May 9, 1944. J. S. THOMPSON 2,348,698

METHOD OF ROLLER COATING

Filed Aug. 3, 1940 2 Sheets-Sheet 1

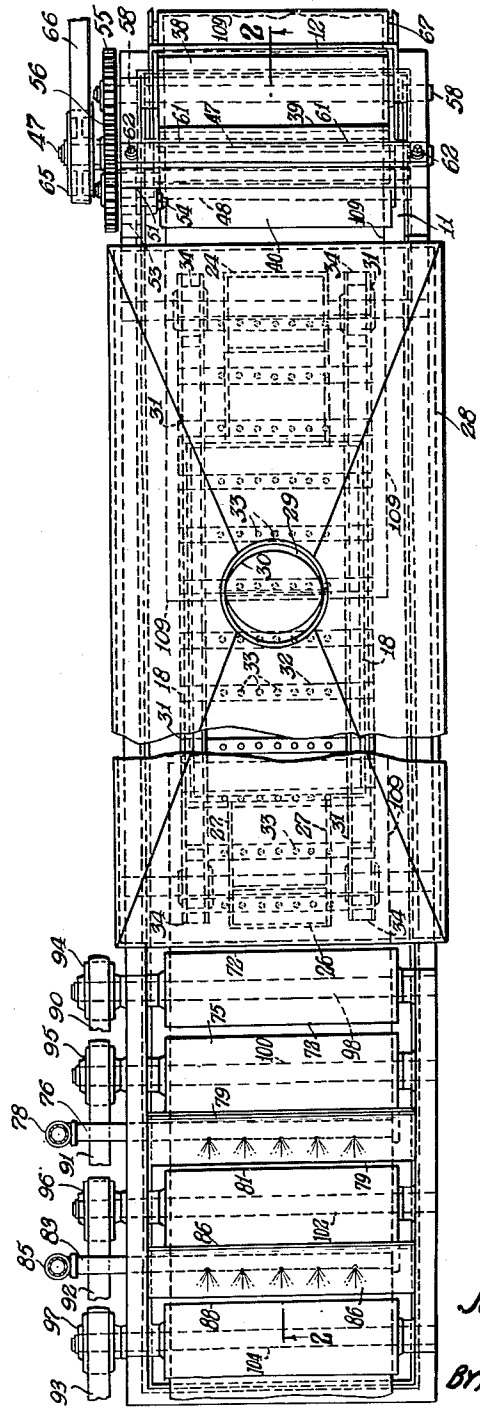

Fig. 1.

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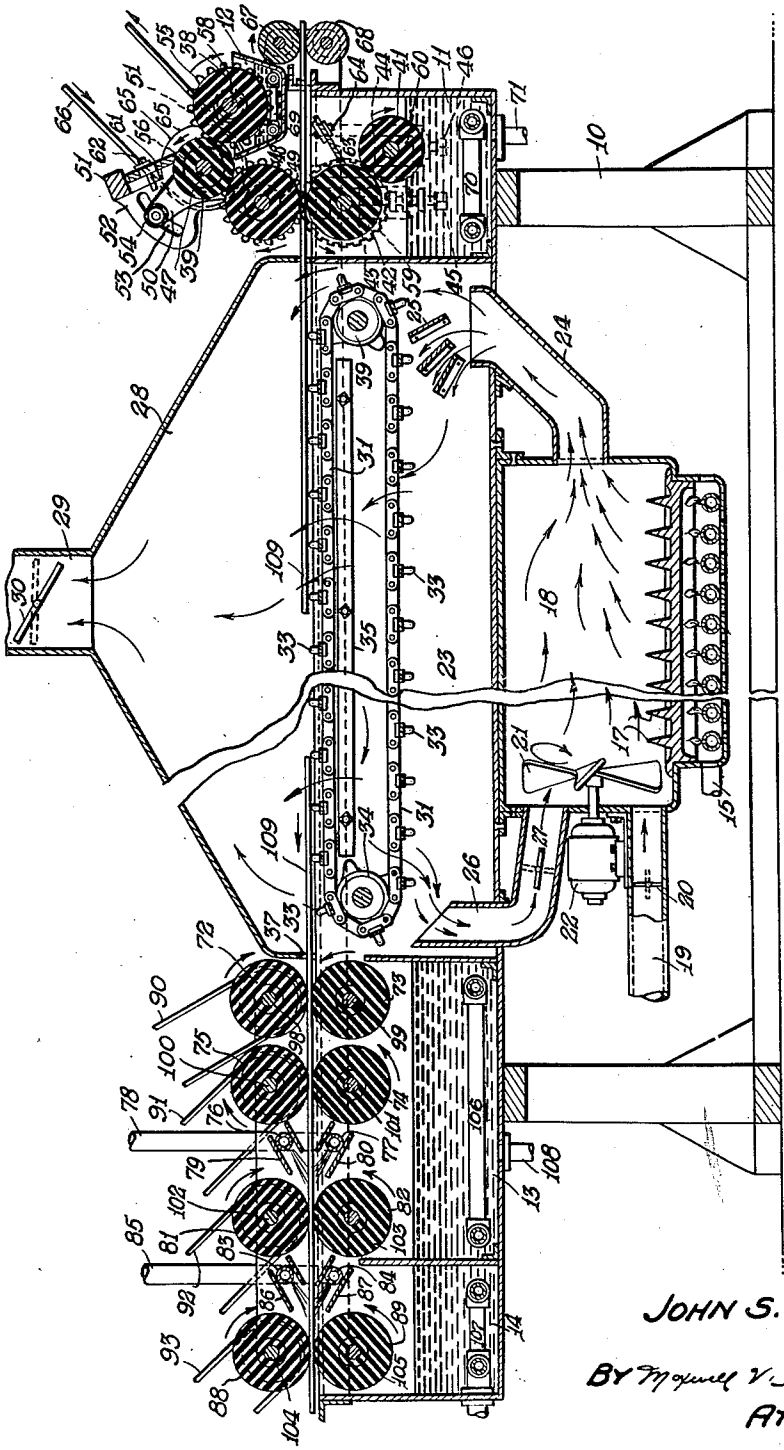

