

March 25, 1941.

S. P. CARY

2,235,825

METHOD OF PICKLING AND LIMING FERROUS ARTICLES

Original Filed Sept. 23, 1937 3 Sheets-Sheet 1

Fig. 1.

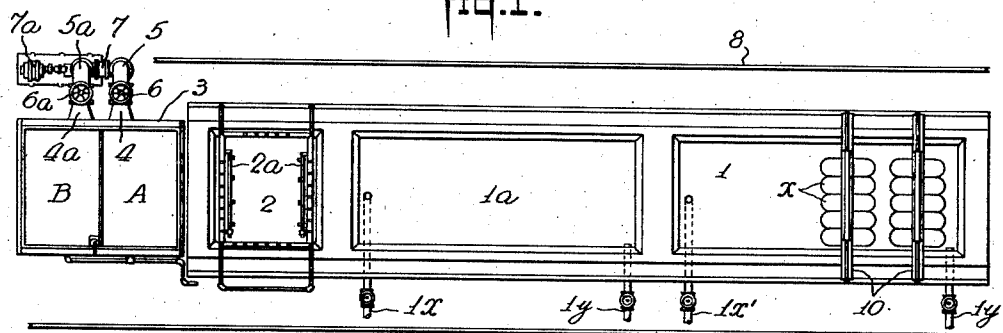
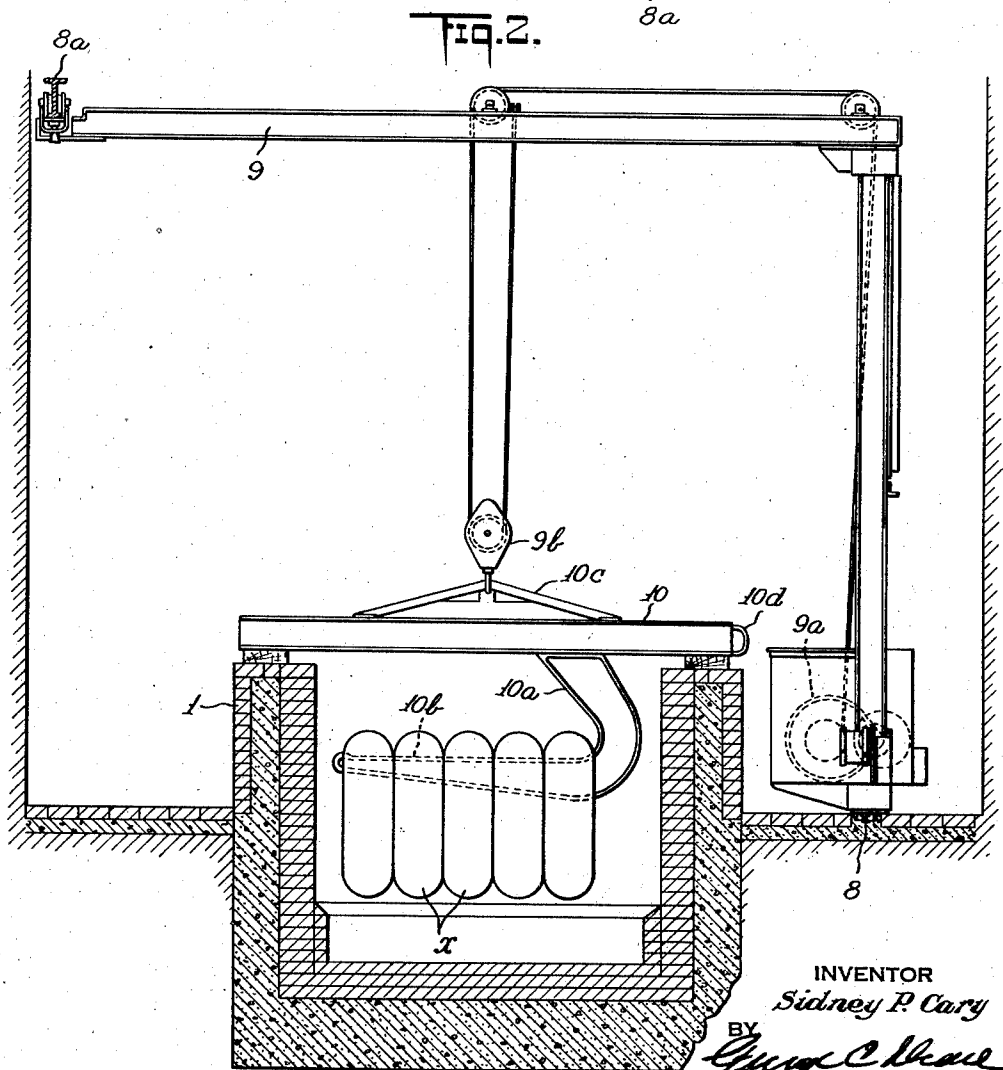


Fig. 2.



