Jan. 21, 1941. W. C. GREGORY 2,229,073

METHOD OF RECOVERING TIN FROM TIN PLATED ARTICLES

Filed July 1, 1935 2 Sheets-Sheet 1

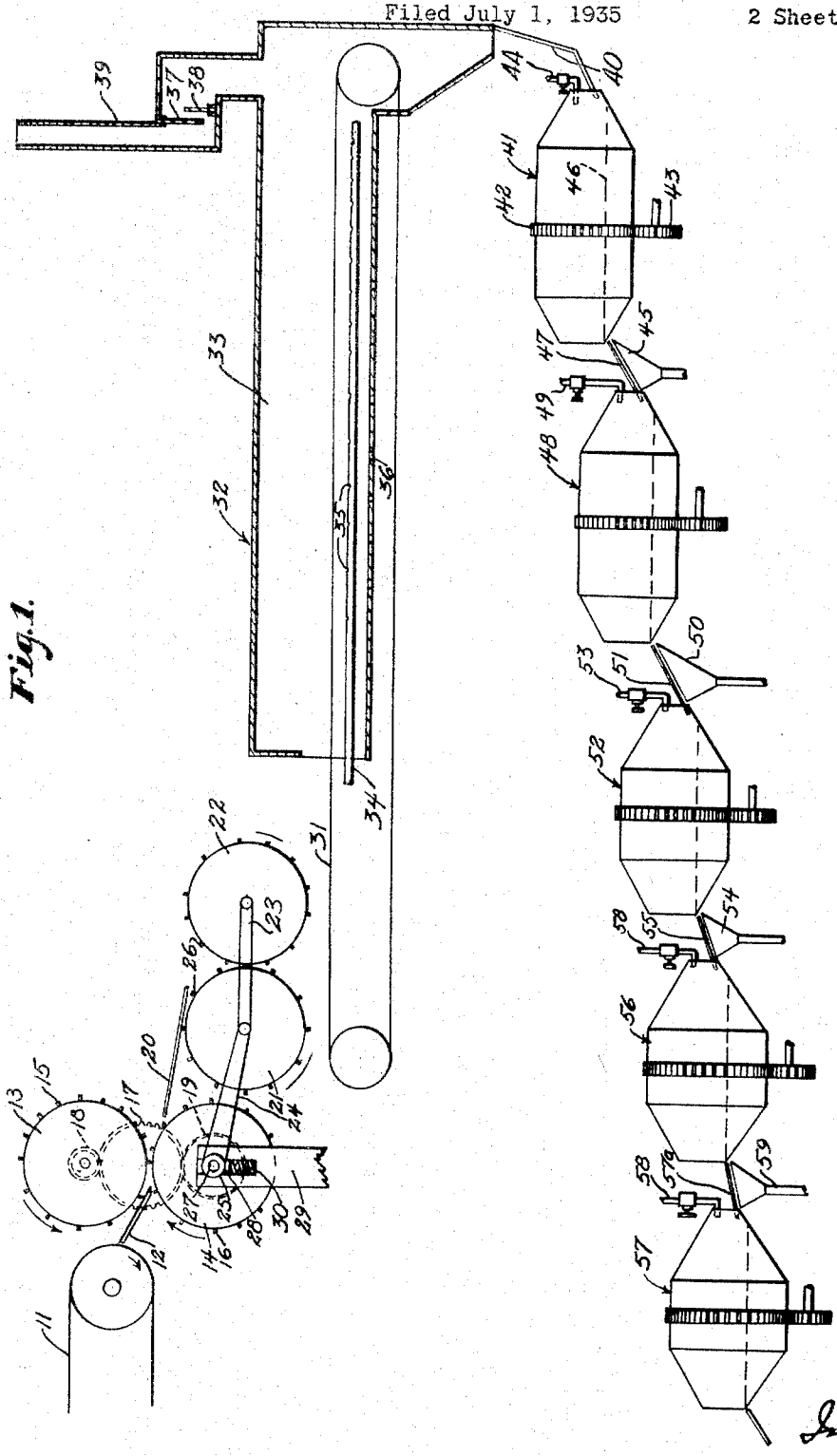


Fig. 1.

