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SCREEN MANUFACTURE

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This invention relates to the manufacture of wire screen coated with corrosion-resisting metal, and more particularly to the manufacture of such screen in which the wires are soldered together at their points of intersection.

For practically all purposes to which woven wire screens are put, it is advantageous to have the wires soldered or welded together at their points of intersection. This increases the strength and rigidity of the material and prevents it from losing its shape or sagging. Also, since they hold their shape well, such soldered screens are easier to handle and to fasten in place, for example, on the frames of window screens, screen doors, and the like, than the ordinary unsoldered woven screens. Furthermore, the soldered screens have an increased resistance to corrosion. This is because in an unsoldered, electroplated screen the coating is usually thin at the points of intersection. In exposure to weather, drops of moisture tend to hang at the points of intersection; hence tendency to corrode is greatest at these points. Also, friction between the wires at their points of intersection often causes the protective layer to be cracked or broken, thus allowing corrosion to occur in the base metal.

Heretofore, soldered wire screens have been made by dipping the screens into a bath of molten metal which coats the wires and solders them at their points of intersection. For example, a galvanized wire screen is made by dipping woven iron or steel screen in a bath of molten zinc. In this process a large excess of the molten metal ordinarily adheres to the screen, and except in the case of the larger mesh sizes, e. g. $\frac{3}{8}$ inch or larger, the metal tends to fill a large number of the openings in the screen. This excess metal is ordinarily removed from the screen while it is still molten by shaking or tapping the article or by brushing or wiping off the excess metal. These methods are satisfactory for large mesh sizes but do not satisfactorily remove metals from the openings of screens having small mesh sizes, e. g. 10 mesh or smaller. For the smaller mesh sizes, it has been proposed to remove the excess molten metal by forcing a blast of air through the screen. This method is not altogether satisfactory since the blast of air required to remove metal from the holes in the screen is in most cases sufficiently strong to remove substantial amounts of metal from the wires themselves, thus tending to defeat the primary purpose of the hot dipping, namely, to produce a satisfactory corrosion resistant coating of metal. Also, air blowing may cause considerable oxidation of the

molten metal; this is particularly disadvantageous when the metal melts at a relatively high temperature. Furthermore, air blowing is not suitable for removing the molten metal from the holes in fine screens, e. g. 50 mesh or smaller since sufficient speed cannot be secured in the air flow to remove excess metal. Heretofore, so far as we are aware, there has been no feasible method proposed for producing fine mesh screens, e. g. 50 mesh to 100 mesh or smaller, having the wires soldered together at the points of intersection nor any wholly satisfactory method for producing soldered screen of sizes up to 8 mesh or thereabouts. Even with air blowing on screens having a mesh-size of 8 to 15, many of the holes remain completely filled up, and others instead of approximating a square have a circular form, or at best, definitely rounded corners. Heretofore, when it has been desired to produce a small mesh coated wire screen, it has been necessary to either weave the screen from the coated wire or to coat the woven screen by electroplating. Heretofore, the corrosion resistance of electroplated wire screens has not been satisfactory due to the difficulty in obtaining a sufficient deposit of electroplated metal at the points of intersection of the wires of the screen.

An object of this invention is to provide an improved coated wire screen and a process for making improved coated wire screen having the wires soldered together at their points of intersection. Another object is to provide an improved process for making corrosion resistant screens by electroplating. A further object is to provide a method for producing wire screens of small mesh size having the wires soldered at their points of intersection. Other objects will be apparent from the following description.

We have discovered that by electroplating a woven metal screen with a metal fusible below the melting point of the base wires and thereafter heating the electroplated article to a temperature slightly above the melting point of the plated metal, the plated wires become firmly soldered together at their points of intersection and the wires are substantially completely covered with a corrosion resistant layer of plated metal at all points. This heating or soldering should be accomplished under conditions conducive to good soldering or merging of the melted plate, i. e. in such manner as to avoid troubles from oxide formation. Furthermore, the effect of heating to fusion of the plated material is to improve the corrosion resistance of the plate at all points. Preferably, we heat treat the plated

screen under non-oxidizing conditions, as hereinafter described.