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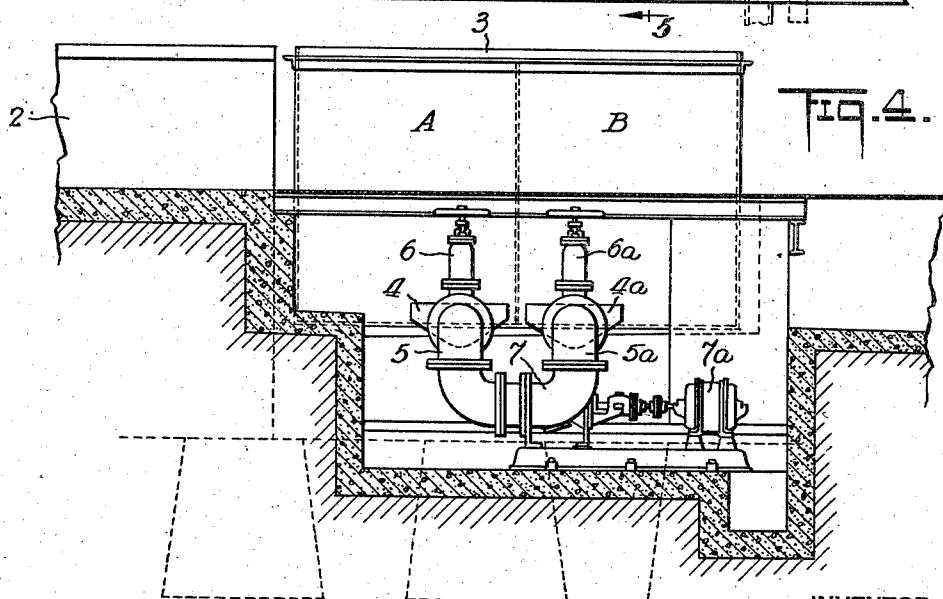
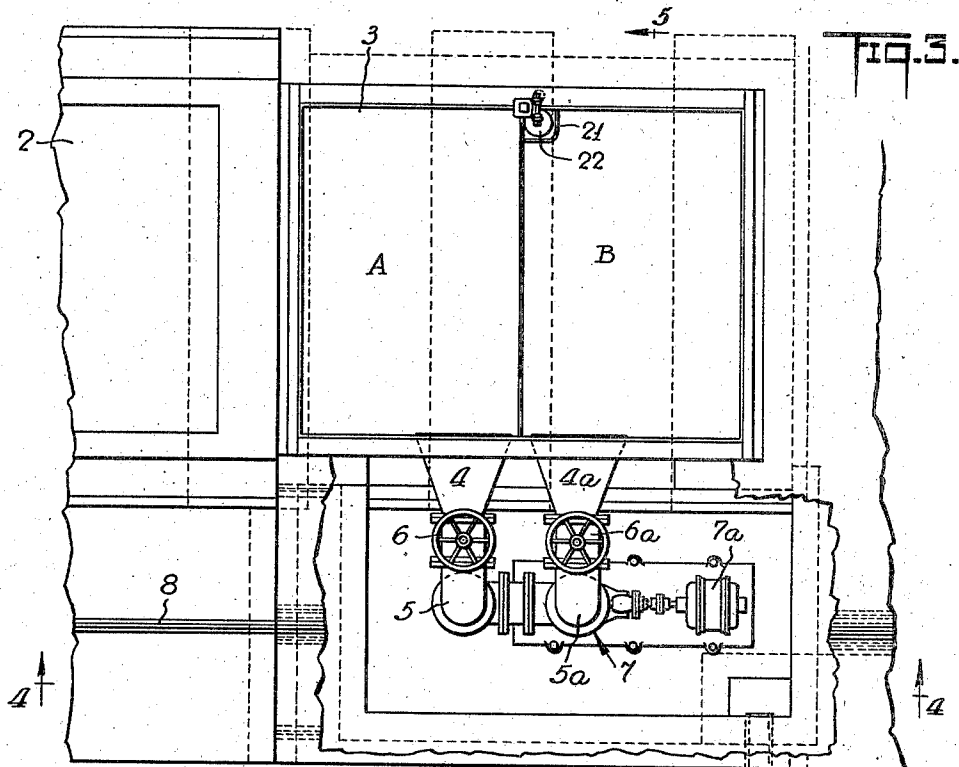
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METHOD OF PICKLING AND LIMING FERROUS ARTICLES

Original Filed Sept. 23, 1937 3 Sheets-Sheet 2



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METHOD OF PICKLING AND LIMING FERROUS ARTICLES

Original Filed Sept. 23, 1937 3 Sheets-Sheet 3

FIG. 5.

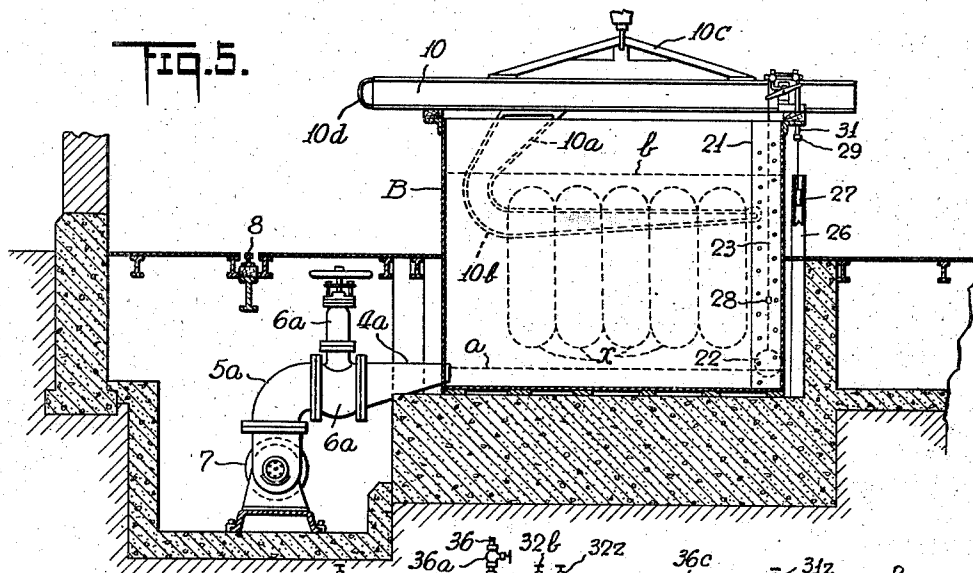


FIG. 7.