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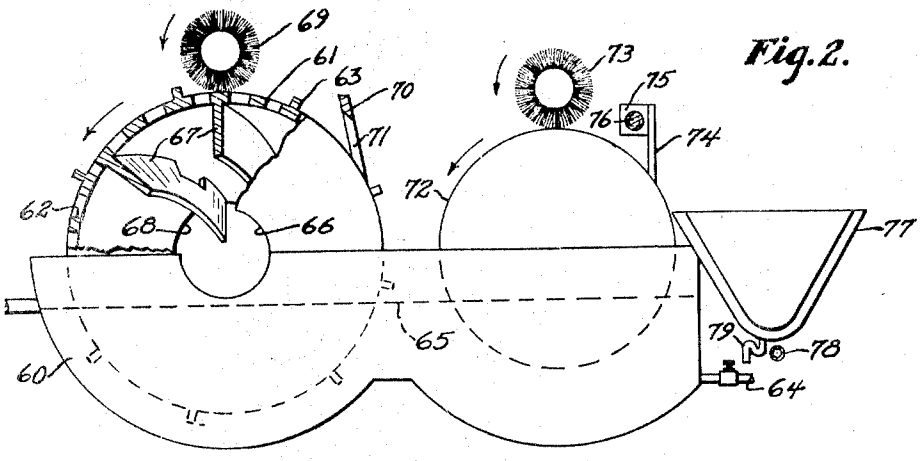


Fig. 2.

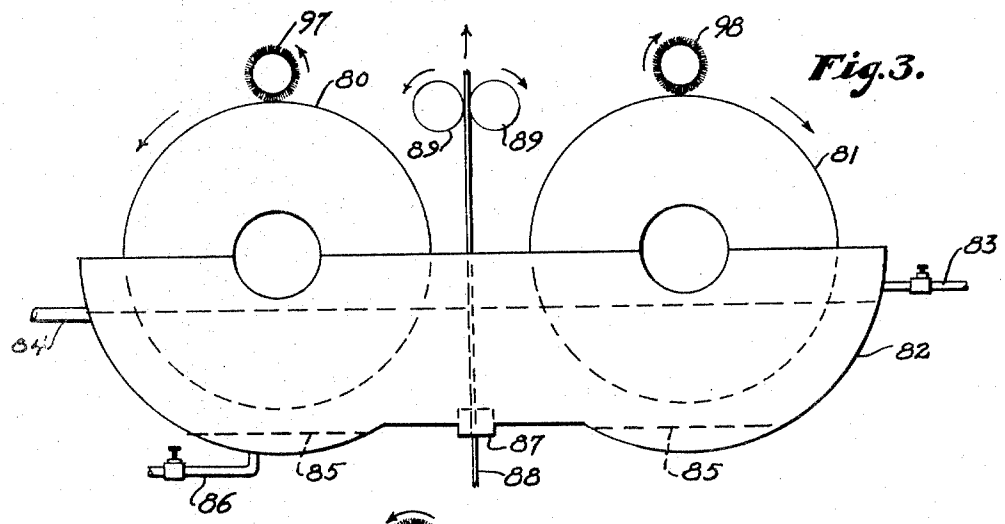


Fig. 3.

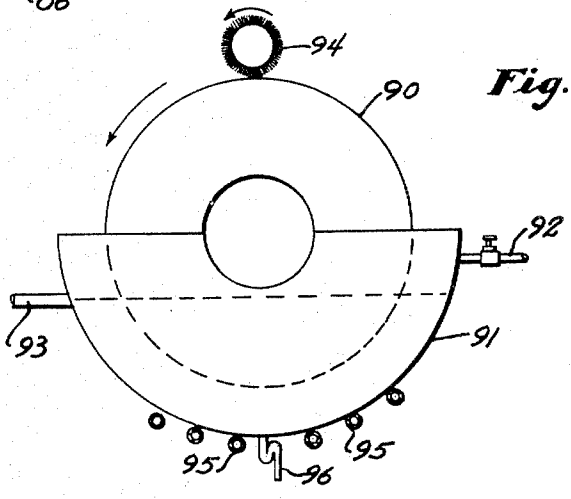


Fig. 4.

INVENTOR:
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Patented Jan. 21, 1941 2,229,073

UNITED STATES PATENT OFFICE

2,229,073

METHOD OF RECOVERING TIN FROM TIN PLATED ARTICLES

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Application July 1, 1935, Serial No. 29,221

5 Claims. (Cl. 204—122)

My invention relates to a method of and apparatus for depositing metal electrolytically and recovering metal from metal plate. Because my invention finds great utility in the recovery of tin from tin plated articles such as tin cans, it will be described for this use, it being understood that my invention is not limited to such use.

In attempts to recover the tin from used tin plated cans commercially, difficulty has been encountered because of the apparent necessity of burning from the cans a substantial portion of the tin plate in order to remove therefrom organic matter adhering to the cans as a result of their use. Further difficulty has been encountered in the deposition of tin electrolytically by the relatively rapid rise of the internal resistance of the electrolytic cell and a consequent necessity of increasing materially the voltage to which the electrolyte is subjected. Much difficulty has also been encountered in attempts to secure a hard, pure deposit of tin from a solution in which the tin from used tin plated articles such as cans has been dissolved because of the tendency for matter other than tin to be deposited on the cathode in such a manner as to prevent the deposition of a hard pure tin.

