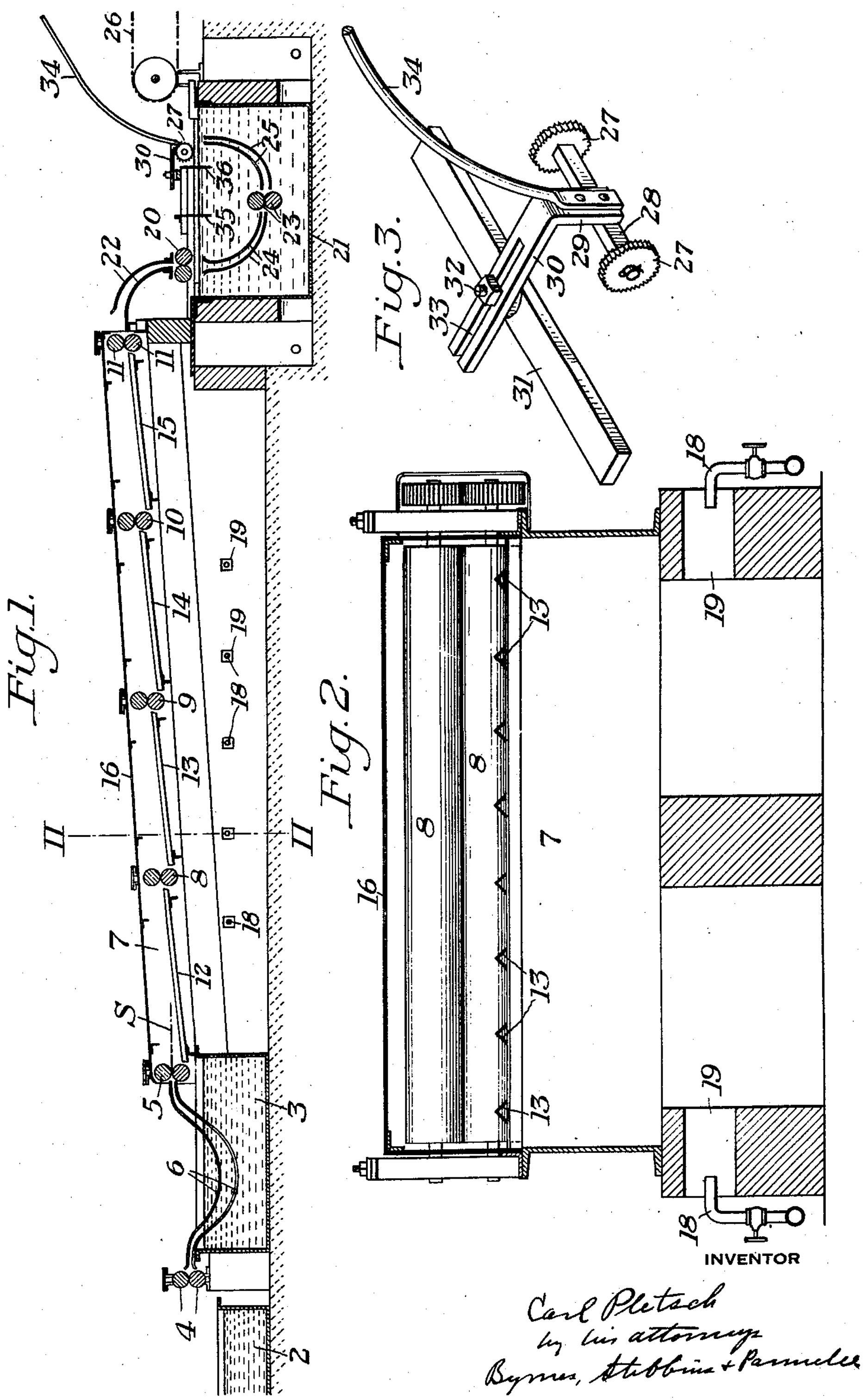
April 22, 1930. C. PLETSCH 1,755,559

GALVANIZING

Filed May 15, 1924 2 Sheets-Sheet 1



INVENTOR

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by his attorneys
Byrnes, Stebbins & Parmelee

