June 3, 1947. R. H. GORDON 2,421,610

APPARATUS FOR RUSTPROOFING OR THE LIKE

Filed May 29, 1942 3 Sheets-Sheet 1

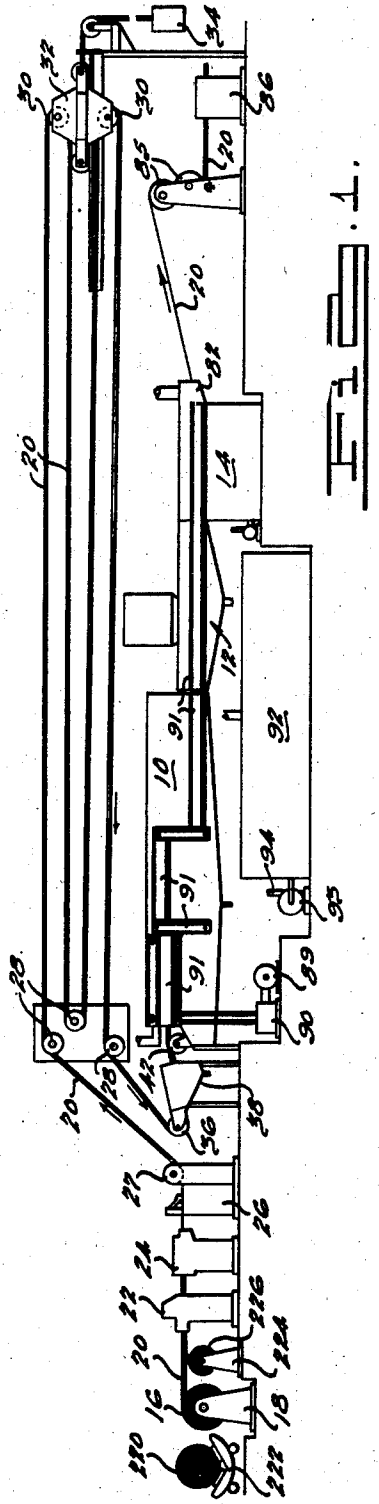


Fig. 1.

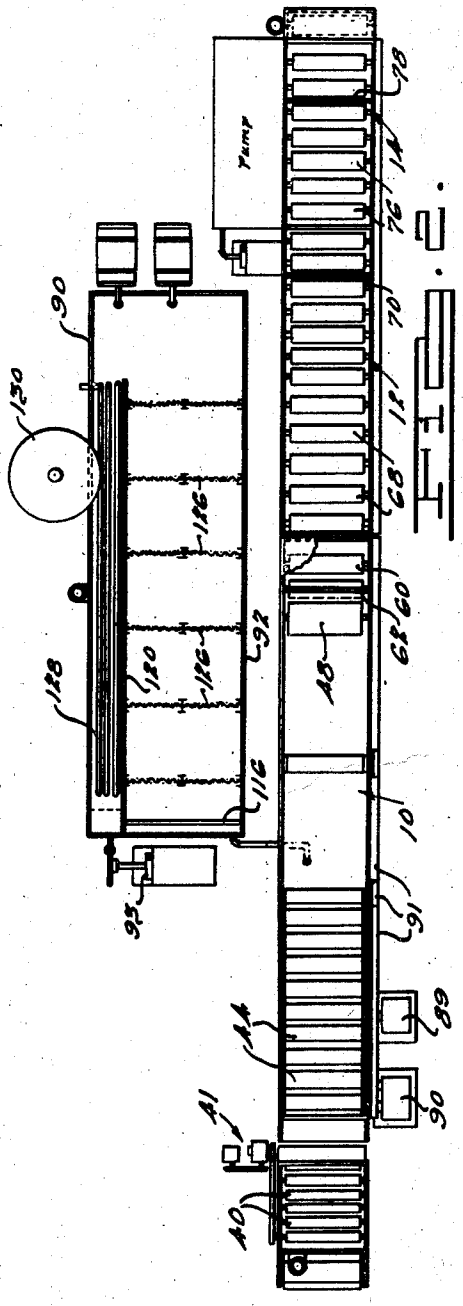


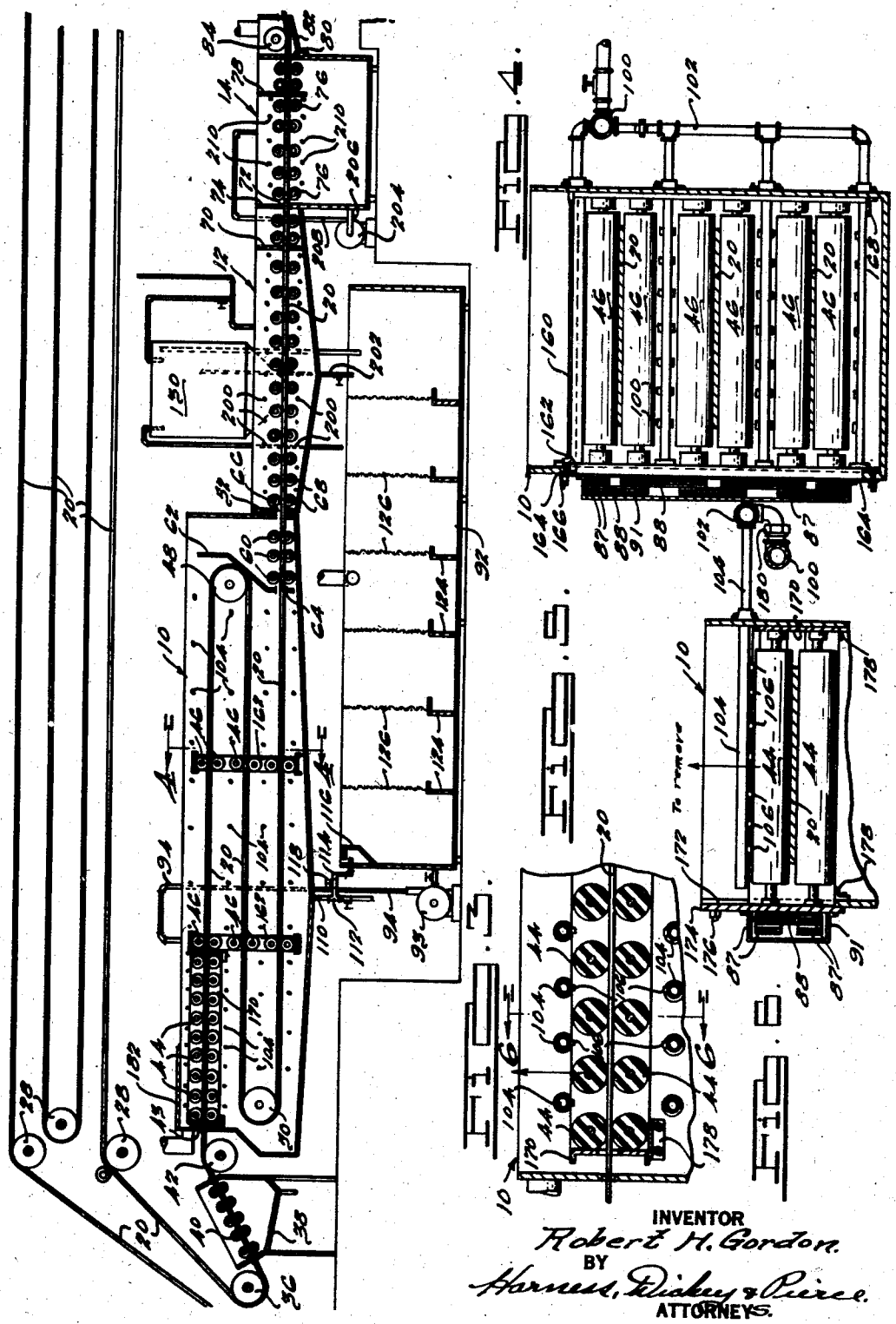
Fig. 2.