It is an object of my invention to provide a method for recovering tin from tin plated articles, such as tin cans, which eliminates the necessity of oxidizing any substantial portion of the tin plate in order to remove the organic matter adhering to the plated articles from their use.

It is a further object of my invention to dissolve from used metal plated articles a greater proportion of the metal than has heretofore been commercially possible.

It is a further object of my invention to provide a process for the recovery of metal from used metal plated articles which prevents the relatively rapid rise in the internal resistance of the electrolytic cell containing the dissolved metal and thus renders unnecessary a relatively rapid increase in the voltage necessary to accomplish the electrolytic deposition of the metal.

It is still another object of my invention to provide a process of recovering the metal from used metal articles which provides for the deposit of the metal while preventing the deposition of those complex salts of the metal and organic materials in the electrolyte which, if deposited, prevent the deposition of the metal in a hard, pure state.

It is a further object of my invention to provide a process for the recovery of metal from metal plated articles which reduces the time required by such process heretofore attempted, and which reduces the cost of and increases the percentage of recovery of such metal over that heretofore possible.

It is also an object of my invention to electrolytically deposit metal in a pure state from sources other than plates of such metal, e. g., blocks of such metal, while preventing substantial rise in the internal resistance of the electrolytic cell and preventing or removing the deposition of the cathode of matter which, if deposited, prevents or renders extremely difficult the deposition of the metal in a hard, pure state.

It is another object of my invention to deposit metal electrolytically in such a manner that it requires no polishing subsequently, and to deposit such metal in substantially uniform thickness upon objects of irregular shape.

A further object of my invention is to provide an apparatus for the performance of the foregoing objects in an efficient manner and one which permits the continuous supply to the electrolyte of the metal to be deposited and the continuous removal, if desired, of the deposited metal, while causing continuous agitation of the electrolyte.

These and other objects and advantages of my invention will be made evident in the following description, which may be better understood with reference to the accompanying drawings in which,

Fig. 1 is a diagrammatic view of the apparatus of my invention which is one embodiment of apparatus capable of performing the process of my invention;

Fig. 2 is an elevational view, partially in section, illustrating the preferred embodiment of the apparatus for removing and re-depositing the plated metal;

Fig. 3 is an elevational view of a first alternative embodiment of such apparatus; and

Fig. 4 is an elevational view of a second alternative embodiment of such apparatus.

In the attempts made heretofore to recover metal from metal plated articles, and particularly to recover tin from tin plated cans and the like, the cans were cut into pieces of a convenient size for handling and subjected to heat, such as gas flames, in an attempt to remove the organic material adhering to the cans from their use. In such removal of the organic material by heat, some of the tin is also removed and lost, this removed and wasted tin often, in such prior attempts, amounting to two-thirds of the tin plated upon the articles. After the pieces of tin plated

articles were subjected to heat they were immersed in a bath of sodium thiosulphate ($Na_2S_2O_3$) for the purpose of dissolving the tin remaining in plate form upon the pieces of the articles. This bath dissolved not only the tin but also organic material adhering to the articles and the enamel used for sealing the cans or for lining the cans.

Thereafter this bath was employed as an electrolyte, the tin being deposited therefrom upon one electrode. During the electrolytic deposition of the tin the internal resistance increased relatively rapidly, in some cases from one and one-half to twenty volts in thirty minutes. This increase in the resistance of the electrolytic cell and consequent necessity for impressing a greater voltage upon the electrodes was accompanied by a deposition with the tin of materials other than pure tin, which not only rendered the resulting product impure, but also prevented the deposition of the tin as a hard metal.

I have discovered that it is unnecessary to subject the used tin plated cans to heat sufficient to remove any substantial amount of the tin plated thereon. According to my process the tin plated articles are subjected to such a temperature for such a length of time that as much of the organic material as possible is removed without removing an appreciable quantity of tin. This temperature and time will vary with the nature of the materials it is desired to remove.