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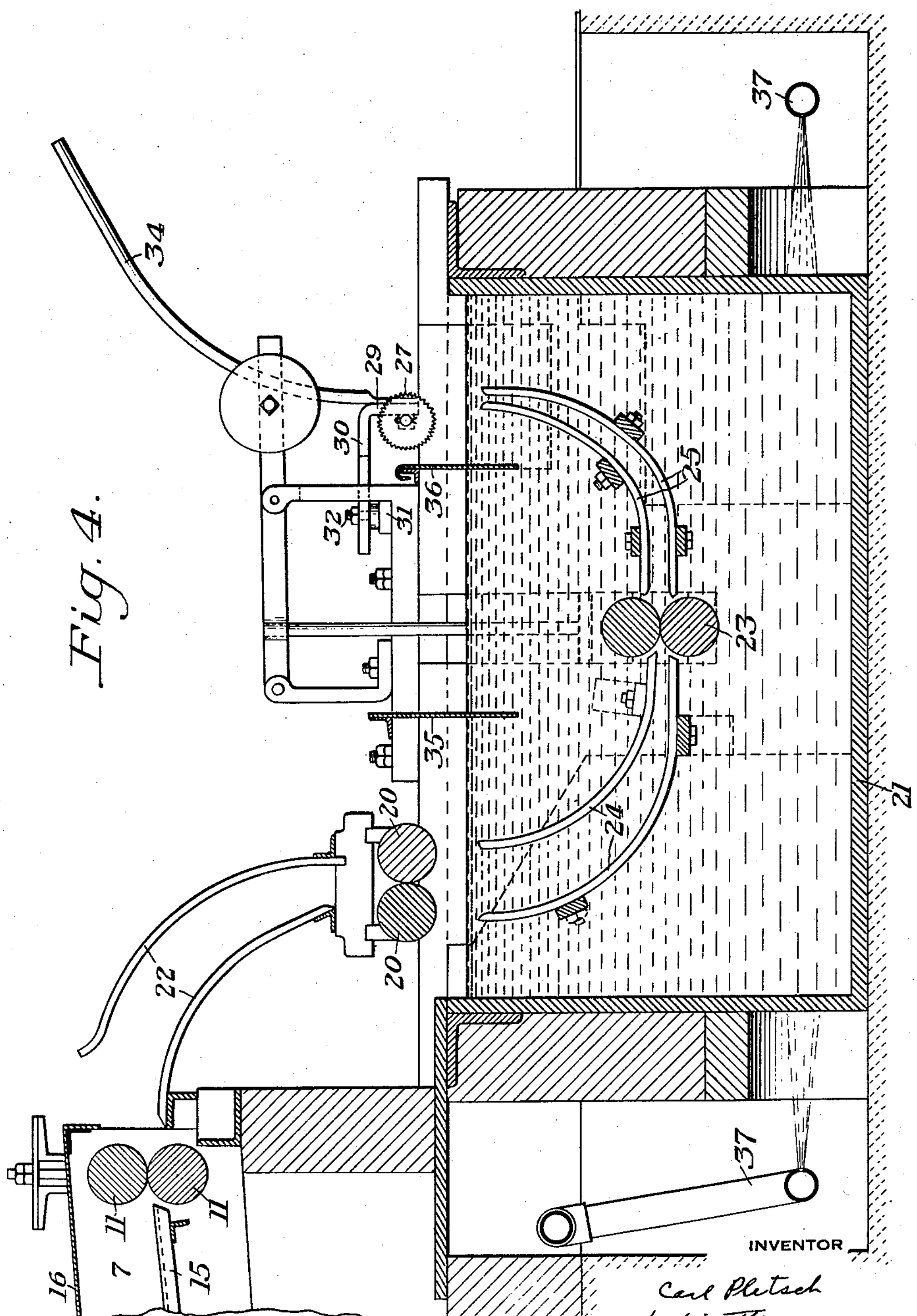

Fig. 4.

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UNITED STATES PATENT OFFICE

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GALVANIZING

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My invention relates to galvanizing, and more particularly to hot galvanizing.

In the process of galvanizing iron and steel sheets now universally employed, the sheets are first pickled in sulphuric acid, washed, and then passed through a dilute hydrochloric acid solution, through a flux box containing sal-ammoniac, into and through the spelter bath in the spelter pot. The zinc coating thus applied is not as adherent to the iron or steel as would be desirable and, when the sheets are bent, beaded or stretched in fabrication, the zinc is liable to crack and peel.