Various corrosion resistant fusible metals are suitable for use as plating materials in our invention; for example, the screen may be plated with tin, cadmium, zinc or alloys of these metals. By the term "fusible metals" as used herein and in the appended claims we mean metals or alloys having melting points not higher than about 500° C.

In one method of practicing our invention, a screen woven from steel or copper wire is electroplated with a lower fusing metal until a layer of metal of a suitable thickness has been produced on the wire. In order to attain a substantial soldering effect in the second step of the process, the electroplating ordinarily should be continued until not less than 0.0001 inch of metal has been electroplated on the wire. In order to obtain soldered joints of suitable strength for most practical purposes, we prefer to electroplate until the deposited layer has attained a thickness of 0.0002 to 0.0003 inch of metal. Various known electroplating processes may be used in accordance with our invention; for electroplating tin we prefer to use the methods described in U. S. Patents 1,841,978 and 1,919,000, whereby tin is electroplated from alkaline plating baths.

After electroplating, in the case of tin, the screen is heat treated to fuse the plate, preferably under non-oxidizing conditions. A suitable method, which may be used to advantage in heat treating screen plated with tin is to immerse the screen in a bath of tallow maintained at a temperature above the melting point of the electrodeposited metal for a suitable time to effect the soldering. Other heating means may be used as hereinafter disclosed. For example, the temperature of the tallow bath may be from 10 to 100° C. above the melting point of the electroplated metal, and the time of immersion may vary from about 3 to 60 seconds. In handling light screen, e. g. 8 to 20 mesh or smaller, we prefer to maintain the temperature of the tallow bath at a temperature slightly higher than the melting point of the plated metal, for example, up to around 30° C. higher and to use an immersion time of 10 to 30 seconds. On removal of the screen from the tallow bath, the wires will be found to be firmly soldered together at the points of intersection. If the electroplated coating is not too thick and if the heat treatment is not too prolonged, the holes will have substantially square corners and the general appearance of the screen will be substantially that of an unsoldered screen.

In some cases, certain electroplated coatings of fusible metal are not satisfactorily soldered by the simple heat treatment. We have found that such coatings may be satisfactorily soldered by applying a suitable solder flux, e. g. zinc chloride, to the plated screen prior to the heat treatment. We prefer to use a flux to solder screens plated with zinc or plated with tin from an acid bath, as illustrated below.

In practicing our invention, to produce a soldered screen coated with tin or tin alloy, we prefer to plate the tin or tin alloy from an alkaline electroplating bath. However, satisfactory results may be obtained by plating tin from acidic baths, if proper precautions are observed. We have found that in general, a heavier coating of electroplated metal is required when using an acid bath; the minimum coating required will vary somewhat for different types of acidic baths. For most purposes, we prefer to

avoid the use of colloidal organic addition agents, such as glue, in acidic baths; if such addition agent is present in substantial amounts, a heavy coat of metal, e. g. 0.001 inch thick or heavier, must be plated out in order to effect soldering by the subsequent heat treatment and the resulting soldered screen often has a rough appearance. This adverse effect is probably due to the tendency of such colloidal materials to deposit on the cathode during electroplating. If a light coating of tin is plated from an acidic bath containing glue, for example, a plate around 0.0002 to 0.005 inch thick, little or no soldering will occur on heating under non-oxidizing conditions, e. g. by tallow dipping. However, such light coating may be soldered to give a smooth, uniformly soldered product by treating the plated screen with a suitable soldering flux, e. g. a zinc chloride flux, and heating to the requisite temperature.

Acidic tin electroplating baths which contain substantially no organic colloids, are suitable for producing smooth, uniformly soldered screen by our invention, although heavy coatings, e. g. around 0.001 inch thick or heavier, generally are required. Such acidic baths are those which contain soluble organic addition agents, such as phenol or cresylic acid, or baths free from organic addition agents, for example, a pyrophosphate bath.