I have found that good results are achieved by employing as a tin solvent an agent which attacks tin more readily than the iron upon which the tin to be recovered is plated. If this solvent is an alkaline solution this iron does not dissolve as readily as, and the tin dissolves more readily than if the solvent is acid. Good results are achieved by using as a solvent an alkaline or alkaline earth acid salt or neutral salt of the persulfate radical, $(S_2O_8)^=$, the pyrosulfate radical, $(S_2O_7)^=$, the sulfite radical $(SO_3)^=$, the hyposulfite radical $(S_2O_7)^=$, the pyrosulfite radical $(S_2O_5)^=$, the thionate radical, $(S_2O_6)^=$, the thiosulfate radical $(S_2O_3)^=$, or a combination of these or the corresponding ions of selenium or tellurium, or a combination of them. To this solvent and electrolyte may be added the oxide or hydroxide of the alkali earth metals, e. g., calcium, to form a comparatively insoluble compound with the organic material and other products of partial reduction at the anode while not preventing the desired deposition of the metal at the cathode. Such addition of the free hydroxide or oxide also acts to lower the resistance of the electrolyte. The comparatively insoluble compounds of the gums, resins, rosins, and fatty acids of high molecular weight from the organic material adhering to the cans and the sealing material used on the cans, which compounds are soaps or soap-like, can be employed as an abrasive for the purpose hereinafter described, but are preferably precipitated and removed from the tin solvent.

The undesirable organic matter may also be prevented from depositing upon the anode by adding to the solution alkali salts and alkali earth salts of the halogens, e. g., sodium chloride, NaCl, which reduce the resistance of the electrotype and act as oxidizing agents at the anode. The nascent halide at the anode formed by the discharge of the halide ion will oxidize the organic matter, thus keeping the anodic resistance at a minimum. The hydro-halogen acid, e. g., HCl, and the hypo-halogen acid, e. g., HOCl (hypochlorous acid), formed by reaction with the water in the electrolyte, facilitate the dissolving of the tin if the tin cans are used as the anode and also oxidize the organic matter. The concentration of the halogen can be regulated by the addition of the halide of the same alkali as contained in tin as the solvent, i. e., by the common ion effect. An example is the addition of NaCl to a tin solvent consisting of $Na_2S_2O_3$.

I have discovered that a larger proportion of the tin can be dissolved from the tin plated articles employing any suitable tin solvent, such as sodium thiosulphate, if an abrasive is added to the solvent and a relative motion of the solvent and the tin plated articles is secured, so that the particles of abrasive contained in the solvent, by impingement upon the plate on the articles, mechanically urge the tin from the plated articles into solution.

This abrasive material may consist of one or more of a variety of substances which may be conductive inorganic substances, such as graphite or carbon, non-conductive inorganic substances, such as sand, silt, pumice or crystals formed by having the solvent in the form of a super-saturated solution, or organic materials such as particles of wood dust, paper, or the like. The essential consideration in the provision of the abrasive is that it be divided to a sufficient fineness that when the desired relative motion of the solvent and the plated articles is secured, the abrasive particles will impinge the plated articles and exert an abrasive effect upon the tin plated on the articles when they impinge upon this plate.

After the tin has been thus placed in solution, the solution may be concentrated to such a degree that upon cooling the tin is crystallized out and separated from the mother liquid. However, I prefer to use this solution as an electrolyte to accomplish the electrolytic deposition of the tin in a manner which will now be described.

The solution containing the tin contains also some organic material which adhered to the tin plate as a result of the use of the articles. This organic material may be a very small amount, some tests indicating as little as one-half of one per cent by volume of the solution. The solution also contains some gums from the enamel employed in sealing tin cans and in some instances in lining the tin cans. These gums oxidize at a higher temperature than the solution and are therefore difficult to remove therefrom. The solution may also contain metals other than tin, such as iron, and such as lead and zinc from the solder employed in the construction of the can. There may likewise be present in this solution, in colloidal form, complex salts of metals which are probably uncompleted reduction products of the metals.

If the solution is employed as an electrolyte with two electrodes immersed therein and a potential impressed upon these electrodes, the ionic tin present in the solution will be deposited to some extent upon the cathode. I have found that the cause of the rise in the internal resistance of the electrolytic cell is the deposit with the tin of colloidal matter including the organic matter, the gums, complex salts of tin, and the salts of the other metals hereinabove described. Many of these colloids have an inherent charge which causes them to move with the ionic tin to the cathode upon which they are deposited. When the colloids are deposited they are deposited upon the cathode less firmly and tenaciously than the

ionic tin and they present a less conductive medium than the electrode or the deposited tin so that a greater resistance to the passage of electrical current to the cathode is offered. These same materials deposited render the deposit of tin an impure product and one which is very porous and somewhat spongy and formed in fragile trees which break off from the cathode. Moreover, some colloids are deposited upon the anode, which tend to increase the internal resistance of the electrolytic cell. If particles of graphite or conductive carbon are added to the electrolyte they are deposited upon the anode with the colloidal particles and while the deposit is a rather porous mass its conductivity is good and a material increase in the internal resistance of the cell is prevented. The particles of graphite or conductive carbon also decrease the resistance of the electrolyte. Employing an iron anode and an electrolyte containing compounds of sulphur, the conductivity of the anode is decreased by the deposit of iron sulphite; with such an electrolyte I therefore prefer to use an anode of graphite or carbon or a noble metal or a metal or alloy not easily attacked by compounds of sulphur, such as nicrom.