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APPARATUS FOR RUSTPROOFING OR THE LIKE

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APPARATUS FOR RUSTPROOFING OR THE LIKE

Filed May 29, 1942 3 Sheets-Sheet 3

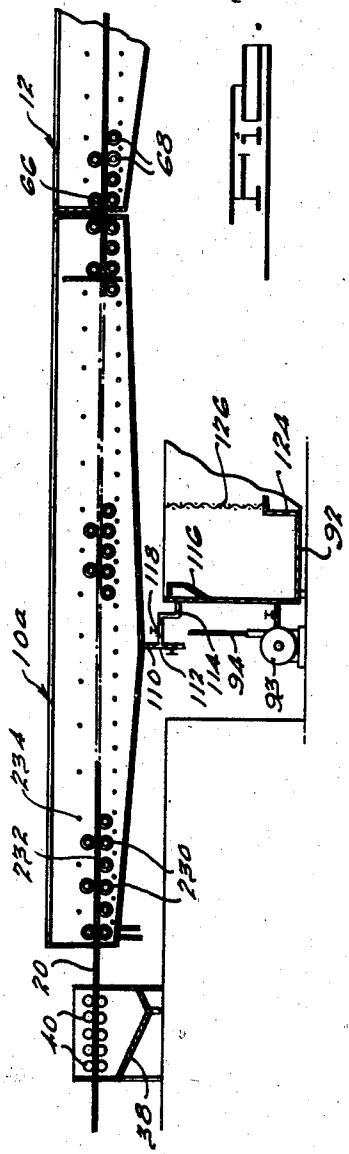


Fig. 2.

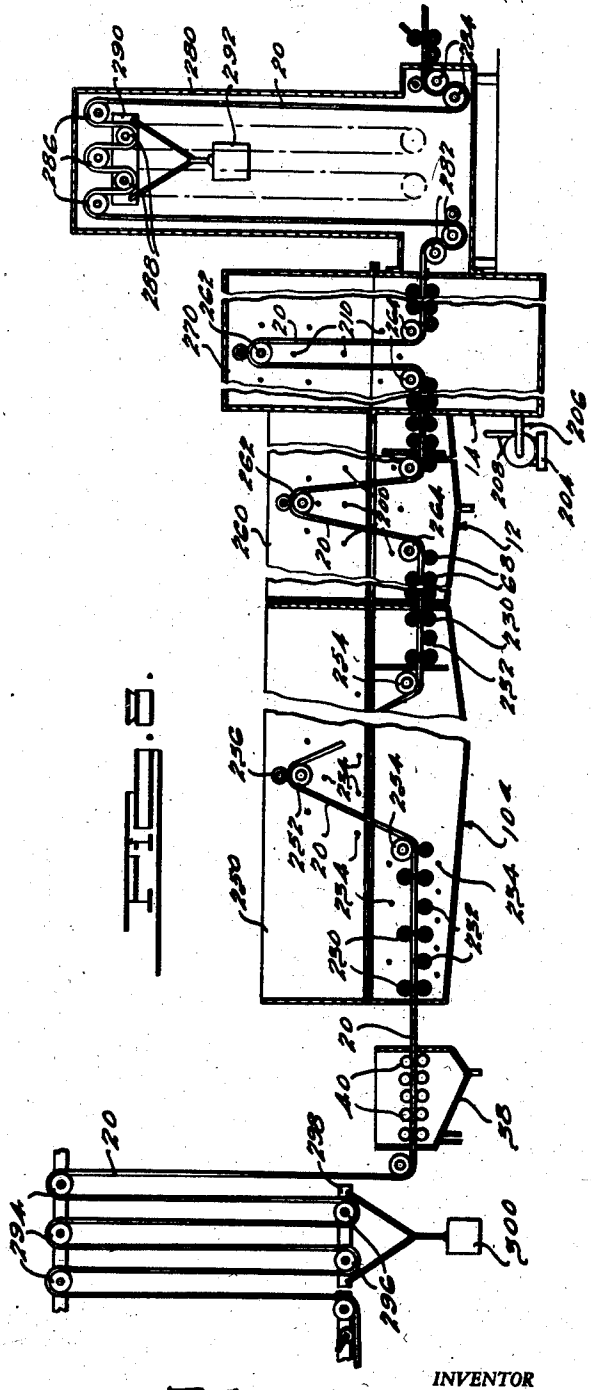


Fig. 3.

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UNITED STATES PATENT OFFICE

2,421,610

APPARATUS FOR RUSTPROOFING OR THE LIKE

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Application May 29, 1942, Serial No. 445,037

12 Claims. (Cl. 91—29)

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This invention relates to apparatus for use in the chemical coating of metal strips or sheets and the principal object is the provision of apparatus of this type by the use of which chemical coatings may be applied to such sheets or strips in a quick and efficient manner.

Objects of the invention include the provision of apparatus for chemically coating metal sheets or strips by the application of a chemical solution thereto and including a multiplicity of rolls arranged as a group or unit and applicable to and removable from the apparatus as such; the provision of apparatus of the type described in which a plurality of pairs of rolls are mounted in a supporting frame which may be applied and removed as a unit to and from the remainder of the apparatus; the provision of apparatus as above described in which each roll unit includes means for driving the rolls of the unit in unison with each other; and the provision of apparatus of the type described in which the roll units may be applied in both vertical and horizontal position in the apparatus.

Further objects of the invention include the provision of apparatus of the type described capable of handling strip material at a greater rate of speed than apparatus heretofore provided for such purposes; the provision of apparatus as above described in which the speed of the strip being treated through the apparatus may be maintained equal to that of apparatus for the same purpose heretofore employed, but in which the bulk of the apparatus may be decreased; and the provision of apparatus as above described in which the strip being treated by the chemical solution to produce a chemical coating thereon is caused to reverse its direction of travel in the tank in which such solution is applied thereto.

Further objects of the invention include the provision of apparatus for chemically coating metallic sheets and strips by the application of a chemical solution thereto including a chemical solution treatment tank, a rinse tank, and an acid bath tank arranged in line with each other for receiving and treating the work therein, the chemical solution treatment tank being removable from the remainder of the apparatus whereby a chemical solution tank adaptable only to the treatment of strip material may be replaced by one adaptable for treating either strip or sheet material, and vice versa; and the provision of apparatus of the type described in which the chemical solution treatment tank is capable of being modified from one capable of treating either sheet or strip stock to one capable of treating strip stock only but at a higher rate of speed.

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The above being among the objects of the present invention the same consists in certain novel features of construction and combinations of parts to be hereinafter described with reference to the accompanying drawings, and then claimed, having the above and other objects in view.