We have further discovered that the soldering of a screen plated with tin from an acidic bath may be facilitated by electroplating from an alkaline bath a thin or "flash" coat of tin or tin alloy over the coating plated from the acidic bath. This composite plate has preponderantly the characteristics of an alkaline plated coating, insofar as the soldering action is concerned.

Our invention may be further illustrated by the following examples:

Example 1

A sample of commercial iron wire screen of 14-mesh size was electroplated with tin in an alkaline electroplating bath made up by dissolving the following ingredients in water in the proportions indicated:

	Oz./gal.
Sodium stannate.....	8 to 18
Sodium hydroxide.....	½ to 2
Sodium acetate.....	2 to 4
100-vol. hydrogen peroxide.....	¼ to ½

The bath was operated at a temperature of 60 to 70° C. at a current density of about 25 amps. per square foot and a voltage of about 4 to 6 volts. A Straits tin anode was used and the ratio of anode area to cathode area was approximately 3 to 1. The screen was electroplated under these conditions for about 13 minutes, at the end of which time it had acquired a coating of about 0.18 oz. per square foot, the depth of the coating on the wire being approximately 0.0003 inch. The electroplated screen was immersed for about 15 seconds in a bath of tallow maintained at a temperature of 240 to 260° C. The resulting article was uniformly coated with tin and the wires were securely soldered at all points of intersection, and the holes thereof had substantially square corners.

Example 2

A sample of 100-mesh brass screen was electroplated and tallow dipped in the manner described in Example 1. When viewed under the microscope, the appearance of the resulting screen was

similar to the product of Example 1. The screen was uniformly coated with tin and all joints were firmly soldered. The holes appeared to be substantially square with only a slight rounding at the corners.

Example 3

A lead-tin alloy coating was electroplated onto 14-mesh copper wire screen from an alkaline plating bath made up according to the following formula:

	Oz./gal.
Sodium stannate.....	12
Sodium hydroxide.....	2
Rochelle salts.....	4
Lead acetate.....	1/3

The plating bath was operated at a temperature of 60–80° C., with a Straits tin anode and a cathode current density of approximately 25 amperes per square foot. The screen was plated until a coating 0.0002 to 0.0005 inch thick was obtained, whereupon the plated screen was immersed for about 15 seconds in a tallow bath at a temperature above the melting point of the alloy plate; temperatures of 185 to 230° C. were found effective to solder the plated screen uniformly.

Example 4

A cadmium-tin alloy coating was plated on a 14-mesh copper wire screen from an alkaline electroplating bath made by adding about 1 oz. per gallon of cadmium oxide dissolved in a sodium cyanide solution to the formula given above in Example 1. The cadmium-tin bath was operated under the conditions described in Example 1 and the plated tin was heat treated by immersion in a tallow bath at 240 to 260° C. for about 15 seconds. The resulting soldered screen closely resembled the product of Example 1.

Example 5

Copper wire screen of 14-mesh size was tin plated from an acidic pyrophosphate electroplating bath made according to the following formula:

Stannous chloride.....	1 oz. per gal.
Sodium pyrophosphate.....	6 oz. per gal.
Hydrochloric acid.....	Sufficient to make the solution acid to litmus

The bath was operated at about 180° F. with a Straits tin anode and a cathode current density of 5 to 10 amperes per square foot. The plated screen was heat treated by the method described in Example 1. A sample of screen plated with about 0.0001 inch of tin from this bath exhibited little or no soldering on heat treatment. Another sample, plated with an 0.0005 inch coating was well soldered at about one-third of the wire intersections after heat treatment.