The process of my invention contemplates the prevention of the increase in electrical resistance of the cathode and the accomplishing of a deposit of pure tin as a hard, uniform deposit, either by preventing the deposition upon the cathode of the colloidal materials, or by periodically removing them at frequent intervals after their deposit. The colloidal material may be prevented from depositing upon the cathode by either interrupting or varying the current so that the colloidal matter bearing electrical charges does not reach the cathode in undesirable quantities before the current is interrupted or reversed. It is known that such colloidal matter bearing the electric charge travels less rapidly toward the cathode than ions of the metal it is desired to deposit. Consequently, if there is employed a direct current which is periodically reversed, as by a commutator, or a continuous pulsating current or an alternating current whose positive and negative phases are such that the majority of the current flows in one direction, or an alternating current of varying frequency whereby one current is superimposed upon the other in such a manner that the major portion of the current travels in one direction, the time interval of the flow of the current will be greater in one direction than in the other, and thus the travel of the colloidal matter bearing electrical charges towards the cathode in an electrolyte which is agitated will be interrupted or reversed before such colloidal matter reaches the cathode for deposit in any substantial quantity. The ions of tin, travelling more rapidly than the charged colloidal particles, will be deposited upon the cathode. In this manner, if the electrolyte is agitated, the electrolytic deposition of the desired metal can be accomplished while the deposition of the colloidal matter to an undesirable extent is prevented. The electrolyte may be agitated by moving arms or paddles or by injected steam or air, the agitation being performed to that degree necessary to prevent the deposit of the colloidal matter to an undesirable degree.

I have found also that the addition to the electrolyte of particles of one or more such substances as are added to the solvent to facilitate the dissolving of the tin is very effective in preventing the deposition of such colloidal matter upon the cathode, particularly if the electrolyte is agitated. This may be due to the adsorption of the colloidal particles by the matter, such as sand, etc., added, or it may be that such matter added, because it bears an opposite charge, discharges those electrical charges upon the colloidal particles causing them to move towards the cathode; I believe that such added matter acts in some instances in both manners. The agitation of the electrolyte containing such matter provides relative motion of the particles of such matter and the colloidal particles, facilitating their contact with each other.

The removal of the deposited colloidal matter may be accomplished in several ways, all of which rely upon the fact that such deposited colloidal matter clings to the electrode less firmly and tenaciously than does the tin which is electrolytically deposited. For example, it is possible by periodically rubbing the electrode to dislodge the deposited colloidal particles while the deposited tin is not dislodged. The electrode may be rubbed at frequent intervals with rubber or any suitable brush or the like. For example, with a current density of 5 amperes per square inch, if the cathode is so rubbed at intervals of about 10 seconds, no material increase in the electrical resistance is noted. Likewise, it is possible, by securing a relative movement of the electrode and the electrolyte, to dislodge such deposited colloidal particles. If the cathode itself is moved, or if the cathode is maintained stationary and the electrolyte is caused to flow past the cathode in a definite current, or if the cathode is maintained stationary and the electrolyte is agitated by a stream of air or steam or paddles, or the like, most of the colloidal particles deposited will be removed. I have found that if there is added to the electrolyte an abrasive material, this sweeping or scouring action is increased and the deposited colloidal matter is more easily and completely removed. For this purpose abrasive material such as graphite, carbon, sand, silt, pumice, particles of sawdust or paper, or crystals of the substance dissolved in the electrolytic solution, may be advantageously employed. Likewise, any combination of such materials may be utilized. The amount and density of the abrasive added and the degree of the agitation of the electrolyte depends upon the concentration of the electrolyte and the concentration of the colloidal particles therein. Such amount and degree may be readily determined empirically by adding the abrasive and increasing the agitation until the deposited metal has the desired appearance and the internal resistance of the cell remains substantially constant. I have found that the addition of 1 part of sand to 5 parts by volume of a saturated solution of sodium thiosulphate with the electrolyte agitated by air bubbling therethrough adjacent the cathode gives a very satisfactory deposit. It is particularly advantageous in the step of electrolytically depositing the metal, as hereinbefore pointed out, to employ an abrasive material which itself carries an electrical charge tending to cause the abrasive material to move in a direction opposite to that in which the ions of tin are moving to be deposited. The charges from the abrasive particles discharge those charges upon the colloidal particles which tends to cause the colloidal particles to travel towards the cathode. Such charged abrasive particles as, for example, graphite, carbon, sand, silt, sawdust or paper, thus serve the dual purpose of counteracting the electrical charges upon the colloidal particles and thus preventing their travel towards

the cathode, and, by impingement with the colloidal particles deposited, sweeping such deposited colloidal particles from the tin and, I believe, the third purpose of adsorbing such colloidal particles and thus preventing their deposit upon the cathode.