In the accompanying drawings which illustrate suitable embodiments of the present invention and in which like numerals refer to like parts throughout the several different views,

Fig. 1 is a more or less diagrammatic side elevational view of apparatus constructed in accordance with the present invention;

Fig. 2 is an enlarged plan view of the central portion of the apparatus shown in Fig. 1 in which the chemical coating operation actually takes place;

Fig. 3 is a slightly enlarged, vertical sectional view taken centrally through that portion of the apparatus shown in Fig. 2 in which the coating of the sheets or strips takes place;

Fig. 4 is an enlarged, transverse sectional view taken on the line 4—4 of Fig. 3 and illustrating in greater detail the method of supporting the vertical stacks of rollers;

Fig. 5 is an enlarged, fragmentary, vertical sectional view taken through the lefthand end of the horizontal row of rollers shown in Fig. 3 to better illustrate the method of mounting the same;

Fig. 6 is a fragmentary vertical sectional view taken on the line 6—6 of Fig. 5;

Fig. 7 is a more or less diagrammatic, fragmentary, vertical sectional view illustrating how the mechanism shown in the preceding views may be changed to accommodate it to the chemical coating of sheets instead of strips at a minimum of expense; and,

Fig. 8 is a fragmentary, broken vertical sectional view illustrating the manner in which mechanism of the type illustrated in Fig. 7 may be converted to operate upon strips instead of sheets and at an advanced speed of travel therethrough.

The present invention relates to apparatus for

use in the production of coatings on metal surfaces by the action of chemical solutions. Typical of such coatings are phosphate coatings applied to iron, steel, zinc, or the like to form a bond for paint. While the present invention may be useful in connection with the application of other chemical coating solutions, it will be described in connection with the production of phosphate coatings to obtain paint bonding coatings for which purposes it is especially suited.

Apparatus of this general type has been heretofore disclosed as, for instance, in the co-pending application for Letters Patent of the United States for Improvements in apparatus for rust-proofing sheet metal, filed by Robert R. Tanner on August 21, 1941, and serially numbered 407,775, now Patent No. 2,373,432, issued April 10, 1945, and owned by the assignee of the present application. As in the case of said Tanner application the present invention contemplates first subjecting metal sheets or strips to the effects of a chemical solution applied thereto through spray nozzles whereby to provide such sheets or strips with a phosphate coating. During the application of a chemical solution the sheets or strips are passed through a plurality of cooperating pairs of rolls and preferably the chemical solution is applied to these rolls in addition to the sheets or strips passing through them. After being subjected to the chemical solution for a required length of time the sheets or strips are then passed through a tank or other enclosure in which the chemical solution is thoroughly rinsed therefrom by the use of fresh water following which the sheets or strips are passed through another tank or enclosure in which they are subjected to the effects of an acid solution, such as a chromic acid bath, following which they are dried and ready for use. As in the case of the chemical solution the rinse water and the chromic acid bath are preferably applied to the sheets or strips through spray nozzles and the sheets or strips are preferably passed through cooperating pairs of rolls during such treatment.

The apparatus for the above stated purposes heretofore designed and built capable of handling either sheets or strips have been so constructed and arranged that by the use of a suitable chemical solution for a period of ten seconds they will acquire the desired chemical coating. Inasmuch as such apparatus heretofore designed and built has been capable of handling metal in the form of either strips or sheets, it has required such sheets or strips to pass through the spray tank portion of the apparatus in a single plane and under such circumstances and in order to avoid excessive lengths of apparatus the maximum speed of passage of the sheets or strips through the apparatus has been limited to substantially 200 feet a minute. In accordance with the present invention apparatus is provided by means of which the speed of passage of the work, when comprising strips only, may be materially increased as compared to the prior practice without increasing the length of the apparatus in any respect, permitting speed of passage of the work to be increased to 500 feet per minute or more. This further permits the amount of work treated by a single unit to be materially increased as compared to prior practices and results in greater economies in operation due to the smaller amount of equipment required per unit of work turned out thereby.

The above described improvements of the present invention are obtained by so mounting the

rolls in the chemical treatment portion of the apparatus as to cause the work in strip form to travel in more than one direction between the opposite ends of the tank whereby a greater length of work may be contained within a given length of such tank than in the case where the work is passed through in a single plane.

Another feature of the present invention is the provision of apparatus of the type described in which the chemical treating tank portion of the apparatus is removably associated with the remainder of the apparatus, thus enabling it to be removed and replaced by a different form of tank portion. As a result of this feature of the present invention existing forms of apparatus designed to handle sheet material may be re-constructed to handle strip material only at a materially increased rate of speed simply by replacing the tank portion of the apparatus. On the other hand where the apparatus is originally designed to handle strip only and to convey it in more than one direction through the length of the chemical treating tank portion of the apparatus, the present invention in permitting the replacement of the tank portion only of the apparatus without disturbing the remainder thereof permits the strip treating type of chemical tank portion to be replaced with one which is capable of handling either sheet or strip forms of work. Thus the present invention provides a construction which may be converted from one which is capable of handling strip type of work only to one which is capable of handling either strip or sheet types of work, or vice versa, at a minimum of expense.

Still another feature of the present invention is in connection with the ready removal and replacement of the rolls referred to through which th work is passed. This is particularly important in connection with that portion of the apparatus in which the work is subjected to the effects of the chemical solution for the reason that in such portion of the apparatus the interaction between the chemical solution and the work produces a sludge which has a tendency to adhere to the surface of the rolls and in time to build up to such an extent thereon as to adversely affect the intended functioning of the rolls in certain respects. Where such sludge builds up on the surface of the rolls to such an extent that it does impair the proper operation of the apparatus, it is necessary to clean the rolls of this sludge and this is best accomplished by applying an acid solution to the rolls. In accordance with the present invention at least a portion of the rolls and particularly those rolls arranged near the entrance end of the chemical solution treatment tank are mounted in groups and in such a manner that each group may be readily removed from the chemical treatment tank and readily replaced therein. This permits each such group of rolls to be removed from the chemical treatment tank when the sludge builds up thereon to an extent requiring cleaning, and immersing the entire group in a tank of suitable cleaning solution, or applying such cleaning solution to the rolls otherwise, and after the sludge has been removed thereby to replace them in position in the chemical treatment tank. By this means the rolls may be quickly and effectively cleaned and may be removed and replaced in a minimum of time and with a minimum expenditure of labor so that operation of the apparatus will be delayed for a relatively

short length of time whenever the rolls require such cleaning.

Referring now to Figs. 1 to 6, inclusive, which illustrate apparatus constructed in accordance with the present invention for the purpose of handling stock in strip form only, the main body portion of the apparatus will be seen to comprise a chemical treating tank illustrated generally at 10, a rinse tank illustrated generally at 12 and an acid rinse bath indicated generally at 14, these three tanks being arranged in consecutive order and in end-to-end relationship. The chemical treatment tank 10 is preferably formed separately from the tanks 12 and 14 but the latter tanks are preferably formed as a unit with one another as best brought out in Fig. 3.

In Fig. 1 the strip stock being fed through the apparatus is illustrated in the form of a roll 16 suitably supported on a standard 18, the strip 20 of such roll 16 being first led through a shearing apparatus indicated more or less diagrammatically at 22, then through a welding apparatus indicated more or less diagrammatically at 24, then through a strip holder 26 and under a roller 27 and thence to a slack take-up device comprising a plurality of rollers 28 mounted on fixed axes and a plurality of rollers 30 mounted upon a movable carrier 32 constantly urged away from the rollers 28 by means of a weight 34. It will be understood from an inspection of Fig. 1 that the strip 20 first passes over one of the rollers 28 and then over one of the rollers 30 and back to another roller 28, thence to another roller 30 and back to the remaining roller 28. From the roller 28 the strip 20 is directed downwardly over a roller 36 and thence through a surface wetting device indicated generally at 38 and, as best brought out in Fig. 3, including a plurality of pairs of rolls 40, the rolls of each pair of which are resiliently pressed towards one another and certain of which rolls are driven at a different surface speed than others thereof whereby to apply a scrubbing action to the strip 20 passing therebetween. Water and preferably a mixture of water and steam is applied to the strip 20 during its passage through the device 38. The device 38 forms no part of the present invention but does form the subject matter of the co-pending application for Letters Patent of the United States filed by Robert R. Tanner on the 25th day of April, 1942, for Method of rust-proofing, and serially numbered 440,441. The rolls 40 may be driven in any suitable manner such as by the electric motor and reduction gear unit indicated generally at 41 in Fig. 2.