Fig. 2.

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UNITED STATES PATENT OFFICE

2,348,698

METHOD OF ROLLER COATING

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Application August 3, 1940, Serial No. 351,900

7 Claims. (Cl. 148—6)

This invention relates to the coating of metal and particularly to prepare the surface of metal to receive paint, dye, lacquer or the like, and is a continuation in part of my application, Method of roller coating, Serial No. 199,129, filed March 31, 1938. It has been known for some time that the surface of metal may be changed or converted from one of metal to one of non-metal by the use of various solutions. The art first taught the submerging of the article to be coated or converted into the solution and allowing the article to remain therein until the coating operation had been completed. Later it was discovered that coating could be obtained by spraying the solution upon the article to be coated either while the article remained stationary or while it was being passed through a chamber upon a conveyor, the spray bombarding the article with solution and bringing about the conversion necessary to completely coat the article. It has now been discovered that fine corrosion retarding coatings may be obtained upon metal surfaces by passing the metal through a plurality of rollers which have become wet with a solution which will convert the surface from one of metal to one of non-metal.

In the preparing of metal surfaces to resist corrosion a great many solutions are known which in turn form many types of coatings, according to the solution used. Of the better known coatings the phosphates, chromates, oxalates, and oxides lead the field today.

The method herein disclosed is particularly useful at the mill or point of metal manufacture because it enables the manufacturer to coat the sheets as they come from the final manufacturing step preparatory to shipping. The problem has presented itself of preventing corrosion of sheets between the time they leave the mill and the time they reach the point where they are to be used. At times the sheets are not used for weeks and even months and in this interval corrosion sets in and necessitates an additional operation to remove this rust before painting. With the present method the sheets are treated immediately following the last manufacturing step so that the method fits into the modern mill or modern manufacturing plant as another step or operation and saves the user forwarding his stock to a jobber or separate plant to have his sheets prepared for painting.

The principal object of the present invention is to provide a new and improved method for converting the surface of metal from one of metal to one of non-metal.

Another object of the present invention is to provide a new and improved method of coating metal which aids in the precleaning of the sheets, the rollers performing a scrubbing and pressure action thereon which lessens the effect of extraneous and deleterious matter that usually adheres to the sheets in their travel through the various manufacturing steps.

A still further object is to provide a new and improved method for coating metal whereby the surface of the metal is not only transformed from one of metal to one of non-metal, but the sheets are dried, water rinsed and acid rinsed to prepare them for the immediate application of paint, lacquer, dye or the like.

The above and other objects will appear more fully from the following more detailed description, and from the drawings, wherein

Fig. 1 is a top plan view of the apparatus used to carry out this method of coating metal; and

Fig. 2 is a section of the apparatus taken substantially on the line 2—2 of Fig. 1.