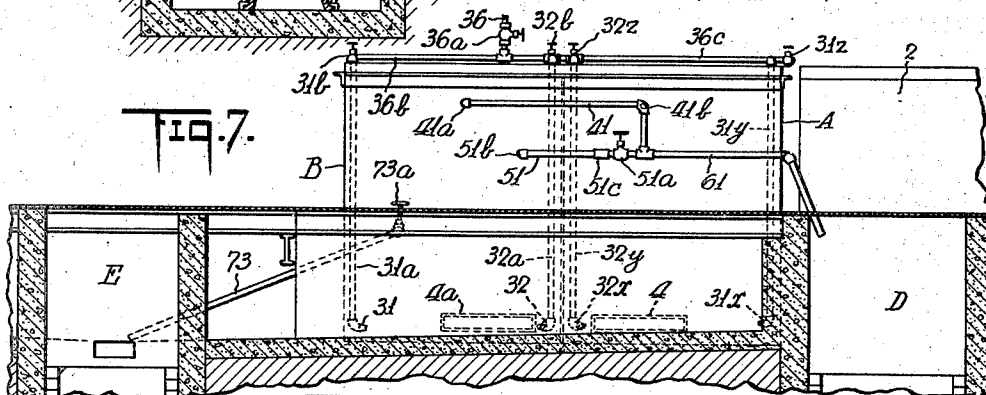


FIG. 8.

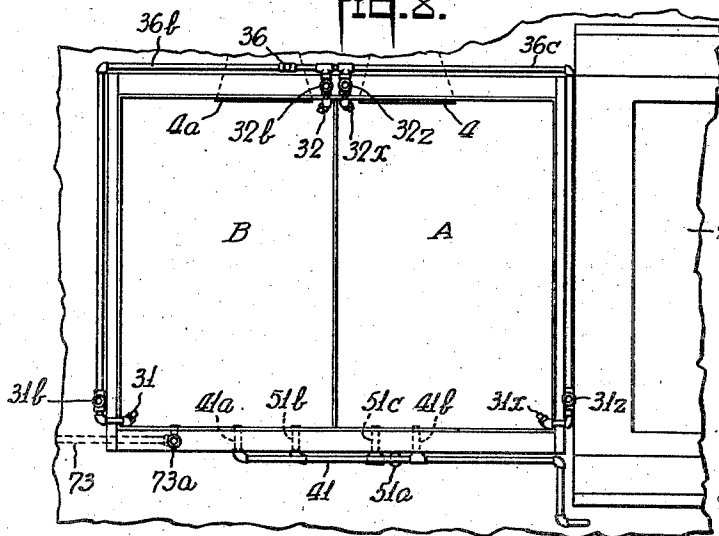
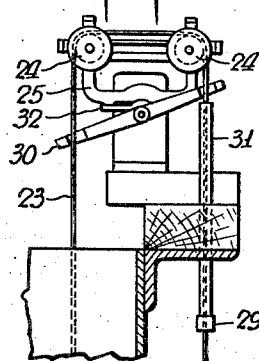


FIG. 6.



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2,235,825

METHOD OF PICKLING AND LIMING
FERROUS ARTICLES

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Original application September 23, 1937, Serial
No. 165,268. Divided and this application April
24, 1939, Serial No. 269,597

7 Claims. (Cl. 91—70)

The present invention concerns methods set forth in my application Ser. No. 165,268, filed Sept. 23, 1937, of which this is a division. They are disclosed in connection with pickling and lime-coating loosely coiled wire or rod material; or, more specifically, ordinary commercial bundle coils in which the wire or rod is iron, steel or ferrous alloy, but it will be obvious that certain features of the invention may be utilized for analogous purposes, in connection with specifically different articles, metals or coatings.

It is common practice to clean such articles, and where the metal is ferrous, free them from scale, by first submerging them in a hot acid or pickling solution to remove the scale; then rinsing in water to remove the acid; then treating it with hot liming solution and drying a coating of lime thereon, so as to neutralize acid that remains after the rinsing; and to prevent oxidation; and, in the case of wire or rod material, the lime coating is also utilized as a lubricant during further processing, as for instance drawing the wire or rod through dies, or cold rolling it, to decrease its diameter, or to change the shape of its cross-section. The liming "solution" referred to is a mixture in which relatively large quantities of hydrated lime are held in suspension in the water. The part of the lime that can be actually in solution in the hot water is somewhat less than one per cent.

Commonly, the lime coating is applied by submerging the metal in a hot liming solution long enough to heat the metal; then lifting it above the solution to expose it to the air until dry. This leaves the metal with a lime coating of a definite thickness predetermined by the viscosity, cohesion and surface tension of the liming solution. One such coating is seldom sufficient, and such submerging and drying operation is repeated as many times as necessary to build up the coating to a desired thickness.