The zinc coating applied by my process is more adherent than that applied by the processes now in use. It has the desired brilliant metallic lustre and spangles. The weight of the coating may be readily controlled in my process.

In my process, the metal articles to be galvanized, such as sheets, pipe or wire, are pickled and washed in the usual manner and then given a coating of zinc chloride as a flux, preferably by applying a zinc chloride water solution, and drying. The articles are then coated with spelter containing a small amount of aluminum or of aluminum and tin.

My process will now be described in more detail with particular reference to the galvanizing of sheets, although the process is not so limited in its application but may be employed for galvanizing other articles.

In the drawings, which illustrate the preferred form of apparatus employed for galvanizing sheets—

Figure 1 is a longitudinal vertical sectional view through the apparatus;

Figure 2 is a transverse vertical sectional view taken on the line II—II of Figure 1;

Figure 3 is a detail perspective view of guiding means associated with the spelter pot; and

Figure 4 is a longitudinal vertical sectional view, on a larger scale, through the spelter pot and a portion of the oven.

The metal sheets which are to be galvanized are first thoroughly cleaned by pickling in hydrochloric or sulphuric acid. They are then washed, and when sulphuric acid is employed for pickling, they are next run through a weak hydrochloric acid solution. The sheets are then run into a storage tank 2 containing water or a very dilute solution of hydrochloric acid. Adjacent to and in line with the tank 2 is a tank 3 containing a nearly saturated solution of zinc chloride having a specific gravity of about 35° to 45° Beaumé. Mounted at the opposite ends of this tank are pairs of feed rolls 4 and 5, and extending between these pairs of feed rolls are guides 6 which dip down into the zinc chloride solution in the tank. The sheets are removed from the tank 2 by the workmen by means of tongs and inserted between the rubber feed rolls,—which act as squeegee rolls to remove excess liquid from the sheets. These rolls feed the sheets through the tank 3, between the guides 6. The sheets, wet with the zinc chloride solution, pass from the tank 3 through the feed rolls which remove surplus zinc chloride solution from the surfaces of the sheets, leaving them however wet with the solution, into a heating oven 7 which is positioned adjacent to and in line with the tank 3 and has an oblong chamber through which the sheets pass. The feed rolls 5 are positioned at one end of this chamber, and additional pairs of feed rolls 8, 9, 10 and 11 are arranged within the chamber. Any desired number of feed rolls may be employed in the heating oven. Between the feed rolls 5, 8, 9, 10 and 11 are sets 12, 13, 14 and 15 of longitudinally extending spaced parallel bars. These bars are preferably of angle iron positioned with their channels facing downwardly so as to bring their sharp apex edges uppermost. Each set of bars is inclined. The rear ends of the bars are below the bite of the pair of feed rolls adjacent such rear ends and the forward ends of the bars are slightly below the bite of the pair of feed rolls adjacent such forward ends. As a sheet S is fed by the feed rolls 5 into a heating oven, its leading edge does not come in contact with the bars 12 until a considerable length of the sheet has passed into the oven. As the feed of the sheet continues, the leading edge bends over into contact with the bars and slides along the bars until it is caught in the bite of the feed rolls 8. While the leading edge slides along the bars, the body of the sheet is kept out of contact with the bars 12 by the feed rolls 5. This gives the sheet an opportunity to have its coating partially dried before the rear end of the sheet drops onto the bars 12. In similar manner, the sheet is fed forward through the feed rolls 9, 10 and 11. The sharp upper edges of the bars make a minimum of contact with the sheets and have little tendency to wipe off any of the protecting film of zinc chloride from the sheets.

The oven chamber has a metal cover 16 which may be formed in sections. As shown more particularly in Figure 2, the oven has a plurality of gas burners 18 extending into burner openings 19 in the brick setting of the oven. The gas flames from these burners furnish a current of heated air which rises into the oven chamber and dries the sheets as they are fed through the oven. The oven chamber is preferably maintained at a temperature sufficient to dry the sheets but not to destroy the zinc chloride film thereon. Preferably, the temperature of the oven chamber will be maintained between 400° and 600° F. The entry end of the oven chamber is preferably the hottest part thereof, so that the sheets are dried immediately upon entering the oven chamber. The dried film of zinc chloride serves to protect the sheets against oxidation as they travel through the oven chamber and into the spelter bath.