Referring now to the drawings, the numeral 10 designates supporting means for supporting the superimposed apparatus for carrying out the method herein disclosed. Conveniently located at one end of the apparatus is a solution reservoir 11 above which is suitably located an additional solution reservoir 12 for a purpose later to be described. Conveniently located at the other end of the apparatus is a pair of rinsing tanks 13, 14, and midway between the solution tanks and rinsing tanks there is provided a heating and drying chamber comprising a heat producing means, which in the drawings is shown as a gas pipe 15 having a plurality of holes 16 therein for the gas flame which in turn impinges a base plate having a plurality of fins 17 formed integral with the base of the heating chamber

and running transversely thereof to provide a greater heating area to said chamber. Any well known heating means, such as coal or electricity may be used, gas being used in this illustration merely as an illustrative example. Immediately above and formed integral with the heating means just described is a heat circulating chamber into which air is brought from atmosphere through duct 19, said duct being provided with damper means 20 to close the duct when required. A circulating fan 21 is conveniently provided within the heat circulating chamber 18, the same being rotated by means of motor 22. Superimposed upon and built integral with the heat circulating chamber 18 is a drying chamber 23. A warm air duct 24 connects heat circulating chamber 18 and drying chamber 23 and a plurality of directional baffles 25 act to direct the warm air in the circuitous path desired. An additional duct 26 is provided to connect the drying chamber 23 with the heat circulating chamber 18 and to return part of the air back into the heat circulating chamber and deposit the same directly back to the circulating fan 21 so that it may be again passed over the heated fins 17 and returned to the drying chamber 23. A damper 27 is conveniently located within duct 26 so that this duct may be closed when desired. A hood 28 is located directly above and built integral with the drying chamber 23 and provides means for taking off the fumes by means of a stack 29 having a damper 30 located therein to close the stack when desired. Suspended within the drying chamber 23 is a pair of endless conveyor chains 31 with a plurality of spaced transverse ribs 32 supported thereon (shown best in Fig. 1 of the drawings) said ribs having secured thereto a plurality of pointed pins 33 which act as supports for the metal sheets as they are carried by the conveyor. The pins are tapered or pointed to reduce the area covered on the sheet by the pin so that practically the entire sheet will receive warmed air during the drying operation. The conveyor chains 31 are trained about a pair of sprocket wheels 34, and to prevent the conveyor chains from sagging there are provided supports 35 comprising a pair of angle irons which in turn support each chain as they make their run. The numeral 36 designates a transverse opening or slot provided to allow the sheets to pass into the drying chamber 23 and numeral 37 designates an opening or transverse slot to allow the sheets to pass from the drying chamber 23 to the rinsing operation.

Suitably located within the solution reservoirs is the mechanism for applying the corrosion retarding solutions which comprises a solution feeding roller 38 which is at all times partially submerged in the solution, contained in reservoir 12. Roller 38 is at all times in mesh with a driving roller 39 which in turn is in mesh with a driven solution feeding and spreading roller 40. Driven roller 41 is at all times partially submerged in solution reservoir 11 and is at all times in mesh with driven solution spreading and feeding roller 42. To compensate for the various thicknesses of sheets which are passed between rollers 40 and 42 there is provided vertical adjusting means located adjacent lower reservoir 11, the adjusting means comprising a slidable bearing 43 for adjusting roller 42 and a slidable bearing 44 for adjusting roller 41 by means of adjusting screws 45, 46. Roller 40 is mounted on shaft 48, the shaft being mounted in arm 49, which is integral with arm 50 which is rotatably mounted on shaft 47. The numeral 51 designates a portion of the machine frame in which shaft 47 is mounted. Portion 52 of the machine has a slot 53 formed therein to allow for movement of bolt 54 so that the same may be either raised or lowered in said slot, said adjustment permitting roller 40 to be moved toward or away from roller 42. These rollers are operated through a train of gears 55, 56, 57 which are suitably mounted on the end of shafts 47, 48, 58. The lower feeding rolls 42 and 41 also are operated through gears 59 and 60, gear 59 being directly beneath gear 57 and in mesh with same. The machine frame projection 52 has mounted thereon a scraper 61 which is provided with an adjusting means 62. Lower coating roller 42 is also provided with an adjustable scraper 63 provided with adjusting means 64. The main driving means comprises pulley 65 having a belt 66 trained thereon, said pulley being secured to shaft 47 so that when the shaft is rotated gear 56 is rotated and in turn rotates gears 55, 57, 59 and 60. A pair of guide rollers 67, 68 are provided to guide the sheets so that they will pass between the coating rollers 40, 42. Steam pipes 69 and 70 are provided in the upper and lower solution reservoirs to keep the solution at the temperature desired for processing. A drain pipe 71 is provided in reservoir 11 to clean out the same when necessary.