If the acid remaining after rinsing is not completely neutralized by the liming, there is always danger that it will cause brittleness in the steel; and in certain cases, this has led to liming methods which do not neutralize all the acid in the lime coated metal, the remnant of acid being neutralized by baking it in an oven, at low temperatures. This is troublesome and expensive; and one advantage of the present invention is that the last traces of acid in the steel are eliminated in the liming tank where the coiled wire or rod material is heated to about 180° F. This treatment expels the occluded hydrogen

(due to the action of the acid) whose presence causes brittleness.

According to the old method, the coils were handled by an overhead crane which was kept busy supplying coils to the pickling tank, transferring them to the rinsing tank and then to the liming tank. In such cases, the crane deposited the rinsed coils in the liming solution as expeditiously as possible, and, after the coils were heated, lifted them above the solution and held them suspended while drying. For some classes of work, the crane had to do this only two or three times; but on other classes, four or five times would be necessary. It was found that such submerging, for the required length of time, hoisting and drying for the required length of time and again submerging took so much time, that it delayed the other work of the crane in transferring coils into and out of the pickling solution; and into and out of the rinsing tank, thus seriously decreasing the production rate.

The primary object of the present invention is to provide methods whereby the above described unbalance of the several operations is obviated and rate production greatly increased. An important factor in producing such balance is novel improvements in the construction and operation of the liming part of the apparatus.

As a result of experiment, it was discovered that it is not necessary to lift the coil above the liming tank, and hold it there while drying, in order to get substantially uniform coating of the lime; that if the solution heats the coil sufficiently, it may be made to emerge from the solution at a rate which will permit sensible heat from the wire or rod, to absorb latent heat and evaporate the water in which the lime is suspended practically as fast as the coil emerges; that the conditions of the drying coating just above the surface are so uniform throughout the emerging operation, that the coating will be substantially uniform, notwithstanding the fact that the lowermost part of the coil is submerged much longer than the upper part; that by thus drying the coating by heat derived from the metal, it becomes unnecessary to lift the coil out into the dry upper air; and that the wire dries as fast or faster, by reason of the fact that the small lengths of wire just above the surface of the solution are heated not only by heat stored up within the wire, but also by heat from adjacent wire which is still submerged and is itself receiving heat from the solution.

It was also discovered that during the gradual submerging and emerging of the coil, heat flow

from the solution into the wire and lengthwise in said wire is so rapid, that relatively short intervals of complete submergence and complete emergence, are sufficient for producing approximately uniform temperatures throughout the coil, by the time the top of the coil begins to emerge; and correspondingly uniform lower temperatures, by the time the bottom of the coil begins to be submerged.

To utilize the above described, somewhat paradoxical, method of progressively drying the wire by heat continuously derived from the solution, in addition to heat stored up in itself, the present invention contemplates leaving the coil suspended in the liming tank, and alternately submerging and exposing it, by lowering and raising the level of the solution.

So far as concerns practice of the basic principles of the above method, it will be evident that approximately parallel temperature and drying effects could be produced by raising and lowering the coil with respect to a constant-level surface for the lime solution. However, it will be evident that by keeping the coil stationary, at a low level in the hot tank during and after emergence, both maximum and minimum temperature for the coil will be higher for any given temperature of the solution, and the temperature factor in neutralizing the acid will be correspondingly more effective.

Further important advantages result from employing a two-compartment liming tank, and pumping the liming solution alternately from one compartment into the other, thereby raising the level of the solution to progressively submerge the coils in one compartment, while correlatively lowering the level and exposing the coils in the other compartment. In a given case, and for a given thickness of lime coating, the output may be doubled; or for a given output, the thickness of the coating may be doubled; or increased output may be combined with increased thickness of coating. The so-called solution carries much lime in suspension and the pumping keeps the mixture uniform in this respect; and tends to keep the temperature uniform. The active discharge of the solution into the liming tank, during the submerging period, creates convection currents forcing circulation of the hot solution to, through, and from, the convolutions in the coils; thereby washing them thoroughly, and greatly increasing the amount of heat that the solution can impart to the coils in a given time.

The above and other features of my invention may be more readily understood from the following description in connection with the accompanying drawings, in which

Fig. 1 is a plan view of my improved pickling, rinsing and liming apparatus;

Fig. 2 is a vertical section transversely of the apparatus, showing the overhead crane, in its relation to any one of the tanks, in this case, one of the pickling tanks;

Fig. 3 is a plan view showing the two-compartment liming tank, and the pumping mechanism;

Fig. 4 is a vertical section on the line 4-4, Fig. 3;

Fig. 5 is a vertical section on the line 5-5, Fig. 3;

Fig. 6 is a detail view showing the automatic switch mechanism for reversing the pump motor, the same as in Fig. 5, but on a larger scale; and

Figs. 7 and 8 are respectively, a rear elevation, and a plan view, both showing the overflow and

drainage and steam pipe arrangement for the two-compartment liming tank.