After the strip 20 is passed through the device 38 it passes over a roller 42 and then into one end of the chemical treatment tank 10. As best brought out in Fig. 3 in passing into the chemical treatment tank 10 it passes through a slot 43 in an end wall thereof adjacent the upper margin of such end wall. Immediately upon entering the tank 10 the strip 20 passes between a multiplicity of pairs of cooperating rolls 44, such pairs of rolls 44 being arranged so that the strip passing between the rolls of each pair travels in a horizontal direction towards the opposite end of the tank 10. The rolls 44 are preferably so constructed as to provide a surface portion formed from a yieldable material such, for instance, as fabric, rubber, or the like and preferably of either natural or artificial rubber.

Immediately after passing through the rolls 44 the strip 20 passes through the upper pair of a vertically arranged group of pairs of rollers 46.

In the particular embodiment illustrated in the drawing there are three pairs of rollers 46 arranged vertically one above the other with the rolls of each pair arranged vertically one over the other. The rolls of each pair of rolls 46 are resiliently pressed toward one another. The rolls 46 may be of the same character as the rolls 44. A second group of rolls 46 arranged and formed identically to the group of rolls 46 thus described is mounted in the tank 10 in materially spaced relation to the first group to the right thereof as viewed in the drawings. In other words while the various pairs of rolls 44 are grouped in closely adjacent relationship, the two groups of rolls 46 shown are materially spaced from one another in a horizontal direction and the sheet or strip 20 is unsupported therebetween. As many such groups of rolls 46 may be employed as is deemed necessary or desirable, two being shown in the particular embodiment illustrated as indicative of a suitable embodiment.

It will be appreciated that the strip 20 after passing through the rolls 44 and through the upper pair of rolls 46 of the first group of rolls 46 then passes through the upper pair of rolls 46 of the second group and then continues towards the righthand end of the tank 10 as viewed in the drawing to a roller 48 suitably mounted between the opposite side walls of the tank 10, and over this roller 48, and is then directed towards the lefthand end of the tank 10 first passing through the intermediate pair of rollers 46 of the second group above described, then continuing through the intermediate group of the first group of rollers 46 first described, then continuing to the left and passing around the roller 50, similar to the roller 48, where its direction of travel is reversed and from which it passes through the lower pair of rollers 46 of the first group and then through the corresponding pair of rollers of the second group to the righthand end of the tank 10 from which it is discharged through a slot 52 in the righthand end wall thereof adjacent the bottom thereof.

It will be appreciated from the above that approximately three times the length of the strip 20 is contained at one time within the tank 10 than would be the case if it passed through the tank 10 in a straight line and in one direction only. The construction, therefore, permits a strip to be subjected substantially three times as long to the effects of the chemical solution as compared to the construction providing the straight horizontal path therethrough in travelling at the same rate of speed in both cases, or it permits each increment of length of the strip to be subjected to the chemical solution in the tank 10 the same length of time as a strip passing in a straight line horizontally through the tank but in this case travelling substantially three times the speed of such singly directed strip. It will thus be appreciated that as compared to the straight horizontal run type of apparatus heretofore employed the apparatus of the present invention may provide for the same length of treatment either at a speed which is a multiple of the former speed, or for the same length of treatment in a tank which is a fraction of the length of the type heretofore employed. It is, of course, obvious that the advantages of the present invention may be multiplied in the above mentioned respects over that shown in the specific embodiment illustrated by simply expanding the apparatus to provide additional vertical spaced runs in the chemical treatment tank 10.

Before the strip 20 passes through the slot 52 to leave the chemical solution tank 10 it passes through a plurality (shown as three) of pairs of rolls 60, similar to the rolls 44 previously described and located in horizontal alignment with the center of the slot 52. These rolls 60 are for the purpose of wringing the chemical solution from the sheet 20 before it is discharged from the tank 10. To protect such rolls 60 from contact with the chemical solution being applied to the strip 20 in the remaining portion of the tank 10 a baffle structure 62 extending between opposite sides of the tank 10 and from a point adjacent the top thereof to a point adjacent the point thereof is arranged in protecting relation to the rolls 60. The baffle 62 is provided with a slot 64 of the same general character as the slot 52 to provide for passage of the strip 20 therethrough.

After passing out of the chemical solution tank 10 the strip passes into the rinse tank 12 through a slot 66 formed in the corresponding end wall thereof in alignment with the slot 52 and then passes between the cooperating rolls of a multiplicity of pairs of rolls 68, of the same general character as the rolls 44 and 46, which are rotatably mounted between the opposite sides of the rinse tank 12 and in closely associated relationship with respect to each other over substantially the full length thereof. The rolls 68 are arranged in the same horizontal relationship as the rolls 60 so that the strip 20 travels in a generally horizontal direction. A baffle 70 is arranged in protecting relation with respect to the last two pairs of rolls 68 in the rinse tank 12 for the same general purpose as the baffle previously described.

The strip 20 is discharged from the rinse tank 12 through a slot 72 provided in the rear end wall 74 thereof, which also serves as the front wall for the acid bath tank 14, it passes through a multiplicity of cooperating pairs of rolls 76 arranged in closely adjacent relationship to each other and rotatably mounted between the opposite side walls of the tank 14. The last two pairs of rolls 76 in the acid bath tank 14 are protected from the remainder of the tank 14 by means of a baffle 78, which may be substantially identical to the baffle 70, and it is then discharged through a slot 80 in the rear end wall of the tank 14 as indicated.

The rear end of the tank 14 is provided with a trough or gutter-like extension housing 82 provided with a slotted rear end wall through which the strip 20 is passed and within it is provided with a roll 84 arranged on the upper side of the strip 20 and serving as a guide therefor. After leaving the housing 82 the strip 20 is passed in an upward direction over and through a pair of suitably supported rolls 85, then preferably through a roller leveler such as 86 from which it may be either received and coiled or else passed through a shear to cut it into suitable lengths and stacked. Hot air may be applied to the strip 20 between the housing 82 and the rolls 85, if desired, to accelerate the drying of the strip 20.

The various rolls 44, 46, 60, 66 and 72 above described, or at least one roll of each of such pairs of rolls, may be driven so as to cause, or at least to aid in causing, the passage of the strip 20 therethrough. In the drawings this is shown as being accomplished by providing each of the corresponding ends of the shafts for these rolls with a pair of axially spaced sprockets 87, best shown in Figs. 4 and 6, and connecting one sprocket to a sprocket on the next adjacent shaft in one direction, and the other sprocket to a sprocket on the next adjacent shaft in another direction, by means of endless chains 88. Thus all such rolls may be drivingly interconnected with each other. A motor such as 89 acting through a reduction gear such as 90, as indicated in Figs. 1 and 2, may thus drive all of the rolls by being directly connected to one of them. Preferably a removable protective housing such as 91 is provided over the sprockets 87 and chains 88 of each group of rolls.

The strip 20 in passing through the chemical solution tank 10 is bathed with a suitable chemical solution which reacts therewith to provide the desired chemical coating thereon. As best brought out in Fig. 3 this chemical solution is contained within a tank 92 positioned below the tanks 10 and 12. The solution is withdrawn from one side of the tank 92 by a pump 93 which delivers it through an upwardly extending pipe 94 which extends to the top of rollers 44 and 46 and there connects with a header 100 extending longitudinally of the tank 10. The header 100 is connected to a plurality of sub-headers 102, one of which is associated with each group of rolls 44 and 46.