The agitation of the electrolyte containing particles of the materials previously mentioned, and particularly the more abrasive materials such as graphite, carbon, sand, silt, or pumice, or materials of similar abrasive nature, serves to scour and polish the metal deposited upon the cathode so that it is bright and requires no subsequent polishing. Thus, if articles having smooth surfaces to be plated are employed as a cathode, upon their removal from the electrolytic bath, they will be finished products. Furthermore, such abrasives may be added in such concentration, and the electrolyte may be agitated to such a degree that the deposited tin may be removed. This is of great importance in plating with a plate of substantially uniform thickness articles having an irregular surface with cavities and projections. Plating such articles prior to my invention, the plate upon the projections has been deposited very thickly, in some instances and with some metals so thickly that it was dull and unlike in appearance a thinner plate before the plate upon the recessed portions reached the desired thickness. With abrasives in the electrolyte and the electrolyte agitated as described, the abrasive tend to impinge upon and remove the deposited tin from the projections just as the ionic tin tends to deposit upon the projections. This abrasive action upon the deposited metal may be increased by directing the electrolyte by baffles into a stream or streams against the projections. For a given article of irregular surface, the concentration of the abrasive and the degree of agitation of the electrolyte is determined empirically and, maintaining such factors uniform, a uniform plate is secured. To secure such a uniform thickness of plate on objects of irregular surface, a greater concentration of the abrasive and/or a greater degree of agitation of the electrolyte is required than that required merely to sweep the deposited colloids from the cathode.

The process of my invention can well be employed continuously by continuously supplying to the deplating solvent bath the articles bearing the metal plate to be removed or pieces of the metal to be deposited, so that a continuous supply of the metal is available. The solvent with the tin in solution and containing the colloidal materials and abrasive materials may be continuously supplied to a reservoir in which the tin is electrolytically deposited so that the tin in solution is continuously replenished and the deposition of tin is continuous. If desired, the tin may be deposited electrolytically upon a continuously moving electrode, such as a ribbon of metal, so that a plate of tin is formed on either or both sides of the electrode and a finished plated article is produced. If ingots of tin are desired, the electrode is not continuously withdrawn from the electrolyte, but is withdrawn only periodically when the desired quantity of tin has been deposited.

Referring to the drawings, the numeral 11 indicates a belt conveyor upon which the plated articles, such as cans, are delivered to a chute 12 from which they are fed between an upper wheel 13 and a lower wheel 14. The upper wheel 13 is provided with radial spikes 15 on its periphery, and the lower wheel 14 is provided with similar spikes 16, the spikes 15 and 16 being axially spaced with regard to each other so that they intermesh. The numeral 17 indicates a driving gear which drives the upper wheel 13 through the driven gear 18 at a greater speed than the lower wheel 14 is driven by the driven gear 19. Thus, when the spikes 15 and 16 engage the same plated article, they tear it and separate its seams. A chute 20 delivers the cans from the wheels 13 and 14 to shearing wheels 21 and 22 which are driven at the same rate of speed by a belt 23 connecting the wheels 21 and 22, and a belt 24 connecting the wheel 21 to a pulley 25 on the lower wheel 14. Each of the wheels 21 is provided with radially extending shearing knives 26, the knives on the two wheels 21 and 22 intermeshing as the wheels are rotated.

A shaft 27 upon which the lower wheel 14 is mounted is journalled in a block 28 which is mounted for vertical movement in a supporting member 29. A compression spring 30 resiliently supports the shaft 29 in its uppermost position. If a solid piece of metal is accidentally conveyed between the upper and lower wheels 13 and 14, the lower wheel 14 is moved downwardly, moving the driven gear 19 out of engagement with the driving gear 17, thus terminating the rotation of the lower wheel 14 and the wheels 21 and 22 so that damage to the apparatus is prevented.

From the shearing wheels 21 and 22 the plated metal, now in small, relatively flat strips, is discharged onto a conveyor belt 31 of porous heat resisting material, on which belt it is carried into a furnace 32. The furnace 32 includes a heating chamber 33 with pipes 34 extending therein beneath the carried portion of the belt 31. The pipe 34 is provided with openings 35 therein for the discharge of combustible gas. Air is admitted through openings 36 in the floor of the furnace and the heated gases pass upwardly through the porous belt 31 and heat the plated articles. The temperature in the furnace should be as low as it is possible to make it and still cause the greater part of the organic matter adhering to the articles to be burned off. The atmosphere within the furnace is preferably a reducing one to prevent the formation of tin oxide.