In Fig. 1, the complete apparatus is shown as comprising a line of end-to-end tanks including two similar pickling tanks 1, 1a; a rinsing tank 2 in which the rinsing spray nozzles 2a are more or less diagrammatically and incompletely indicated; the liming tank 3, comprising two similar compartments A, B; and pumping mechanism for pumping the liming solution from one compartment to the other, said pumping mechanism including intake and discharge nozzles 4, 4a having intake and discharge openings at the bottoms of the respective compartments, A, B, pipes 5, 5a controlled by valves 6, 6a, connecting said nozzles with reversible centrifugal pump 7, driven by an electric motor 7a.

These aligned tanks are paralleled by rails 8, 9a. As shown in Fig. 2, these rails carry an overhead crane 9, operated by a motor 9a, diagrammatically indicated in dotted lines. The hoisting tackle 9b is adapted to be hooked to any one of a number of similar coil carriers. Each carrier includes a beam member 10, adapted to extend widthwise across and rest upon, the top walls of any one of the tanks. The beam has depending therefrom a rigid bracket 10a, formed with a horizontal hook-like support 10b, adapted to hook through and support one or more wire or rod coils x, preferably a batch of such coils, as shown. The beam 10 of each coil carrier is equipped with suitable bail 10c for hoisting, and a handle 10d for guiding it while suspended.

The acid pickling tanks 1, 1a, are shown in cross-section in Fig. 2, and as indicated in Fig. 1, each of them is adapted to accommodate four of the above described coil carriers, each supporting a batch of coils, giving a pickling tank capacity of eight carriers. This large coil capacity is because of the relatively long time required for pickling, as compared with rinsing. The rinsing tank 2 accommodates only one coil carrier at a time; and the liming compartments A and B, each accommodates one coil carrier. These capacities give a fair working balance between the different kinds of work each requiring different lengths of time for completion.

Fig. 3, with the above reference characters applied thereto, gives the plan view relations and proportions of the liming compartments and reversing pump. Fig. 4 gives similar information with respect to the rear elevation of said parts. Further details necessary for explanation of my liming apparatus and methods are shown in Figs. 5 and 6.

Fig. 5 shows liming compartment, B; also, in dotted lines, the coils x which are suspended therein, on the carrier 10, 10a, 10b; also a desirable low level of the solution is indicated by the dotted line a, at approximately the level of the upper edge of the flattened intake and discharge nozzle 4a; and a desirable high level is indicated by the dotted line, b.

An important feature of the invention is that proper uniform operation is best ensured by a uniform rate of emergence and submergence of the coils. For this purpose, the rate of charge and discharge may be adjusted by regulating the speed of the pump motor 7a, or adjusting valves 6 or 6a. A fixed rate of correlatively emptying and filling the respective compartments being thus established, it is desirable also to automatically regulate the pump reversals, and so that they will occur whenever the desired high and low levels are reached in the respective compart-

ments. Since either one of the compartments will have the high and low levels that determine the time for reversal, it is convenient to gauge the reversal in accordance with the high and low levels in one of the compartments.

As shown in Figs. 1 and 5, compartment B happens to be selected for this purpose, and the mechanism employed is best shown in Figs. 5 and 6. In one corner of compartment B is a perforated partition 21, which protects a float 22, attached to chain 23. Chain 23 runs over pulleys 24, on support 25; and down into pipe 26, where it is connected to, and tensioned by, counterweight 27.

On chain 23 are two collars, one collar 28 a suitable distance above the float and the other collar 29 a suitable distance above the weight. As shown in Fig. 5, float 22 is at its lowest level, and the collar 29 has pushed slidable tube 31 upwards, and has raised one end of a tilting lever 30, to a point where it has operated a pivoted switch member 32, more or less diagrammatically indicated in Fig. 6. This switch has operated through ordinary electrical control mechanism, not shown, to reverse the motor 7a, thereby reversing the pump 7. This reversal having occurred at a time of low level in tank B, the pump discharges into said tank, gradually raising the level thereof, and thereby raising float 22. It will be obvious that when the float reaches the high level dotted line, b, the collar 28 will contact with the other end of the tilting lever 30, thereby operating the electrical control devices in the opposite direction and again reversing the pump motor.

The maintenance of standard high and low levels for the liming solution is important. Steam is used to keep the liming solution at the desired high temperature, and condensation of this steam increases the total volume of the solution. The desired heating of the coil is to such a temperature that the liquid will be quickly evaporated from the coil by the heat of the coil when the liquid level is below the coil. It has been found that a liming solution temperature of about 180° F. is satisfactory, but a higher temperature would not be objectionable, and a much lower temperature slows up the operation.

The low level c, is made more definite, and more suddenly arrived at, by having nozzles 4—4a flattened horizontally parallel with the bottom of the compartment, with their upper edges horizontal, and near the level of said low level line c. Thus arranged it will be obvious that when 4a is operating as an intake for the pump it will be fully submerged and will be lowering the surface of the solution at approximately uniform rate, until well after the emerging coil has been fully exposed; and the coil in the other tank is correlatively submerged.

As concerns the functioning of the pump nozzles, when acting as discharge nozzles, it will be noted that their side walls diverge horizontally, and their top and bottom walls converge vertically toward the discharge opening. So each nozzle discharges a flat divergent stream directed along the bottom of the compartment, thereby stirring up and mixing in any lime that might otherwise tend to settle out of the mixture. Furthermore, as soon as a coil begins to be submerged, the stream can circulate upward and actively penetrate the convolutions of the coil. This has an important effect as concerns rapidly heating the wire and rod material; also as concerns ab-

sorbing occluded hydrogen that has been freed from the steel by the heat.