After the sheets have passed through the drying chamber 23 a plurality of apposed guide rollers 72, 73, 74, 75 carry the sheets between rinsing means comprising a pair of transverse pipes 76, 77 containing a plurality of apertures therein to allow the rinsing medium to escape onto the sheets. These pipes are fed by stand pipe 78 and directional baffles 78, 80, direct the spray so that it impinges directly upon the sheets and thoroughly sprays the entire area beneath the pipes. Another pair of rollers 81, 82 drive the sheets between an additional rinsing means comprising a pair of transverse pipes 83, 84, containing a plurality of apertures therein to allow the rinsing medium to escape onto the sheets. These pipes are fed by stand pipe 85 and directional baffles 86, 87, direct the spray so that it impinges directly upon the sheets and thoroughly sprays the entire area beneath the pipes. An additional pair of driving rollers 88, 89, carry the sheets from beneath spray pipes 83, 84, and out of the apparatus. Driving rollers 72, 75, 81 and 88 are driven by belts 90, 91, 92, 93 trained about pulleys 94, 95, 96, 97 (see Fig. 1 of drawings). The rollers as shown are of rubber and bonded to shafts as follows: roller 72 to shaft 98, roller 73 to shaft 99, roller 75 to shaft 100, roller 74 to shaft 101, roller 81 to shaft 102, roller 82 to shaft 103, roller 88 to shaft 104, and roller 89 to shaft 105. Although rubber is shown, any adsorbent material may be used, or metal rollers smooth or suitably corrugated may be substituted. Steam coil 106 is conveniently located in reservoir 13 to keep the rinsing solution at the desired temperature and steam coil 107 is located in reservoir 14 to keep the rinsing solution in this reservoir at the desired temperature. A drain pipe 108 is located in the bottom of reservoir 13 so that the same may be dumped when necessary.

Although the process may be operated with many different corrosion resistant solutions to coat many types of metals, such as iron, steel, zinc, cadmium, copper and lead, there are given below a few specific examples of corrosion retarding solutions. These examples are given by way of illustration and not limitation, it being understood that wide deviations are possible in

ingredients, proportions, temperatures, etc., without departing from the spirit of the invention:

To coat zinc use—

	Parts by volume
1. 75% phosphoric acid	8
60% nitric acid	6
Water	50

To coat zinc, iron and cadmium use—

2. Zinc dihydrogen phosphate	lbs.	8.2
50% zinc nitrate solution	lbs.	36.5
70% nitric acid	av. ozs.	14
Copper carbonate	grams.	57
Wetting agent (Novonacco NN)	cc.	75
Water	lbs.	74

To coat iron and steel use—

	Per cent
3. Zinc dihydrogen phosphate	2.8
75% phosphoric acid	2.5
Chromic acid	1.0
Wetting agent (Novonacco NN)	.4
Balance	Water

To coat iron and steel use—

4. Zinc dihydrogen phosphate	grams.	140
Copper nitrate	do	28
Water	liters	4

To coat iron and steel use—

	Per cent
5. 100% phosphoric acid	8.5
Chromic acid	9.0
Wetting agent (Duponol)	1.0
Balance	Water

To coat zinc use—

6. Oxalic acid	grams.	360
Sodium nitrate	do	120
Ferrous sulfate	do	60
Fuller's earth	lbs.	4
Water	gallon	1

To coat iron, zinc, cadmium, copper and lead use—

7. Oxalic acid	lbs.	10
Ferric oxalate	lbs.	50
Water	gallons.	100

A rinse with a solution containing chromic acid or other hexavalent chromium compounds, preferably in an acid medium may be used following the use of any of the above coating solutions to enhance the corrosion-resistance and paint-bonding properties of the coatings.

In some instances it is difficult to obtain uniform wetting of the metal by the coating solution especially where relatively high concentrations of chromic acids or other hexavalent chromium containing solutions are employed. In such instances it may be necessary to first pre-treat the metal by means of solutions which will produce a surface which is more reactive with the hexavalent chromium containing solution than the untreated metal.