Example 6

A 14-mesh copper wire screen was tin plated from an acidic bath made according to the following formula:

	Oz. per gal.
Sodium stannate.....	6
Sulfuric acid (60° Baumé).....	16
Phenol.....	1

Using a Straits tin anode and a cathode current density of 4 to 6 amperes per square foot, the screen was plated until a coating approximately 0.001 inch was formed. When the plated screen was heat treated by the method described

in Example 1, the wires were heavily soldered at substantially all the intersections and the heat treated screen had a smooth, bright appearance.

Example 7

Samples of 14-mesh copper wire screen were electroplated with tin coatings of varying thickness from an acidic bath having the formula given in Example 6, except 1/2 oz. per gallon of animal glue was added. After plating, the samples were heat treated by the method of Example 1. The following results were observed:

Sample	Approximate thickness of tin plate	Percentage of intersections soldered
	Inch	
1.....	0.0004	None.
2.....	0.0008	Less than 1%.
3.....	0.0012	About 1%.
4.....	0.0048	About 50%.

Example 8

Copper wire screen of 14-mesh size was plated by the method of Example 7 until a coating about 0.001 inch thick was obtained. A portion of the plated screen then was plated from the alkaline bath described in Example 1 with a coating of tin about 0.00005 to 0.0001 inch thick. After heat treating both screens by the method of Example 1, the screen plated from the acid bath only was soldered at 1 to 2% of the intersections and had a rough appearance, while the screen to which had been given the additional plate from the alkaline bath had a smoother appearance and was well soldered at every intersection.

Example 9

A 14-mesh copper screen was plated with a coating of tin about 0.0003 inch thick by the method of Example 7. On heat treating in the tallow bath by the method of Example 1, substantially no soldering occurred. Portions of the screen then were treated by applying zinc chloride solution and "Star and Crescent Brand" (paste) solder flux, respectively and heating above the flame of a gas burner. A smooth, uniformly soldered screen resulted.

Example 10

A 14-mesh steel wire screen was electroplated from an acidic zinc sulfate plating solution with a layer of zinc approximately 0.001 inch thick. One portion of the plated screen was treated with a solution of zinc chloride and then heated over a non-oxidizing gas flame to melt the zinc coating. Another portion was similarly heated in the gas flame without the pretreatment with zinc chloride. Both screens were soldered, but the screen which had been treated with zinc chloride had a brighter appearance.

Example 11

A 0.001 inch layer of cadmium was electroplated on a 14-mesh steel wire screen from a cadmium cyanide electroplating bath and separate portions were heated in a gas flame, and by immersion in a molten salt bath, respectively, at temperatures above the melting point of the plated cadmium. In both instances the screen was soldered at the intersections of the wires, and a continuous coating remained on the wires between the intersections.

Various means of heat treating the plated screens out of contact with oxidizing influences

may be used. One method consists in heating the plated screens in an atmosphere of an inert non-oxidizing gas, for example, hydrogen or nitrogen. Also, various heating baths which are not chemically incompatible with the plated metal may be used in place of the above-described tallow bath. Such baths may comprise various organic materials such as lubricating oil, paraffin, or other hydrocarbon material, low-melting fused salts and the like. Various temperatures above the melting point of the metal or alloy coating may be used. We prefer to heat-treat the plated screen for 10 to 20 seconds at a temperature up to about 100° C. above the melting point of the plated metal or alloy. We have found that if the screen is heated at temperatures too far above the melting point of the plate, there is often a tendency for the fusible metal to run off from the wire; hence, when higher temperatures are used, the time of heat treatment should be shortened correspondingly.

Another method of practicing our invention consists in electroplating or otherwise coating wire with a fusible metal, weaving the coated wire into screen and heat treating the screen under non-oxidizing conditions to effect the soldering.