While the above described action of the stream liming solution is effective for absorbing liberated hydrogen, my present method contemplates combining this with other factors, the most important of which is heating the steel to a temperature high enough to cause the hydrogen to be expelled from the steel. When the solution is applied in accordance with my present invention, it heats the steel so nearly to its own temperature that solution temperatures substantially below boiling are effective; and in a particular case, solution temperatures of about 180° F. were found to be sufficient to free the steel from occluded hydrogen probably completely, and certainly completely enough to eliminate all danger of its making the steel too brittle.

It has been discovered that the most desirable way of applying the heat is by discharging live steam into the liquid, preferably near the bottom thereof, preferably distributing the discharge through separate nozzles located in the respective compartments. Preferably at least one nozzle in each compartment is arranged in cooperative relation with the stream of solution discharged through the pump nozzle.

In the preferred arrangement as shown in Figs. 7 and 8, there is a steam nozzle 32 in the lower corner of tank B discharging toward the edge of the stream of solution issuing from pump nozzle 4a. Preferably also there is another nozzle 31, in the diagonally opposite corner discharging toward the stream of solution. Such locations and directions for the steam nozzles contribute to preventing the suspended lime from settling out of the mixture.

A convenient way of supporting the nozzle 32, and supplying it with steam, is to have it at the lower end of a vertical pipe 32a controlled by valve 32b supplied through pipe 32c, supplied by pipe 36 leading from a suitable steam supply, and controlled by valve 36a.

Steam nozzle 31 is similarly supported by vertical pipe 31a controlled by valve 31b supplied with steam through pipe 36b from supply pipe 36.

The arrangement for compartment A is preferably similar and symmetrical with respect to that of compartment B, nozzle 32x being supported by supply pipe 32y controlled by valve 32z, and supplied from pipe 36c; the other nozzle 31x being supported by supply pipe 31y communicating through control valve 31z with supply pipe 36c.

By the above arrangement the solution may be kept at the desired high temperature notwithstanding the great amount of heat absorbed as latent heat, in evaporating the large amounts of water which must be evaporated in order to dry the lime coating on the wire or rod material. It is possible also that live steam thus discharged into the stream of solution, and circulated through the coils, may be specifically beneficial in connection with removing or neutralizing occluded hydrogen.

Obviously the condensate contributes water to replace that evaporated; but, in practice, the amount of water so contributed, is greater than required for this purpose. Consequently the volume of the solution gradually increases.

Such increase in volume does not affect the high and low levels of the compartment B, because these are fixed by having the control float, 22, in said compartment; but any excess will operate to raise both the low level and the high

level in compartment A. As shown in Figs. 7 and 8, such increase in volume is prevented by gravity overflow in excess solution through pipe 41 which has intakes 41a, 41b leading from the respective compartments, both intakes being at the same predetermined limit of high level for the solution.

For convenience, there is also a pipe 51 which can be closed by valve 51a. This pipe has intakes 51b, 51c leading from the respective compartments at the level required for predetermining the proper level when the circulating pump is not in use and the coils are being coated by the old method, namely, using the crane to lift them out of the tank, and hold them suspended while the coat is drying. Pipes 41 and 51 discharge through pipe 61 into sump D. There is also a gauge overflow pipe 73, controlled by valve 73a, which discharges into sump E. This pipe is for use in charging the compartments with the proper volume of liming solution required for the preferred alternating pump operation. The overflow will gauge the volume so that, in operation, it will give the predetermined high and low levels indicated in Fig. 5. Such volume is of course equal to the capacity of compartment B up to the low level line a; plus the volume in compartment A, which at that time is up to the high level line b.

The above described apparatus permits operation in accordance with a method affording a practically satisfactory approximation to perfect time balance for operation of the crane. In general, it may be said that the time required for each of the operations is different for different diameters of wire or rod used; different conditions as to the grade of steel and the amount of scale or rust on the surfaces of the metal; and for different temperatures and concentration of the solutions. Making due allowance for these variables and without going too far as to these details, a fair idea of the time balance in a typical average case, may be had from the following:

Pickling.—The pickling solution may have, say, 7% to 8% sulphuric acid and may be at a temperature of, say, 150° F. The acidity of the solution may be kept up by additions of sulphuric acid, but it is preferable to let the acidity run down, because, as the acid dissolves the iron, the iron content of the solution increases and when it reaches about 9% or 10%, the solution must be dumped and a new solution made up. Consequently, it is better to let the acid decrease to a practically useful minimum, by the time the iron content has reached the practically permissible maximum. The acid minimum may be 2%, or less in an average case. For alloy steels, the maximum permissible iron is much less, and the minimum permissible acid much higher.

While dumping and preparing new solution does not take much time, it is desirable to run the two tanks so one tank will be in good condition and kept in operation at the time when the other tank must be dumped.

Dumping may be effected through drain pipes 1z, 1z', and charging through supply pipes 1y, 1y'.

With such practice, and in an ordinary case, the pickling time for each coil may average about 40 minutes, and as the two tanks have a capacity of 2 coil carriers, it will be possible to have a carrier full of coils ready for rinsing about every 5 minutes.

Rinsing.—The rinsing tank, which is only diagrammatically indicated, is so effective that it

can always keep up with the pickling and liming rates.