The first treatment, as indicated above, may result in a coating essentially oxide, a coating of a metallic deposit, a coating of a salt of iron and additional salts, if desired, or in mixtures of any two or all three of the types mentioned, and may include sulphides or other ingredients which perform like functions.

For example, the first step may be treatment with any one of the many known phosphate coating solutions, or with solutions of organic coating acids, such as described in Patent No. 1,911,537, to Robert R. Tanner, for example. But, if a solution of this type is employed, whether with or without oxidizing agents, accelerating metal compounds, or other obvious modifications, the treatment should be limited so as to produce a much thinner coat than has been hitherto generally desired as a product of such solutions, so that the major part of the final coating is produced by the second treatment, and preferably so that the second solution may treat the metal surface as well as the product of the first treatment.

The following examples will serve to illustrate means by which oxide coats may be produced upon metal.

Upon steel, first coatings have been produced by treating the surface of the metal with a solution for two minutes where the solution contained as its active chemical 2.5% of the nitrates of manganese, chromium, magnesium, cobalt, iron, lead, cadmium, zinc, aluminum, mercury, or copper, or 5% nitrate of strontium, barium, or calcium.

Widely different concentrations of solutions may be employed and likewise the temperature and time of treatment may be varied, such variations in the strength of the solution, and the time and temperature of treatment being adjusted to obtain the desired thickness of coating in accordance with the principles stated in connection with the detailed disclosure of the second treatment.

As a specific example a solution of the following analysis may be applied to steel sheets by rollers and be allowed to stand in contact with the metal for a period of thirty seconds.

	Per cent
H_2O	93.
H_3PO_4	5.
$NaClO_3$	.25
As_2O_5	.25
Ferric iron	1.
Cl as NaCl	.5

The metal which during this time receives a coating which is predominantly oxide, after receiving a water rinse, is roller coated with a solution having the analysis of

	Per cent
Phosphoric acid	6
Chromic acid	3
Trivalent chromium	.5

The coated sheet is then heated at a temperature of 550° F. for 10 minutes in order to render the applied film insoluble.

The general procedure involving the application of solutions adapted to coat the metals by means of rolls is carried out as follows:

The solution to be used to convert the surface of the metal to be treated from one of metal to one of non-metal is first placed in the solution reservoirs 11 and 12 and the solution for rinsing is placed in the rinsing solution containing tanks 13 and 14. If desired, steam is then injected into the various steam coils in the reservoirs so that the corrosion retarding and rinsing solutions will become heated to the desired temperature. The means for heating the heating chamber beneath the fins 17 is then ignited and fan 21 is turned on. The damper 20 in duct 19 remains at its dotted line open position, as shown best in Fig. 2 of the drawings, so that air is brought in from atmosphere and heated. Inasmuch as it is necessary to have the proper pressure on the work 109 as it passes between rollers 40 and 42, and also to compensate for the various thicknesses of material