The sheets, when they pass from the oven into the spelter pot, being heated to the oven temperature, do not tend to chill the bath, as do the sheets in the usual process now universally employed, in which the sheets are passed cold and wet into the spelter pot. This economizes fuel. Moreover the steam explosions, which would otherwise occur if cold and wet sheets were introduced into the spelter bath, are obviated.

The film of zinc chloride on the sheets acts as a flux to assist in the wetting of the surfaces of the sheets by the spelter. The zinc chloride should be substantially free from iron salts and free acid. I have found that the usual commercial grades of zinc chloride contain too much iron salts, and I prefer to prepare a purer zinc chloride from the pot skimmings which consist principally of zinc oxide and which are commonly called "zinc ashes", by a process hereinafter described.

The sheets pass from the oven through a pair of intake rolls 20 placed a short distance above the surface of the spelter in the spelter pot 21 and having their axes in the same horizontal plane so as to feed the sheets vertically downward into the bath. Extending between the feed rolls 11 at the forward end of the heating oven and the intake rolls 20 are guides 22 which guide the sheets to the intake rolls. The spelter pot has the usual pair of bottom rolls 23, and extending between these bottom rolls and the intake rolls, are guides 24. These guides have their upper ends positioned below the surface of the spelter bath and are so shaped as to guide the sheets vertically downward from the intake rolls and then horizontally to the bottom rolls. On the other side of the bottom rolls are other guides 25 having their upper ends positioned below the surface of the spelter bath and shaped to guide the sheets horizontally from the bottom rolls and then vertically upward out of the pot. The sheets are caused to enter the bath vertically in order to avoid trapping zinc ashes floating on the surface of the bath, and carrying it down into the bath in contact with one side of the sheets. This would occur if the sheets entered the bath in an inclined position, as with the usual arrangement of the intake rolls. The sheets are caused to emerge from the bath in a vertical position in order to permit the surplus spelter to drain evenly from both sides of the sheets. The surface of the spelter bath, particularly where the sheets enter and emerge, should be kept reasonably clear of zinc ashes. This is accomplished by skimming the bath from time to time, either by hand or by a suitable mechanical skimming device. The usual exit rolls which have hitherto been placed with their bite at the surface of the spelter bath are not employed, for a reason which will presently appear.

The sheets pass from the guides 25 to the usual chain conveyor 26 for conveying them to the usual cooling rack. For deflecting the sheets onto the conveyor, I employ a pair of toothed wheels 27, shown more particularly in Figure 3. These wheels are rotatably mounted on the ends of a bar 28 which is secured to the downwardly extending end 29 of a bar 30. The bar 30 is slotted and secured to a bar 31 extending transversely of the pot. The bar 30 is secured to the bar 31 by a bolt 32 passing through the slot 33 in the bar 30, whereby the position of the toothed wheels may be adjusted relative to the guides 25. These toothed wheels merely make point contact with the sheets so that they do not disturb the uniformity of the coating on the sheets. An upwardly extending curved guide bar 34 is secured to the downward extension 29 of the bar 30 and cooperates with the toothed wheels 27 for ensuring the sheets passing to the conveyor from the guides 25. Plates 35 and 36 extend vertically downwardly into the bath and partition off the intermediate portion of the surface of the bath from the portions thereof where the sheets enter and emerge. Consequently, only the latter portions need be kept skimmed.

The spelter bath in the spelter pot can be made of ordinary commercial spelter with minor portions of aluminum or of aluminum and tin added. The spelter known in the United States as Prime Western spelter and usually used by galvanizers and containing not over 1.6% lead and not over .08% iron is suitable. The purer the spelter used, however, the better. The amount of aluminum in the bath is preferably between ¼% and 2%, usually about .5% by weight. The quantity of tin used is preferably from nothing to about 1%, by weight.

The alloying metal or metals are preferably added to the spelter in the form of ingots of a zinc-aluminum or zinc-aluminum-tin alloy containing a relatively large proportion of alloying metal or metals.