Liming.—With liming compartments each of dimensions suitable for ordinary coils 3½ to 4 feet in diameter, the liming solution may be pumped fast enough to complete one cycle of submergence and emergence of coils, in approximately 1¼ minutes, more or less; and in a case when four or five complete cycles are sufficient for properly coating a coil, the batch of coils in one compartment may be ready for removal in say, 5 or 8 minutes after submersion; or, for the two compartments, and allowing reasonable margins, one batch every 4 or 4½ minutes. It takes time for the crane to lift out the completed coils and replace them by a rinsed coil, so it will be obvious that the above suggested 5-minute intervals between pickled coils, ready to be rinsed, will substantially balance the four or four and one-half minute intervals between coated coils.

As before explained, the pump is a centrifugal pump, which is capable of allowing variable slip, to vary the discharge rate, by and in accordance with back pressure which may be regulated by adjusting the valves, 6, 6a. In this way, the time cycle of submergence and emergence may be varied to suit the material being operated upon, as also to suit the time required for coil transference by the crane.

For a given temperature of the solution, the principal effect of increasing or decreasing the time cycle, is to increase or decrease the amount of heat absorbed by a coil, between the time it begins to be submerged and the time when it begins to emerge. In general, the longer the cycle, the more heat can be absorbed by the coil. Consequently, the larger the diameter of the rod or wire, the longer the cycle should be for heating it to a given high temperature.

In all ordinary practice of this method, the thickness of the coating depends almost entirely on the number of times the coils are submerged and exposed. It is true that the lower half of each coil is submerged nearly twice as long as the upper part, but has only half as much time of exposure for drying; and as between the upper third and lower third, the contrast is even greater; but this does not make any substantial difference in the thickness of the lime coating. Ordinarily, the solution is hot enough to heat the metal hot enough so that when exposed, its internal heat will operate to evaporate the water from the liming solution film in a relatively short time; and substantially all the hypothetical difference in thickness of coating which one might expect to result from such widely different times of submergence and exposure, will be completely taken care of and the coating rendered uniform enough for all practical purposes. This may be more specifically explained as follows:

(1) As soon as the rising liquid begins to submerge the lower portions of the coils, the heat absorbed by the wire, begins to be conducted upward through the wire so that by the time the upper portion has been submerged by rise to and fall from line b, all parts of the coil will have reached a substantially uniform maximum temperature.

(2) Then as the solution is drawn off, a reverse process takes place. As soon as metal in the upper part of the coil is exposed, absorbed heat and heat conducted from below, becomes effective to evaporate all of the water from the

film of water and lime clinging to said exposed metal, within a very short time.

(3) This operation continues progressively downward, until the lowermost portion of the coil is exposed, and, at this point, the time it takes the liquid to fall away from the lowermost portion of the coil to the level indicated by the dotted line *a*, and then to rise up again to first contact with the bottom of the coil, is entirely sufficient for said bottom of the coil to dry out as effectively as all other portions have dried.

It is to be noted that conduction of heat from the submerged to the exposed portions of the wire or rod is an important factor of the uniform heating and drying, throughout all parts of the coil, including portions adjacent the top and bottom, as well as throughout the intermediate portions thereof. This shows that the functioning of the method will not be materially interfered with if the entire coil is inclined to the surface of the liming solution at a relatively acute angle; and that the functioning would be the same in principle, though less effective in degree, if the coils were horizontal. It follows also that while the functioning is best where the metal is elongated, and is of uniform cross-section, and a substantial part of it is at a high angle to the surface of the solution, nevertheless the method is capable of functioning, with varying degrees of efficiency, with respect to almost any article, arranged so that the liming solution can drain off sufficiently from the exposed surface of the article.

While I have explained the importance of various phases of my invention such as balance of output as between the pickling, rinsing, liming and conveying elements of the combination; efficiency of the liming apparatus in heating the steel to temperatures closely approximating the temperatures of the liming solution; making said temperatures high enough to ensure freeing the steel from occluded hydrogen, etc.; it will be obvious that the lime coating apparatus, as well as many of its preferred details of construction and operation, will prove useful when employed separately, or when operated at temperatures too low to eliminate occluded hydrogen, or when operating on material that does not contain occluded hydrogen. Similarly the lime coating methods, as concerns gradually and progressively submerging and exposing material to coat it with lime, is useful independently of whether or not advantage is taken of the possibility of operating to heat the steel to temperatures higher than have heretofore been attained; and independently of whether or not these temperatures are high enough to ensure freeing the steel from the occluded hydrogen, and independently of whether or not the steel contains any such hydrogen.

This is of course without prejudice to the special novelties and advantages resulting from employing all of the novel features in combination; and it is a special merit of the methods of operation at high temperatures, that they have a double utility, namely, greatly speeding up the rate of coating, and, at the same time ensuring expulsion of occluded hydrogen from the steel, if it contains any.

In the following claims, it is to be understood that "lime solution," "liming solution" and "solution" are used for convenient, commonplace identification of the hereinbefore described mixture consisting of hydrated lime in suspension in water.

I claim:

1. A method of coating a coil of ferrous wire or rod material, which method includes suspending the coil in a receptacle, maintaining a liming solution at a temperature of about 180° F., raising the level of the hot liming solution in said receptacle to gradually and progressively submerge the coil and to progressively heat the coil; maintaining the solution above the top of said coil until the latter is heated to practically uniform high temperature approximately that of the solution; lowering the level of said solution to gradually expose the coil above the surface of the solution and progressively evaporate water therefrom and dry the lime coating on exposed portions of the coil adjacent said surface, by heat stored up therein and by heat conducted from adjacent submerged portions that are still receiving heat from the solution; and continuing to lower said level, to completely expose the bottom of the coil above the surface of the solution to allow it to drain, and to be dried by the heat stored up therein.