Baffles 37 and 38 are slidably mounted in a chimney 39 of the furnace 33 so that they can be removed from the sides of the chimney to remove therefrom any tin vaporized in the furnace and condensed on the baffles. The air entering the furnace 32 through the openings 36 passes through the returning porous belt 31 which is heated, so that the incoming air is preheated.

From the furnace 32 the heated plated articles, now free of most of the organic matter, are discharged onto a chute 40 and fed into a revolving tank 41. The tank 41 is revolved about a horizontal axis and has a central supply opening at one end of lesser diameter than the central discharge opening at the opposite end so that spiral baffles or vanes within the tank 41 cause the plated articles to pass through the tank 41 and be discharged therefrom while the tank is continuously rotated. A ring gear 42 surrounds the tank 41 and is driven by a driving gear 43 which is rotated in any suitable manner. Wash water is continuously supplied to the interior of the tank 41 through the supply pipe 44 and is continuously discharged therefrom into the waste pipe 45, the liquid level in the tank being indi-

cated by the dotted line 46. This wash water removes the oxidized organic matter from the plated articles. If desired, an abrasive may be added to the wash water, as previously described.

From the wash tank 41 the plated articles are discharged on a perforate chute member 47 which feeds the articles into a revolving rinsing tank 48. The rinsing tank 48 is similar in construction to the wash tank 41 and is driven in a similar manner. Rinse water is continuously supplied through the pipe 49, and continuously withdrawn through the waste pipe 50. The rinsing of the plated articles in the tank 48 removes any detergent adhering to them.

From the rinse tank 48 the plated articles are delivered by a perforate chute member 51 to a treating tank 52 which is driven in a manner similar to the tanks 41 and 81. A supply pipe 53 permits the continuous supply of a liquid, which can be continuously withdrawn through a waste pipe 54. The detailed construction of the treating tank 52 will be later described.

From the treating tank 52 the articles, which now have the plating removed therefrom, are delivered by a perforate chute member 55 to a first rinsing tank 56, from which they are delivered by a perforate chute member 57*a* to a second rinsing tank 57. Each rinsing tank has a supply pipe 58, and the first rinsing tank 56 has a waste pipe 59. The second rinsing tank 57 may have a similar waste pipe if desired. In the rinsing tanks 56 and 57, the electrolyte is washed from the deplated scrap and the scrap is prepared for baling. It will be obvious that by making the central discharge opening of each of the tanks of a greater diameter than the central inlet opening and by providing spiral passages within each tank, the metal will be caused to travel through each tank and be discharged automatically therefrom as the tank is rotated.

Referring to Fig. 2, the numeral 60 indicates a stationary tank which may surround the lower portion of the treating tank 52, the numeral 61 indicating a revolving tank similar to the tank 52 except that it is provided with a plurality of openings 62 therein. The revolving tank 61 may also be provided with a number of outwardly projecting radial arms 63. The stationary tanks 60 being supplied with a suitable solvent for the metal plate through the supply pipe 64 so that the liquid reaches the level indicated by the dotted line 65, the plated articles are continuously supplied to the revolving tank 61 through the inlet opening 66. These plated articles, guided by the perforate spiral baffles 67, travel through the revolving tank 61 as it is rotated and are automatically discharged through the discharge opening 68. The openings 62 in the revolving tank 61 permit the free passage of the liquid solvent into contact with the plated articles, and the projecting arms 63 serve to agitate the abrasive materials placed in the stationary tank 60, as hereinbefore described. A brush 69 rotates in contact with that portion of the outer surface of the revolving tank 61 between the arms 63 to remove therefrom any sulphides or other sulphur compounds adhering thereto which might increase the electrical resistance. Likewise, a scraper 70 is mounted to scrape the surface of the rotating tank 61 for the same purpose, the scraper being provided with openings 71 therein through which the projecting arms 63 pass.

The numeral 72 indicates a revolving drum upon which the metal is electrically deposited, this drum being driven in any suitable manner, as by a ring gear and pinion, as previously described. A brush 73 rotates in contact with the drum 72, and a scraper 74 is attached to a box 75 having a threaded opening therein through which a threaded shaft 76 extends so that, as the shaft is rotated in one direction and then the other in any suitable manner, the scraper 74 moves back and forth along the drum 72, scraping therefrom the deposited metal which falls into a hopper 77. The hopper 77 is inclined with the horizontal so that when it is heated by the combustion of gases supplied through the pipe 78, the metal shavings are melted and flow out of the gooseneck 79.

The revolving tank 61 and the revolving drum 72 are connected to a source of electrical energy in any suitable manner so that the former is the anode and the latter is the cathode.