Each sub-header 102 has connected thereto a plurality of tubes or pipes 104 which, as best brought out in Figs. 5 and 6, extend through one side of the tank 10 in perpendicular relation with respect thereto and substantially the full distance across such tank. Each tube 104, as best brought out in Fig. 6, is provided with a plurality of spray nozzles 106, arranged in line with each other, for the purpose of discharging the chemical solution therefrom. One tube 104 is arranged between the upper rolls of each adjacent pair of rolls 44 and one tube 104 between the lower rolls of each adjacent pair of rolls 44, the nozzles 106 of the upper tubes being arranged to direct the spray therefrom downwardly upon the adjacent rolls 44 and upon the upper surface of the sheet 20 passing between them, and the spray nozzles 106 of such lower tubes 104 being directed upwardly to spray the lower rolls 44 of such pairs and the lower surface of the strip 20 passing between them. Beyond the group of rolls 44, in the direction of travel of the strip 20 through the tank 10, the remaining tubes or pipes 104 are arranged in more widely spaced relationship, as indicated best in Fig. 3, but so as to provide a substantially constant spray of chemical solution upon the entire surface of the strip 20 as it passes through the tank 10 and before it is discharged through the slot 64 in the baffle 62. It will now be appreciated that the function of the baffle 62 is to prevent such spray from reaching the strip 20 after it has passed through the slot 64, thus permitting the rollers 60 to properly function in their intended purpose of wringing the chemical solution from the sheet before it is discharged from the tank 10.

From an inspection of Fig. 3 it will be appreciated that the bottom of the tank 10 is shaped to drain the chemical solution applied to the strip 20 and discharged therefrom towards one low point in the tank 10 from which such chemical solution may be drained through a drain pipe 110. The drain pipe 110 leads to a T connection 112 from which a branch 114 leads into a trough 116 located at one end of the tank 92 adjacent the upper margin thereof. The branch 114 is provided with a suitable shut-off valve as indicated at 118. The chemical solution which is thus discharged from the tank 10 through the pipe 110 and branch 114 into the trough 116 fills the trough

116 and overflows into the tank 92. As best illustrated in Fig. 2 the tank 92 is provided with a longitudinally extending baffle 120 between the sides thereof and which extends from the left-hand end of the tank 92 as viewed in the drawings to a point spaced from the righthand end thereof. The trough 116 extends between the baffle 120 and that side of the tank opposite to that to which the pump 93 is connected. The chemical solution which is returned to the tank 92 is thus caused to flow through substantially the full length of the tank and then return before it may be again withdrawn by the pump 93 and re-delivered to the spray nozzle 106.

The chemical reaction between the solution thus delivered to the sheet 20 during its passage through the tank 10 results in the formation of a sludge which is desirably removed from the chemical solution before the latter is recirculated through the nozzles 106. A portion of such sludge is separated out in the trough 116 and further means are provided in the tank 10 to further separate out such sludge from the chemical solution and entrap it. Such means as best brought out in Figs. 2 and 3 consists of a plurality of relatively shallow baffles 124 spaced longitudinally from each other in the lower portion of the tank 92, each baffle 124 being associated with a vertically extending screen or filter element 126 through which the chemical solution must pass in flowing from one end of the tank 92 to the other end thereof. The screens or baffles 126 tend to separate the sludge out from the chemical solution flowing through them and to deposit such sludge back of the corresponding baffle 124 from which position the sludge may be removed at suitable intervals. On the opposite side of the baffle 120 from the screens or filters 126 a heating coil 128 is preferably provided for the purpose of heating the solution as it flows thereover towards the discharge connection for the tank 92.

It will be understood from the above that the strip 20 in passing through the chemical solution tank 10 is constantly bathed during its passage therethrough with a spray of the chemical solution and that the chemical solution which drips or otherwise is discharged from the strip 20 is drained from the tank 10 into the tank 92 where it is filtered, heated, and again returned through the spray nozzles 106 to the strip 20 as it passes through the tank 10.

When the deposits of sludge built up in the trough 116 and tank 92 to an extent requiring it to be cleaned out, it is withdrawn with a certain amount of the chemical solution and delivered into a settling tank 130. After it has been left in the tank 130 a sufficiently long time to permit the sludge and solution to be separated from each other, the solution is withdrawn from the sludge and the sludge is discharged from the tank 130 into a sewer or other suitable point of deposit.

The sludge referred to above which occurs as a result of the chemical reaction between the chemical solution and the material from which the strip 20 is formed also has a tendency to build up on the rolls 44 and 46 and may be removed from the rolls by washing them in a suitable acid solution. In accordance with the present invention, in cleaning the rolls the various rolls 44 and 46 are bodily removed from the tank 10 and immersed in a suitable acid or other cleaning solution in which they may be thoroughly and manually scrubbed or otherwise acted upon to remove the sludge therefrom.

To accomplish this the rollers 46 of each group of such rollers, as best brought out in Fig. 4, are suitably rotatably mounted in a frame 160 which is introduced through a suitable opening 162 provided in one side wall of the tank 10. The outer member 164 of the frame 160 is of greater dimensions than the corresponding opening 162 so as to form a cover for the opening 162 and is located so as to overlap the margins of the opening 162 to provide a substantially water-tight joint with such side wall. If desired suitable gaskets may be employed between the opposed faces of the cover member 164 and the tank. Suitable studs or bolts 166 are provided in the marginal portions of the cover member 164 and through those portions of the side wall of the tank 10 which they overlap to securely hold the frame 60 in position. Additionally, suitable brackets such as 168 are provided on the inner faces of the side walls of the tank 10 to receive the lower ends of the frames 160 to further locate and support them within the tank 10. Thus when the rolls 46 become covered with such an amount of sludge as to require cleaning thereof, all that is necessary is to remove the bolts or the nuts on the studs 166 and pull each frame 160 with its rollers 46 mounted thereon bodily out of the tank 10, immerse it in the cleaning solution and if desired scrub it while so immersed to better remove the sludge from the rolls 46, after which it may be suitably rinsed and then re-applied and secured to the tank 10. In thus removing either group of vertically arranged rollers 46 as above described it will be appreciated that the sprockets 87 on the shafts of such rollers 46 and the endless chains 88 interconnecting them will be removed with them. The cover member 91 for such sprockets and chains may be allowed to remain on the cover member 164 but the two endless chains 88 which connect each such group to the next adjacent groups or rolls on either side thereof must be removed before such group or unit of rolls can be removed from the tank 10. These last-mentioned chains 88 may be quickly removed in a conventional manner.

The horizontal group of rolls 44 are likewise mounted in a frame 170, similar to the frame 160 previously described so as to form a unit which is applicable to and removable from the tank 10 as such. If desired an opening such as the opening 162 may be provided in the side of the tank 10 for the insertion and removal of the frame 170 with the rollers 44 mounted therein. Preferably, however, and as best brought out in Fig. 6, because of the fact that the group of rollers 44 are positioned adjacent the top of the tank, that side of the tank through which the frame 170 and rollers 44 are to be removed is preferably notched as at 172 and the outer frame member 174 which is also preferably arranged as a cover for such notch as brought out in Fig. 6 is extended upwardly into flush relationship with respect to the upper edge of the tank 10 as shown. Bolt and nut assemblies 176 are provided for removably securing the cover member 174 of the frame 170 and consequently the unit in place in the tank 10. Brackets 178, shown both in Figs. 5 and 6 and similar to the brackets 168 previously described, are provided for supporting such units within the tank 10.

