include their reasonable functional and structural equivalents.

I claim:

1. In the treatment of an elongated metal piece, the method steps including moving the elongated metal piece longitudinally in one direction and successively subjecting successive portions of the metal piece to a plurality of different actions in sequence, as follows: heating by contact with one or more hot gases, a first heating subsequent to the gas heating, immersion in a bath of non-acid descaling liquid material consisting of molten sodium hydroxide and molten sodium hydride, a second heating

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subsequent to the immersion, and impingement by water sprays.

2. In the treatment of an elongated metal piece, the method steps including moving the elongated metal piece longitudinally in one direction and successively subjecting successive portions of the metal piece to a plurality of different actions in sequence, as follows: first heating, immersion in a bath of non-acid descaling liquid material consisting of molten sodium hydroxide and molten sodium hydride, second heating subsequent to the immersion, and impingement by water sprays.

3. In the treatment of metal, the method steps including maintaining a hot liquid bath consisting of molten sodium hydroxide and molten sodium hydride at a predetermined temperature, heating the metal immediately prior to immersion in the bath to a temperature above the bath temperature, immersing the metal in the bath, and removing the metal from the bath and immediately again heating the metal to a temperature above the bath temperature.

4. In the treatment of an elongated metal piece, the method steps including moving the elongated metal piece longitudinally in one direction and successively subjecting successive portions of the metal piece to a plurality of different actions in sequence, as follows: heating by contact with one or more hot gases, a first heating subsequent to the gas heating, immersion in a bath of non-acid descaling liquid material consisting of molten sodium hydroxide and molten sodium hydride, a second heating subsequent to the immersion, and impingement by water sprays, the pressure of the liquid sprays being upwards of 500 pounds per square inch.

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