being run through said rollers, the gear train controlling these rollers must be adjusted so that the proper opening remains constant all during the run. To adjust solution spreading roller **40**, bolt **54** located in slot **53** in frame portion **52** is moved upwardly, and, inasmuch as rollers **40**, **39** and **38** are journaled in movable arm **50**, which in turn is rotatably mounted on shaft **47**, gears **55**, **56** and **57** located on the ends of shafts **47**, **48** and **58** respectively, remain in mesh and the peripheral rubber surface of rollers **40**, **39** and **38** also remain in frictional engagement ready for use. To compensate for this upward movement of rollers **40**, **39** and **38**, rollers **42** and **41** must be moved upwardly so that the gearing on their shafts is also in mesh and the gear **59** remains in mesh with gear **57**. Adjusting screw **45** allows for movement upwardly or downwardly of roller **42** and adjusting screw **46** allows for movement upwardly or downwardly of roller **41**, so that their gears **59** and **60** are always in mesh and the face of these two rollers are always in frictional contact. The scraper **61** mounted on machine frame projection **52** is then adjusted by means of adjusting screw **62** so that the proper pressure is brought to bear on roller **39**, said scraper preventing any sludge from contacting solution spreading roller **40**, and also to provide a means to control even distribution of the corrosion retarding solution when transferred to roller **40**. The lower coating roller scraper **63** is also similarly adjusted by means of adjusting screw **64** for a like purpose. The solution spreading gear train is now set in motion belt **66** turning on pulley **65** in a counter-clockwise direction which in turn drives driving roller **39** in a counter-clockwise direction as shown by the arrow in Fig. 2 of the drawings. As rollers **40** and **38** are in mesh with driving roller **39** roller **38** will turn in a clockwise direction and roller **40** in a clockwise direction, as shown by the arrow in Fig. 2 of the drawings. Roller **38** being partially submerged in coating solution in reservoir **12** picks up solution, and inasmuch as rollers **39** and **40** are in frictional contact at all times this solution is transferred to solution spreading roller **40** which in turn transfers the solution to the work **109**. Likewise roller **41** is also partially submerged in coating solution in reservoir **11** and inasmuch as roller **41** is in mesh with solution spreading roller **42** at all times, solution is transferred to roller **42** and thence to the work **109**, the rollers turning in the direction of the arrows shown in Fig. 2 of the drawings. The work **109** passes first through guide rollers **67**, **68** and when the work is passed between solution spreading rollers the pressure exerted upon the work by the rollers tends to squeeze the solution between the rollers and the surfaces of the work, thereby causing wetting of said surfaces, and consequently the surface of the work is quickly transformed from one of metal to one of non-metal. Upon the completion of the conversion step, i. e., converting the surface from one of metal to one of non-metal, by means of the spreading rollers **40**, **42**, impregnated with corrosion retarding solution, the work passes through opening **36** into drying chamber **23**, where it is picked up by conveyor **31** and transported through this heating chamber at a predetermined speed to allow for a thorough drying of the work. In some cases, depending upon the type of solution being used, and the character of the work being processed, heat may be required to produce the coating, the rollers merely serving as a means of application. Also, in some cases, after applying the solution, by means of the rollers, time is required to complete the conversion of the surface of the metal from one of metal to one of non-metal, heat not being necessary.

The conveyor chains **31** which in turn support the transverse cross members **32** having the supporting pins **33** thereon is driven by a source of power not shown, at a convenient speed to thoroughly dry the work before it reaches the rinsing operation. There is an opening between each cross member to allow heated air to pass therebetween, and inasmuch as the work is supported by the pointed pins **33** the heated air is allowed to contact the under surface of the work and dry the same. Warm air also passes around the ends of the conveyor and between the sheets, as shown best by the arrows in Fig. 2 of the drawings and thus the air above the top of the work becomes warmed and in turn tends to dry the top of the sheets as they pass along on the conveyor. If it is desired to increase the temperature of the air within the hood **28**, the damper **30** in stack **29** is closed and the warm air will follow a circuitous path back down through duct **26** and will again be blown by fan **21** over the heating means in the base of warm air chamber **18** and up through duct **24** and directional baffles **25** to again be used as a drying agent for the work. Damper **20** in duct **19** may also be closed so that no fresh air will enter the warm air chamber **18** and this in turn will raise the temperature of the air already in drying chamber **23**, and convert drying chamber **23** into a baking oven of any desired temperature.

When the work **109** has been dried it passes from the conveyor through opening **37** and between driving and guide rollers **72**, **73**, **74**, **75**, rollers **72** and **75** being driven by means of belts **90**, **91** trained about pulleys **94**, **95** (see Fig. 1 of the drawings). Rollers **73**, **74** are rotated by friction contact with the work. As the work leaves rollers **75**, **74**, it is passed between rinsing pipes **76**, **77**, which run transversely of the work so that the sprays from the apertures therein thoroughly rinse the entire surface of the work passing beneath the pipes, the directional baffles **79**, **80** guide the rinsing solution directly on the work. The rinsing solution, usually water at this step of the process, is heated in reservoir **13** by means of steam coil **106** and is pumped to riser pipe **78** by a pumping means, not shown, from where it enters pipes **76**, **77**. After rinsing, the solution runs off the work and falls into reservoir **13** to be repumped to riser **78** and used over and over again. The work then passes between driving roller **81** and driven roller **82**, driving roller **81** being driven by belt **92** trained about pulley **96**, driven roller **82** being rotated by frictional contact with the work as it moves between the rollers. The work is then passed between a pair of additional rinsing pipes located directly above reservoir **14**, the pipes being located above and below the work and run entirely across the work. A number of apertures allows the solution to be sprayed onto the work and directional baffles **86**, **87** guide the flow of solution directly against the work. The rinsing solution is heated in reservoir **14** by means of steam coil **107**, and is pumped, by means not shown, to riser pipe **85** from where it is carried to pipes **83**, **84** and onto the work, the excess solution returning to reservoir **14**. This final rinsing solution usually contains a dilute solution of chromic acid, phosphoric acid, oxalic acid or a salt of iron, chromium or