Typical alloys to be added to the spelter are as follows:

I

	Parts
Aluminum	20
Tin	25
Zinc	100

II

	Parts
Aluminum	35
Tin	5
Zinc	100

III

	Parts
Aluminum	25
Zinc	100

In making these alloys, the aluminum is first melted in a crucible and the zinc is then added and the mixture stirred, and then the tin is added and the mixture again stirred. The alloy mixture is then cast into small ingots or slabs which are added to the molten spelter in the spelter pot.

An amount of the alloy, usually from about 2% to 4% of the weight of the spelter, is added to molten spelter in the pot to bring the aluminum content or aluminum-tin content to the desired percentage.

The exact amount of aluminum and tin to be added to the bath depends upon the number of conditions and will be determined by the operator from observation of the results being obtained. For example, the amount of aluminum or aluminum and tin to be used will vary, among other conditions, with the grade of the spelter, the weight of the coating desired, the temperature of the spelter pot, and the nature of the steel or iron to be galvanized.

The aluminum when used in about the percentages specified makes the bath much more fluid than the ordinary spelter bath. In fact, the bath is sufficiently fluid, so that the excess spelter will drain off the emerging sheets and the usual exit rolls may be dispensed with. The sheets may therefore be withdrawn from the bath out of contact with any means for wiping off surplus spelter. For any particular grade of spelter, there is a percentage of aluminum, which will give maximum fluidity to the spelter and which if exceeded makes the bath less fluid. The weight of the coating to be applied may be varied by varying the fluidity of the bath. This is of particular advantage in the galvanizing of pipe or other articles which cannot be mechanically stripped of excess spelter. It also permits the usual exit rolls to be dispensed with and obviates defects incident to the use of exit rolls, such as non-uniformity of the weight of the coating in different parts of the sheets and the deposit of flux or other blemishing matter on the sheets.

The aluminum also makes the coating more resistant to oxidation so that the sheets better retain their brilliant metallic lustre and the coating lasts longer than the usual spelter coating. It also makes the surface of the spelter bath less susceptible to oxidation, so that no protecting layer of flux, sand, coke, etc., need be employed in the pot, and the surface where the sheets enter and emerge from the spelter bath may be readily kept clean by skimming. The aluminum also makes a coating which is more flexible and which, when applied with the zinc chloride flux, is more adherent than the ordinary spelter coating. Too much aluminum makes the coating brittle.

The tin has the effect of also making the spelter bath more fluid, and may be employed like the aluminum to vary the weight of the coating. The tin also increases the size of the spangles, which is desired by some customers. Too much tin makes the coating brittle.

The bath may be maintained at the usual galvanizing temperature of from 815° to 830° F. with the requisite fluidity. Increasing the temperature of the bath, of course, renders it more fluid and the amounts of aluminum and tin will be governed to some extent by the bath temperature to be maintained. The spelter pot may be heated in any suitable manner, as by the burners 37 shown in Figure 4.

Other conditions which call for varying amounts of aluminum or of aluminum and tin are the quality of the spelter and the nature of the sheets. Some grades of spelter require more alloying metal in the spelter than others. Also, some grades of steel seem to require more alloying metal in the spelter than other grades of steel.

The combination of the zinc chloride flux applied as above specified and the aluminum or aluminum and tin in the spelter is apparently necessary to secure the best results. There seems to be a peculiar inter-dependence between such use of zinc chloride as the flux and the aluminum or aluminum and tin in the bath, for neither factor alone will produce results approaching those obtained when they are used in combination as described. While I prefer to use aluminum and tin as the alloying metals, other alloying metals, such as antimony, bismuth, copper, etc. may be present in small amounts without seriously affecting the galvanizing operation. Some of these metals, such as antimony and bismuth will have the effect of decreasing the melting temperature of the bath, but if present in any considerable quantity, will tend to make the coating brittle.

While I prefer to use substantially pure zinc chloride as the fluxing material and the best and most economical results have been obtained thereby, it may be possible to have certain amounts of other compounds present in the zinc chloride flux, such for example as cadmium chloride or ammonium chloride, and the terms zinc chloride flux or zinc chloride fluxing material are therefore intended to include not only substantially pure zinc chloride but also zinc chloride accompanied with other compounds. Also it may be possible to use as the flux, chlorides of other metals of the zinc group, such as cadmium chloride.