The above described construction of the unit including the rolls 44 may, if desired, be removed upwardly through the top of the tank 10 instead of through the side if the arrangement of upper tubes 114 over the rollers 44 shown in Fig. 6 is provided. As illustrated in that figure a union

180 is provided in the connection between the main header 100 and the sub-header 102 for such upper row of tubes 114 directly over the rolls 44. This union is positioned on that side of the main header 100 opposite the tank 10 so that upon separating the union the group of tubes 104 over the frame 170 may be readily pulled outwardly from the tank, or at least to such an extent as to not interfere with upward movement of the frame 170. In such case if the cover 182 which is preferably provided over the top of the tank 10 during treating operations is removed the bolt and nut assemblies 176 are loosened or removed, and the chains 88 connecting the opposite ends of the group of rollers 44 to the reduction gear 90 and to the vertical group of rollers 46 to the right of the group of rollers 44 as viewed in the figures are removed, the frame 170 and the rollers 44 carried thereby may be lifted directly out of the top of the tank, and either replaced by a new unit or such unit may be subjected to a cleaning operation and replaced.

It will be appreciated from the above description that by mounting the various rollers 44 and 46 in groups in the manner described and arranging for such groups to be removed as a unit from the tank 10, whenever the rolls of such units acquire a coating of sludge of such character as to become detrimental to the proper treatment of the strip 20 being passed through the tank 10, such roll units may be quickly and readily removed from the tank and either washed free of such sludge or else replaced by a clean unit, in a minimum of time, thereby interfering with the continued operation of the system to a minimum degree.

The rolls 68 in the tank 12 and rolls 76 in the tank 14 may, of course, be likewise arranged in one or more groups or units as in the case of the rolls 44 and 46 above described so as to permit them to be applied to and removed from their corresponding tanks as a unit, but ordinarily, because of the character of the liquid used in these tanks, such cleaning as in the case of the rolls 44 and 46 will seldom if ever be required and, accordingly, the rolls 68 and 76 may be individually secured in place if desired.

The rinse water which is applied to the strip 20 in its passage through the rolls 68 in the tank 12 may be obtained from any suitable source of supply which in the present case may be assumed to be from a municipal water supply system or the like. It is delivered to the strip 20 passing through rolls 68 through a plurality of pipes 200 similar to the pipes 104 previously described, and equipped with nozzles such as the nozzles 106 previously described, and the pipes 200 may be connected to the source of rinse water supply by headers (not shown) of the same general character as the header 100 previously described. The bottom of the tank 12 is sloped downwardly to a central drain 202 through which the rinse water discharged from the strip 20 passing through the tank 12 may be disposed of.

The chromic acid or other solution which is used in connection with the tank 14 may either be re-circulated from a separate storage and filtering tank in much the same manner that the tank 92 is associated with the tank 10, or the bottom of the tank 14 may itself serve as the storage space for such solution. This last construction is illustrated in the drawings by way of illustration and it will be noted particularly from an inspection of Fig. 3 that the tank 14 is relatively deep in order to accommodate it for this use.

A suitably driven pump 204, as best shown in Fig. 3, withdraws solution from the bottom portion of the tank 14 through a pipe 206 and delivers it to a pipe 208 which extends upwardly and is connected to a header (not shown) which may be similar to the header 100 or sub-header 102 previously described. Such header is connected to a plurality of pipes 210 of the same general character as the pipes 104 previously described and equipped with nozzles in a similar manner and through which the solution is applied to the strip 20 passing through the rolls 76. The pipes 210 are positioned both above and below the rolls 76 in the same manner that the pipes 104 are positioned above and below the rollers 44 as previously described. It will be appreciated that the pump 204 in operating withdraws solution from the bottom portion of the tank 14 and discharges it into the pipe 208 from which it flows through the various pipes 210 and their associated nozzles to bathe the strip 20 as it passes through the tank 14. The solution which drips or flows from the sheet 20 in the tank 14 simply drains back into the bottom of the tank to again be re-circulated by the pump 204.

By the use of the above described apparatus, and particularly in view of the length of the strip 20 which is contained within the tank 10, it has been found that an apparatus of the type described of a length no greater than the apparatus heretofore employed for chemically coating sheets or strips of metal in the general manner above described, is capable of being operated at a materially higher strip speed and yet obtain equally satisfactory results. In other words, where, in the apparatus of the length heretofore provided and when employing a suitable type of chemical solution in the chemical treatment tank the speed of the strip or sheet in passing through the apparatus was limited to approximately 200 feet per minute, by the use of the present apparatus the strip may be passed through the apparatus at a speed of approximately 500 feet per minute. Thus by the use of the present invention substantially two and one-half times the amount of material may be treated by the apparatus and yet the apparatus is of no greater total length than the prior apparatus. The economies resulting from this increased speed will be readily appreciated.

In carrying out the above described operation with the apparatus thus described, the apparatus is operated until the roll 16 of the strip 20, as brought out in Fig. 1, is substantially exhausted and the speed of the apparatus is then reduced until the end of the strip is about to pass through the shear 22, at which time the strip holder 26 is operated to lock the strip 20 being processed and the motor 89 driving the various rolls is stopped. A second roll of strip, such as the rolls 220 supported on a dolly such as 222 and which has previously been moved into adjacent relationship with respect to the support 18, is then mounted in the support 18, its free end is drawn into the shear 22, the shear is operated to cut-off both ends in matching relationship with respect to each other and such ends are then moved into the welding machine 24 where they are welded together upon which the operation of the apparatus may be resumed.

Where the apparatus is to be shut down for any material length of time then the following procedure is followed. Between the support 18 and the welder 22 another standard 224 is po-

sitioned and it supports a roll 226 of a strip of preferably the same width and approximately the same thickness as the strip 20. The strip of the roll 226 is preferably of some type of metal that will be unaffected or affected to only a relatively slight extent by the chemical solution in the tank 10, as for instance a roll of stainless steel. In this case as the end of the roll 16 of the strip 20 which is being processed is withdrawn from the roll 16 the apparatus is stopped in the same manner as when a new roll of material is to be fixed thereto for processing, but in this case it is the end of the roll 226 which is fastened to the tail end of the roll of strip under process at the time, and the strip of the roll 226 is drawn through the mechanism until it at last occupies that portion of the tank 10 in which the strip 20 is processed, upon which the apparatus is stopped. Thus with this last-mentioned strip located in the tank 10 and being substantially unaffected by the solution sprayed therein, the apparatus may be allowed to remain inoperative for any required length of time without danger of subjecting actual work to an excessive treatment by the solution which is employed in such tank. When it is desired to resume operation the free end of a new strip 20 of work is simply secured to the rear end of the strip of the coil 226 and operation of the apparatus is resumed, the strip of the coil 226 being simply recoiled and brought back and mounted on the standard 224 so as to be positioned for its next required use. The strip of the coil 226 does not necessarily require it to be of a type that the solution will not affect for the reason that inasmuch as the strip of such coil is preferably never sold and is simply used repeatedly for the purpose specified, an excessive action of the chemical solution upon it is of no particular moment.

There may be instances where the owner of apparatus such as is disclosed in Figs. 1 to 6, inclusive, and adaptable solely for the treatment of strip material might desire to adapt his apparatus for the treatment of both strip and sheet material and in such case, by reason of the fact that the tank 10 is removably associated with the rest of the apparatus, it will be possible for such owner to replace the tank 10 only with a new tank adaptable for both sheet and strip material and thus escape the cost of an entire new apparatus to do this job. The manner in which this may be accomplished is illustrated in Fig. 7.