2. A method of coating a coil of ferrous wire or rod material, which method includes suspending the coil in a receptacle, raising the level of a hot liming solution in said receptacle to gradually and progressively submerge the coil to progressively heat the wire or rod material; maintaining the solution above the top of said coil until heated to practically uniform high temperature; lowering the level of said solution to gradually expose the coil above the surface of the solution and progressively dry the lime coating on exposed portions of the coil adjacent said surface, by heat stored up therein and by heat conducted from adjacent submerged portions that are still receiving heat from the solution; and continuing to lower said level, until the bottom of the coil is exposed above the surface of the solution to allow it to drain, and to be dried by the heat stored up therein; repeating the above cycle of raising and lowering the level of the solution to add additional coatings until the material has been coated to a desired thickness, and delivering steam to said solution to maintain the desired temperature, and to compensate for loss of water evaporated from the surface of the coil.

3. A method of coating coils of ferrous wire or rod material, which method includes suspending coils in separate similar receptacles; pumping hot liming solution from near the bottom of one receptacle to near the bottom of the other alternately in sufficient volume and at suitable rates for gradually and progressively submerging the coil in one receptacle to progressively heat the coil, from the bottom upward; maintaining the level above the top of the coil until the coil is heated to practically uniform high temperature; while correlatively lowering the level in the other receptacle, to gradually expose the coil therein above the surface of the solution and progressively dry the lime coating on exposed portions of the wire or rod adjacent said surface, by heat stored up therein and by heat conducted from adjacent submerged portions that are still receiving heat from the solution, said lowering the level of the solution being continued to completely expose the bottom of the coil above the surface of the solution to allow it to drain, and to be dried by the heat stored up therein, while the coil in the other receptacle is submerged and absorbing heat.

4. A method of coating coils of ferrous wire or rod material, which method includes suspending coils in separate similar receptacles; pumping hot liming solution from near the bottom of one receptacle to near the bottom of the other

alternately in sufficient volume and at suitable rates for gradually and progressively submerging the coil in one receptacle to progressively heat the coil, from the bottom upward; maintaining the level above the top of the coil until the coil is heated to practically uniform high temperature; while correlatively lowering the level in the other receptacle, to gradually expose the coil therein above the surface of the solution and progressively dry the lime coating on exposed portions of the wire or rod adjacent said surface, by heat stored up therein and by heat conducted from adjacent submerged portions that are still receiving heat from the solution; also correlatively lowering the level of the solution to completely expose the bottom of the coil above the surface of the solution to allow it to drain, and to be dried by the heat stored up therein, while the coil in the other receptacle is submerged and absorbing heat; and repeating the above cycle of submergence and emergence to add additional coatings until the material has been coated to a desired thickness.

5. A method of coating a coil of ferrous wire or rod material, which includes suspending a coil in a receptacle, alternately forcing liming solution having a temperature of about 180° F. into the bottom of the receptacle and withdrawing it therefrom, the delivery of the solution to the receptacle being continued until the coil is completely submerged, and the withdrawing being continued until the liquid level is below the coil, the liquid level above the coil being maintained until the coil has substantially reached the temperature of the solution, and the liquid level being maintained below the coil until the liquid on the coil surface has been substantially completely evaporated by the action of the heat absorbed in the coil by its previous submergence.

6. A method of treating a coil of ferrous rod or wire material which has been subjected to pickling in an acid solution and has occluded hydrogen on its surface, which method includes suspending the coil in a stationary position in a re-

ceptacle, delivering hot liming solution into the receptacle in a substantially horizontal direction near the bottom of the receptacle until the level of the solution is above that of the coil and the coil has been heated by the solution to a temperature approaching that of the solution, expelling the occluded hydrogen on the coil surface by the action of the eddy currents of solution around and over the surface of the coil generated by the action of the substantially horizontal delivery of the solution at the bottom of the receptacle, withdrawing the solution from the bottom of the receptacle until the liquid level is below the coil, and maintaining the level below the coil until the heat absorbed by the coil during its submergence has evaporated the liquid from the surface of the coil.

7. A method of treating a coil of ferrous rod or wire material which has been subjected to pickling in an acid solution and has occluded hydrogen on its surface, which method includes suspending the coil in a stationary position in a receptacle, delivering hot liming solution into the receptacle in a substantially horizontal direction near the bottom of the receptacle until the level of the solution is above that of the coil and the coil has been heated by the solution to a temperature approaching that of the solution, expelling the occluded hydrogen on the coil surface by the action of the eddy currents of solution around and over the surface of the coil generated by the action of the substantially horizontal delivery of the solution at the bottom of the receptacle, withdrawing the solution from the bottom of the receptacle until the liquid level is below the coil, and maintaining the level below the coil until the heat absorbed by the coil during its submergence has evaporated the liquid from the surface of the coil, and repeating the delivery and the withdrawal steps until the occluded hydrogen has been expelled and lime coating of the desired thickness has been formed on the surface of the material.

SIDNEY P. CARY.