Coatings of various alloys of fusible metals may be utilized in practicing our invention, for example, alloys of tin, cadmium, zinc or lead. Such alloys may be plated from an electroplating bath containing salts of the metals of the alloy. Another method of producing such alloy coating comprises plating alternate layers of each metal and then heating the plated screen to fuse the plate, whereupon the separately plated metals fuse together to form the alloy and solder the screen. For example, a layer of copper plated on an electroplated layer of tin forms a tin-copper alloy coating when heated to a temperature above the melting point of the tin or preferably to the melting point of the resulting alloy. In producing an alloy coating of tin and a high-melting metal such as copper, we prefer to plate the higher melting alloying metal over the tin. When alloying metals having relatively low melting points, e. g., lead or cadmium, are used, it is usually immaterial which metal is plated first.

Our invention may be utilized to produce either a uniformly soldered screen, that is, one having the wires soldered at substantially all of the intersections or a screen having the wires soldered at part of the total number of intersections. Such partially soldered screens are superior to unsoldered screens in respect to strength and rigidity; however, for most purposes, a completely and uniformly soldered product will be preferred.

We claim:—

1. A process for making soldered, woven wire screen comprising electroplating a woven wire screen with tin from an acidic plating bath, electrodepositing a further tin coating on said screen from an alkaline plating bath and thereafter heating said screen under non-oxidizing conditions to effect a soldering of wires of said screen at their points of intersection.

2. A process comprising fabricating a structure of intersecting wires, said wires having a tin coating obtained by first electroplating tin thereon from an acidic plating bath and then further electroplating tin thereon from an alkali

line plating bath, and thereafter heating said structure under non-oxidizing conditions, whereby the intersecting wires become soldered together at their points of intersection.

3. A process for making soldered, woven wire screen comprising providing an unsoldered woven wire screen, the wires thereof having a fusible coating comprising tin electrodeposited from a plating bath containing 8 to 18 ounces per gallon of alkali metal stannate and 0.5 to 2 ounces per gallon of alkali metal hydroxide and heating said screen under non-oxidizing conditions in the absence of a soldering flux to a temperature above the melting point of said coating to effect a soldering of the wires of the screen at their points of intersection.

4. A process for making soldered, woven wire screen comprising electroplating a woven wire screen with tin from a plating bath containing 8 to 18 ounces per gallon of an alkali metal stannate and 0.5 to 2 ounces per gallon of an alkali metal hydroxide and heating the electroplated screen under non-oxidizing conditions in the absence of a soldering flux to a temperature above the melting point of the tin plate to effect a soldering of the wires of the screen at their points of intersection.

5. A process for making soldered, woven wire screen comprising electroplating a woven wire screen with tin from a plating bath containing 8 to 18 ounces per gallon of sodium stannate and 0.5 to 2 ounces per gallon of sodium hydroxide and immersing the electroplated screen in molten tallow at a temperature of 230 to 300° C. in the absence of a soldering flux to effect a soldering of wires of said screen at their points of intersection.

6. A process for making soldered, woven wire screen comprising electroplating wire with tin from a plating bath containing 8 to 18 ounces per gallon of alkali metal stannate and 0.5 to 2 ounces per gallon of alkali metal hydroxide, weaving the electroplated wire to form a screen and heating said screen in the absence of a soldering flux under substantially non-oxidizing conditions to effect a soldering of wires of said screen at their points of intersection.

7. A process for making soldered, woven wire screen comprising electroplating wire with tin from a plating bath containing 8 to 18 ounces per gallon of sodium stannate and 0.5 to 2 ounces per gallon of sodium hydroxide, weaving the electroplated wire to form a screen and heating said screen in the absence of a soldering flux under substantially non-oxidizing conditions to a temperature of 230 to 300° C. to effect a soldering of wires of said screen at their points of intersection.

8. A process comprising fabricating a structure of intersecting wires, said wires being coated with tin, at least the exterior layer of which is electrodeposited from a plating bath containing 8 to 18 ounces per gallon of sodium stannate and 0.5 to 2 ounces per gallon of sodium hydroxide and subjecting said structure to a heat treatment in the absence of a soldering flux under substantially non-oxidizing conditions to solder intersecting wires together at their points of intersection.

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