Referring now to Fig. 7, which illustrates only that portion of the apparatus first described requiring modification for the purposes stated above, it will be noted that the tank 10 has been removed and has been replaced by a tank 10*a*. The tank 10*a* is of the same length as the tank 10 previously described and shown but in this case it is of a height corresponding to the height of the tank 12 and is located with its upper edge in substantially flush relationship with respect thereto. Within the tank 10*a* is arranged a multiplicity of pairs of rollers 230 arranged in relatively closely adjacent relationship with respect to each other, except in this case as illustrative of a modified arrangement of rollers one additional roller 232 is positioned in line with the lower rollers of the various pairs of rollers 230 between each adjacent pair of rollers 230. The rollers 230 are arranged so that the line of contact between each pair of them lies in the same horizontal plane as the line of contact between the pairs of rollers 68 in the tank 12, and the end walls of the tank 10*a* are slotted for the passage of the strip

20 therethrough in the same manner as in the previously described construction. Likewise pipes 234, which may be identical to the pipes 104 first described and similarly equipped with spray nozzles, are located between each adjacent pair of rollers in both the upper and lower runs of rollers and are connected up to the discharge pipe 94 from the pump 93 in a manner similar to that first described. It will also be appreciated that the rollers 230 and 232 may be arranged in groups each of which is removable from and insertable into the tank 10*a* as a unit through an opening provided therefor in a side of the tank in substantially the same, or in an identical, manner to the rolls 44 previously described.

In the case of the construction shown in Fig. 7, when modified from that shown in the previous figures, the tank 38 with the rollers 40 therein may be swung around so that the lines of contact between the various pairs of rollers 40 lie in the same horizontal plane as the line of contact between the pairs of rollers 230, as illustrated in Fig. 7. Otherwise the construction in Fig. 7 will be identical to that in the previous figures, the main difference being that the tank 10*a* is substituted for the tank 10 thereby to permit either strip or sheet stock to be treated in the tank 10*a*. The speed of operation will, of course, necessarily be reduced from that in the first described construction where the tank 10*a* is of the same length as the tank 10, but at the same time it has the advantage of being able to treat either strip or sheet stock.

Another condition may arise where a manufacturer originally had an apparatus such as disclosed in Fig. 7 capable of handling either strip or sheet stock and desires to convert it to the handling of strip stock only at an increased rate of speed. In such event he may, of course, replace the tank 10*a* by a tank such as the tank 10 first disclosed, but on the other hand the tank 10*a* may be converted to the same purposes as the tank 10 by a relatively simple addition thereto and without the necessity of replacing the tank 10*a*. Such conversion is illustrated in Fig. 8 from which it will be noted that the tank 10*a* employed in Fig. 7 and the same tanks 12 and 14 as are also employed in Fig. 7 and in the previous figures are also employed here. The same pre-wetting tank 38 with associated rolls 40 is employed the same as in Fig. 7. In order to modify the construction to handle strip material only at a faster rate of speed the tank 10*a* is provided with a top extension 250 which effects an upward extension of the sides and ends thereof. Between the side walls of such extension a plurality of rolls 252 of larger diameter than the rolls 230 and 232, are rotatably mounted in spaced relation to each other longitudinally of the tank. Between each adjacent pair of rolls 252 and beyond the end ones thereof, similar rolls 254 are mounted between the side walls of the tank 10*a* with the lowermost portions of the surfaces thereof in the same plane as the upper surface of the strip 20 passing between the pairs of rolls 230. The rolls 230 and 232 between each pair of large rolls 254 are removed and the strip 20 is then threaded in zig-zag fashion under each roll 254 in turn, then up over the next adjacent roll 252 in the direction of length of the tank 10*a*, then down below the next adjacent roll 254 and so forth from adjacent one end of the tank to adjacent the opposite end thereof. The first roll 254 is, however, spaced sufficiently far from the entrance end of the tank 10*a* so that a substantial group

of rollers 230, corresponding more or less with the number of rollers 44 illustrated in Fig. 3, receive the strip 20 in its passage into the tank before the strip begins its zig-zag movement. Preferably a roll such as 256, which may be of the same character as the rolls 230, is arranged over each roll 252 so as to press the strip 20 between it and its cooperating roll 252 during the passage of the strip 20 therebetween.

The pipes 234 between adjacent rolls 254 may be removed and replaced in the extension 260 as indicated so as to cause the chemical solution to be sprayed upon the vertically directed runs of the strip 20 in its zig-zag passage over the rolls 252 and 254.

In converting the construction shown in Fig. 7 to that shown in Fig. 8, if it is desired to provide a greater length of run of the strip 20 in the rinsing tank 12 because of the higher speed of passage of the strip 20 therethrough, this may be accomplished in a manner similar to the treatment of the tank 10a in Fig. 8, that is, by providing an upward extension 260 for the side and end walls of the tank 12, and providing rolls 262 and 264, equivalent to the rolls 252 and 254 previously described for likewise causing the strip 20 to travel in zig-zag relation through the tank 12 as indicated. In such case the rolls 68 between the rolls 264 will, of course, be removed and additional spray pipes 200 will be projected through the side wall of the extension 260 to spray the rinse water on the vertically directed runs of the strip 20 during its passage through the tank 12.

In a similar manner an extension 270 may be applied to the tank 14 and rolls 262 and 264, corresponding to the rolls 252 and 254 previously described, may be mounted in the extension and in the main body portion of the tank 14 for causing the strip to travel in vertically directed runs therethrough. Likewise additional spray pipes 210 will in such case be inserted through a side wall of the extension 270 to spray the solution from the tank 14 upon the vertically directed runs on the strip 20.

In case of the conversion illustrated in Fig. 8 the housing 82 at the rear end of the tank 14 is preferably removed and replaced by a relatively tall housing 280 in which a slack take-up mechanism may be mounted and which may also be employed as a drying oven. In such case it is preferred to provide a pair of rolls 282 in the housing 280 for reception of the strip 20 as it is discharged from the tank 14 and a similar pair of rolls 284 at the outlet side of the housing. Between the rollers 282 and 284 the strip 20 passes over a plurality, shown as three, pulleys 286 rotating about fixed axes in the upper portion of the housing 280, the strip 20 between each roll 286 passing over a roll 288 mounted in a movable frame 290 and constantly urged in a downwardly direction by means of a weight 292, which thus serves to take any slack developing in the discharge end of the strip 20.

A similar slack take-up mechanism may be provided for the strip 20 at the entrance end of the apparatus, the construction shown including a plurality, three in number, of rolls 294 mounted to rotate about fixed axes and intervening rolls 296 mounted in the movable frame 298 constantly urged in a downwardly direction by means of a weight 300, the strip 20 passing over these rolls in the same manner as the rolls 286 and 288 previously described.

It will be appreciated from the above description that in accordance with the present invention apparatus is provided which in the first place permits sheet material to be chemically treated at a relatively high speed of travel through the apparatus, that the apparatus is adaptable for being changed to handle either strip or sheet stock at a minimum of expense, and that the latter type of apparatus may be modified at a minimum of expense to enable it to treat strip stock only at the higher rate of speed. It will also be appreciated that in mounting the various rolls in groups which are applicable to and removable as a unit from the chemical treatment tank, a simple and effective means for cleaning such rolls of the sludge which tends to build up on them during treatment, is provided.