The zinc chloride may be prepared in the following manner, utilizing the zinc oxide which forms on top of the spelter bath and which will be skimmed off periodically. To 6000 lbs. of hydrochloric acid in a suitable tank is added zinc oxide at the rate of 50 lbs. per half hour, stirring continuously with a mechanical stirring device until the acid is completely saturated with zinc, which may be determined by any suitable form of test. This quantity of hydrochloric acid will require about 2000 lbs. of zinc oxide which will dissolve in about 48 hours. A part of the solution is then transferred into a second tank, agitated and heated to about 110° F. by means of a combined air and steam blast. This heating renders the solution slightly acid, which is then completely neutralized by the addition of a small quantity of milk of lime. The air blast serves to oxidize iron salts. Chloride of lime may also be added for this purpose. These with milk of lime cause the precipitation of iron as a flocculent hydrate. When the iron has been completely precipitated, the solution is pumped through a filter press and thoroughly filtered and is then ready for use.

The zinc chloride in the tank 3 is maintained neutral by means of zinc ingots put into the tank as necessary. The zinc neutralizes any free acid which may be carried into the tank 3 on the surfaces of the pickled sheets coming from the tank 2. The solution being neutral does not attack the iron walls of the tank 3 and therefore does not become contaminated with iron from this source, which would occur if the solutions were allowed to become acid. Moreover introduction of free acid into the spelter pots is avoided.

In the old process of galvanizing, employing sal-ammoniac as the flux, considerable iron salts are carried with the sheets into the spelter bath, forming a dross containing from 95% to 98% metallic zinc, the remainder being principally iron. This dross collects in the bottom of the pot and has to be dipped out periodically. In my process very much less dross is produced and less loss of zinc occurs by dipping out this dross. In the old process, sal-ammoniac has to be constantly supplied to the top of the spelter bath and a considerable amount must be used. Moreover, the sal-ammoniac produces vapors that are very objectionable, and frequently sal-ammoniac spots result on the finished galvanized sheets, which are very objectionable. In my process, no such layer of sal-ammoniac flux has to be maintained on the top of the spelter bath. There will be some collection of zinc chloride on top of the spelter bath adjacent the delivery rolls, which can be skimmed off from time to time with the zinc ashes. The oxidation of the zinc surface will form a thin layer of zinc ashes or zinc oxide which may be skimmed off and utilized for the preparation of the zinc chloride flux, as already explained. When sal-ammoniac is used as a flux for galvanizing, sal-ammoniac skimmings containing from 50% to 60% zinc are produced. These sal-ammoniac skimmings must be removed from the surface by periodical skimming resulting in a considerable loss of zinc.

The life of the spelter pot which is made of steel is greatly lengthened in my process as compared with the old process. Zinc chloride acts as a flux for the interior of the pot and causes it to become galvanized and better resists corrosion. In the old process, the acid carried into the pot had a tendency to corrode the steel walls of the pot.

While the zinc coating is preferably applied to the metal articles to be galvanized by dipping them in a bath of molten zinc or flowing molten zinc over them, the zinc might be otherwise applied as for example by painting or dusting the surface with a powdered zinc and heating to melt the zinc in situ. Similarly while it is preferred to apply the fluxing material to the surfaces to be galvanzed by dipping them in a solution containing the fluxing material such as a zinc chloride solution or pouring such solution over the articles, the fluxing material might be otherwise applied as for example in a dry form such as a powder or molten flux.

While I have described the preferred method of carrying out my invention, and a preferred form of apparatus for practicing the method, it will be understood that I do not limit myself either to the exact details of the method as described or to the exact construction of apparatus shown, as variations may be made in both without departing from the spirit of the invention or scope of the appended claims.

I claim:

1. The process of galvanizing metal articles comprising cleaning the articles by a cleaning treatment including pickling in acid, applying a solution containing zinc chloride to the surfaces of the articles to be galvanized, neutralizing any free acid introduced in the zinc chloride solution by the pickled articles, heating the articles to dry the solution, and applying molten zinc containing small amounts of aluminum and tin to the surface to be galvanized.

2. The process of galvanizing metal articles comprising cleaning the articles by a cleaning treatment including pickling in acid, applying a solution containing zinc chloride to the surfaces of the articles to be galvanized, heating the articles to dry the solution, and applying molten zinc containing small amounts of aluminum and tin to the surfaces to be galvanized.

In testimony whereof I have hereunto set my hand.

CARL PLETSCH.