In the first alternative embodiment illustrated in Fig. 3, the numerals 80 and 81 indicate revolving anodes which may be similiar in construction to the revolving tank 61. These tanks 80 and 81 contain the plated articles and are partially immersed in a stationary tank 82 to which the solvent is supplied through a supply pipe 83, and from which it is withdrawn through an overflow pipe 84. Abrasives are supplied to the stationary tank 82 to the approximate level indicated by the dotted lines 85, and a pipe 86 supplies compressed air to the bottom of the stationary tank 82 to agitate these abrasives. A packing box 87 is provided in the bottom of the stationary tank 82 so that a metal ribbon 88 may pass therethrough in fluidtight relationship and through the tank 82. This metal ribbon is moved by two friction rollers 89 and constitutes the cathode upon which the metal is deposited. The ribbon is connected to one terminal of a suitable source of potential, the anode tanks 80 and 81 being connected to the other terminal.

In the second alternative embodiment illustrated in Fig. 4, the numeral 90 indicates a rotating tank similar in construction to the tank 61 previously described, and a stationary tank 91 acts as the cathode. A supply pipe 92 provides the solvent to the tank 91, this solvent being withdrawn through an overflow pipe 93. A brush 94 removes from the rotating tank 90 any undesirable deposits thereon. With this embodiment of my invention the revolving tank 90 and the stationary tank 91 are connected to a suitable source of potential and the tank 90 is rotated while the plated articles are continuously supplied to and discharged therefrom until a deposit of the desired thickness is electrolytically formed on the stationary tank 91. The liquid is then withdrawn from the tank 91 and a combustible gas is supplied through pipes 95 to heat the deposited metal which flows from the tank 91 through the gooseneck 96. The gooseneck 96 retains sufficient of the metal to always seal itself so that no valve need be provided. If the anode drums 61, 80, 81 and 90 are formed of chromium steel or other alloys which are less active than iron in forming sulphides or other sulphur compounds increasing their electrical resistance, the brushes 69, 73 and 94, and brushes 97 and 98 cooperating with tanks 80 and 81, respectively, and the scraper 70, may be omitted. The direction of the revolving parts is indicated by appropriate arrows in each figure.

While I have described the practice of the process and the use of the apparatus of my invention with particular reference to the recovery of tin from tin plated articles, it will be understood that my invention is not so limited, for it

may be employed with metals in forms other than plate and with metals other than tin, including chromium, silver, nickel, gold, etc.

I claim as my invention:

1. The method of recovering tin from used cans having adhering thereto materials of electrical conductivity less than that of metallic tin, which includes the steps of: dissolving the tin in an alkaline electrolyte while converting the materials of low electrical conductivity to soluble soaps by washing the cans with said electrolyte; and depositing the tin electrolytically from said electrolyte while substantially preventing the deposition of said materials with the tin by precipitating the soaps by maintaining sodium chloride in solution in said electrolyte.

2. The method of recovering tin from used cans, which includes the steps of: dissolving the tin in an alkaline electrolyte and converting the materials of low electrical conductivity associated with such cans to soluble soaps by washing the cans with said electrolyte; converting the soluble soaps to insoluble soaps by adding sodium chloride and depositing the tin electrolytically from said electrolyte upon a cathode while mechanically sweeping the cathode with such insoluble soaps.

3. The method of recovering metallic tin electrolytically from used tin plated articles, such as cans, containing colloidal organic matter, gums and impurities adhering to such articles which includes the steps of dissolving the tin, organic matter and impurities from said articles in an aqueous solution consisting essentially of an alkaline solution of a halogen salt selected from the group consisting of the alkali and alkali earth metals, passing an electric current through the solution so obtained and dislodging the colloidal organic matter and impurities deposited with the tin upon the cathodes by impinging upon said cathode particles existing in the solution.

4. The method of recovering metallic tin electrolytically from used tin plated articles, such as cans, containing colloidal organic matter, gums and impurities adhering to such articles which includes the steps of dissolving the tin, organic matter and impurities from said articles in an aqueous solution consisting essentially of an alkaline solution of a halogen salt selected from the group consisting of the alkali and alkali earth metals, agitating the solution and articles to assist in the dissolution of the tin, passing an electric current through the solution so obtained and dislodging the colloidal organic matter and impurities deposited with the tin upon the cathodes by impinging upon said cathode particles existing in the solution.

5. The method of recovering metallic tin electrolytically from used tin plated articles, such as cans, containing colloidal organic matter, gums and impurities adhering to such articles which includes the steps of dissolving the tin, organic matter and impurities from said articles in an aqueous solution consisting essentially of an alkaline solution of a halogen salt selected from the group consisting of the alkali and alkali earth metals by using said articles as the anode in said solution, passing an electric current through the solution so obtained and dislodging the colloidal organic matter and impurities deposited with the tin upon the cathodes by impinging upon said cathode particles existing in the solution.

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