Having thus described by invention, which I claim by Letters Patent is:

1. Apparatus for chemically coating work in the form of metal sheets or strips comprising three tanks arranged in end-to-end relationship, cooperating pairs of rolls in each of said tanks for the passage of the work therebetween, means for directing a chemical solution upon the work during its passage through the first of said tanks, a fourth tank for holding said chemical solution, means for removing said solution from said first tank as it drains from said work and delivering it to said fourth tank, pumping means associated with said fourth tank for withdrawing said solution therefrom and delivering it to said work in said first tank through the first mentioned means, means for applying rinse water to said work during its passage through the second of said tanks, means for applying a different chemical solution to said work during its passage through the third of said tanks, and said first tank being removable from said apparatus independently of the remaining of said tanks whereby said first tank may be removed and replaced by a tank of a different character without materially disturbing the remainder of said apparatus.

2. Apparatus for chemically coating work in the form of metal sheets or strips comprising three tanks arranged in end-to-end relationship, cooperating pairs of rolls in each of said tanks for the passage of the work therebetween, means for directing a chemical solution upon the work during its passage through the first of said tanks, a fourth tank for holding said chemical solution, means for removing said solution from said first tank as it drains from said work and delivering it to said fourth tank, pumping means associated with said fourth tank for withdrawing said solution therefrom and delivering it to said work in said first tank through the first mentioned means, means for applying rinse water to said work during its passage through the second of said tanks, means for applying a different chemical solution to said work during its passage through the third of said tanks, said second tank and said third tank being integral with each other, and said first tank being removable from said apparatus independently of said second tank, said third tank, and said fourth tank, thereby enabling said first tank to be replaced by a tank of a different character thereby to enable said apparatus to be adapted for treating work of a desired character.

3. Apparatus for use in the chemical coating of metal strips comprising a tank, a plurality of relatively closely adjacent pairs of rolls positioned in said tank for receiving a work strip intro-

duced into said tank therebetween, additional pairs of rolls in said tank for receiving and guiding said strip during its passage through said tank and spaced from one another by a distance greater than the spacing of the first-mentioned rolls, a chemical solution storage tank, and pumping means associated with said storage tank for withdrawing solution therefrom and applying it to said strip during its passage through the first-mentioned tank, and means for draining solution from said first-mentioned tank into said storage tank for re-circulation therefrom.

4. Apparatus for use in the chemical coating of metal strips comprising a tank, a plurality of relatively closely adjacent pairs of rolls positioned in said tank for receiving a work strip introduced into said tank therebetween, additional pairs of rolls in said tank for receiving and guiding said strip during its passage through said tank and spaced from one another by a distance greater than the spacing of the first-mentioned rolls, the last-mentioned rolls being arranged to cause said strip to travel in zig-zag relation through said tank, a chemical solution storage tank, and pumping means associated with said storage tank for withdrawing solution therefrom and applying it to said strip during its passage through the first-mentioned tank, and means for draining solution from said first-mentioned tank into said storage tank for re-circulation therefrom.

5. Apparatus for chemically coating metal strips comprising a tank having an entrance end and an outlet end, a multiplicity of pairs of cooperating rolls rotatably mounted in said tank adjacent the entrance end thereof for receiving a strip of work to be treated, a plurality of additional rolls within said tank arranged to receive said strip of work from said multiplicity of rolls and directing said strip in zig-zag relation through said tank to the outlet end thereof, spray nozzles mounted in said tank for directing a spray of chemical solution upon said strip during its passage therethrough, a storage tank for said solution, means for collecting that part of said solution applied to said strip in the first mentioned tank in excess of that required to wet said strip and for discharging said excess into said storage tank, and pumping means connected with said storage tank for removing solution therefrom and re-delivering it to said spray nozzles.

6. Apparatus for chemically coating work in the form of metal strips comprising a tank having a plurality of cooperating pairs of rolls therein arranged in substantially horizontal alignment with each other, side extensions on said tank projecting above the upper edges of the side walls thereof, a plurality of rolls extending between and rotatably mounted by said side extensions, additional rolls mounted between the sides of said tank whereby said work may be caused to pass through said horizontally arranged pairs of rollers and then back and forth between said rollers mounted between said extensions and the last-mentioned rollers, spray nozzles in said tank and between said extensions arranged to direct a spray therefrom upon said work during its passage between and over said rolls, and means for discharging a chemical solution through said nozzles.

7. Apparatus for use in the rustproofing of work in the form of metal sheets or strips comprising, in combination, a tank, a plurality of cooperating pairs of rolls in said tank for the passage of the work therebetween, and means for applying a chemical solution to said work during its passage through said rolls, said rolls being arranged in groups and each group comprising a unit applicable to and removable from said tank as a unit.

8. In apparatus for applying a chemical coating solution to strip metal, a tank structure, a plurality of pairs of cooperating rolls rotatably mounted in said structure and adapted for the passage of said strip therethrough, a reservoir for said solution, means for collecting amounts of said solution applied to said strip in said tank in excess of that required to wet said strip and for delivering said excess to said reservoir, and means for withdrawing said solution from said reservoir and spraying it upon said strip during its passage through said rolls, said rolls being arranged as a unitary group and said tank having an opening in a side wall thereof through which said group of rolls may be inserted into said tank structure and removed therefrom as a unit.

9. In apparatus for applying a chemical coating solution to strip metal, a tank structure, a plurality of pairs of cooperating rolls rotatably mounted in said structure and adapted for the passage of said strip therethrough, a reservoir for said solution, means for collecting amounts of said solution applied to said strip in said tank in excess of that required to wet said strip and for delivering said excess to said reservoir, means for withdrawing said solution from said reservoir and spraying it upon said strip during its passage through said rolls, and a frame structure supporting a group of said rolls as a unit, said frame structure and said group of rolls supported thereby being applicable to and removable from said tank structure as a unit.

10. In apparatus for applying a chemical coating solution to strip metal, a tank structure, a plurality of pairs of cooperating rolls rotatably mounted in said structure and adapted for the passage of said strip therethrough, a reservoir for said solution, means for collecting amounts of said solution applied to said strip in said tank in excess of that required to wet said strip and for delivering said excess to said reservoir, means for withdrawing said solution from said reservoir and spraying it upon said strip during its passage through said rolls, said tank structure having an opening in a side wall thereof, a frame for supporting said group of rollers as a unit and movable as a unit through said opening into and out of operative relation with respect to said tank structure, and means for locating and supporting said frame within said tank structure.

11. In apparatus for applying a chemical coating solution to strip metal, a tank structure, a plurality of pairs of cooperating rolls rotatably mounted in said structure and adapted for the passage of said strip therethrough, a reservoir for said solution, means for collecting amounts of said solution applied to said strip in said tank in excess of that required to wet said strip and for delivering said excess to said reservoir, means for withdrawing said solution from said reservoir and spraying it upon said strip during its passage through said rolls, said tank structure having an opening in a side wall thereof, a frame for supporting said group of rollers as a unit and movable as a unit through said opening into and out of operative relation with respect to said tank structure, said frame including a member arranged in overlapping relationship with respect to the margins of said opening when said frame

is positioned in operative relation within said tank structure.

12. Apparatus for use in the chemical coating of metal strips comprising a tank, a plurality of relatively closely adjacent pairs of rolls positioned in said tank for receiving a work strip introduced into said tank therebetween, additional pairs of rolls in said tank for receiving said strip after its passage through the first mentioned pairs of rolls and guiding said strip during its passage through said tank and spaced from one another by a distance greater than the spacing of the first-mentioned rolls, and means for applying a chemical solution to said strip between adjacent pairs of said pairs of rolls, whereby to subject the surface of said sheet to a succession of squeezing and rolling contacts while wet by said chemical solution, the said contacts following each other

in more rapid succession at the beginning of the operation than later in said operation.

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