aluminum, such as aluminum nitrate or sulphate, ferrous sulphate, ferric nitrate and chromic sulphate or nitrate. It has been found that by the use of a final rinse, such as that described above, paint blistering is reduced to a minimum. The solution may be used from 150° to 180° F. From 7 to 21 ounces of the acid or salt per 100 gallons of water is the preferred strength from the standpoint of economy, although stronger solutions are just as effective. A treatment of one minute in these solutions is sufficient. Following the above described rinse, the work passes between driving roller 88 and driven roller 89, driving roller 88 being driven by means of belt 93 trained about pulley 97, roller 89 being driven by frictional contact with the work. Having passed through the last two mentioned rollers the work is ready to be force dried or air blown, following which paint may be applied.

As an example of a solution for coating zinc, iron and cadmium to be followed with a chromic acid rinse, the following is given:

To 74 pounds of water add—

Zinc dihydrogen phosphate	lbs.	8.2
50% zinc nitrate solution	lbs.	36.5
70% nitric acid	av. ozs.	14
Copper carbonate	grams	57
Wetting agent (Novonacco NN)	cc.	75

("Novonacco" is a trade-marked product, obtained by the interaction of a hydrocarbon with sulphuric acid, the product is manufactured by The National Aniline and Chemical Company, Inc., of New York, N. Y.) A coating produced with the above solution may be followed by a rinse comprising 14 ozs. of chromic acid per 100 gals. of water used.

It will be seen from the above description that there is here set forth a new and unique method of coating metal preparatory to painting. This method may be installed at the mill and become another step in the manufacture of sheets or it may be installed in the jobbing plant where the sheets may be treated before painting and formed into the finished article. Also one side only of the sheet need be coated, the reservoir holding the coating solution supplying either the upper or lower coating roller may be emptied so that only one roller receives solution. Where common immersion or spray methods of applying chemically reactive corrosion retarding solutions are employed and the solution is applied over and over again, it must be replenished with proper chemicals to keep it in balance so that it will coat successfully. The roller method herein disclosed requires replenishing of the solution reservoirs insofar as the solution being used is concerned, but where the applying rollers transfer the solution from the solution reservoirs to the work and the solution stays on the work and is not returned to the solution reservoirs, the problem of keeping the solution in balance is overcome.

What I claim is:

1. In the chemical treatment of a metallic surface to form a corrosion-resistant paint-holding base thereon, the steps of moving a metallic surface in non-immersed condition past a roll having a yielding surface thereon, pressing the roll against the metallic surface during said moving, feeding an aqueous solution containing paint-base-forming chemicals between said roll surface and said metallic surface, adjusting the pressure of the roller against the metallic surface so that said solution is pressed into chemically reactive contact with said metallic surface and the desired amount of solution remains on said metallic surface and forming a paint-holding coating on the metallic surface from the chemicals so applied and their reaction products.

2. A method in accordance with claim 1 and comprising first applying a film of the solution to a roller and then transferring the solution from the roller to said surface.

3. A method in accordance with claim 1 wherein the treated metallic surface is of the class consisting of iron, zinc and their alloys.

4. A method in accordance with claim 1 wherein the treating solution is an aqueous solution of compounds of PO_4 and of compounds of hexavalent chromium.

5. A method in accordance with claim 1 wherein the treated metallic surface is of the class consisting of iron, zinc and their alloys and the treating solution is an aqueous solution containing compounds of PO_4.

6. A method in accordance with claim 1 wherein the treated metallic surface is of the class consisting of iron, zinc and their alloys and the treating solution is an aqueous solution containing compounds of PO_4, and comprising the added step of applying a solution containing hexavalent chromium to coating produced by said chemicals.

7. In the method of providing a metallic surface with a corrosion retarding and paint-bonding coating, the steps of moving said surface in a non-immersed condition past a roll, feeding to said surface in a position to be spread on the surface by said roll a solution adapted to producing a more chemically reactive surface than is the metallic surface with a solution containing hexavalent chromium, and thereafter applying in the same manner a solution containing hexavalent chromium.

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