Aug. 24, 1965 J. E. BRIDE 3,202,589

ELECTROPLATING

Filed Sept. 12, 1963 3 Sheets-Sheet 1

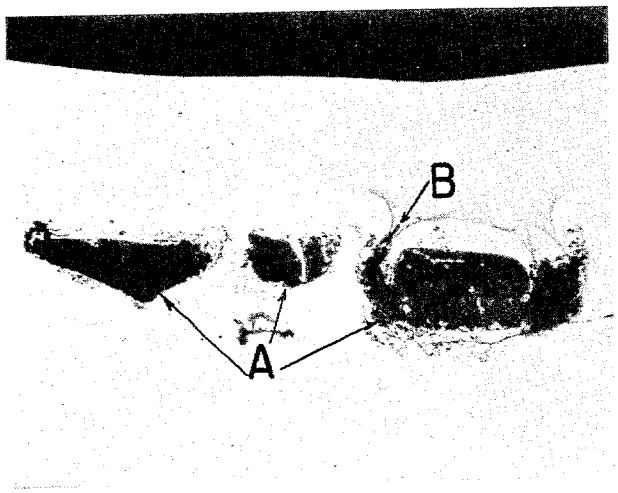


Fig. 1

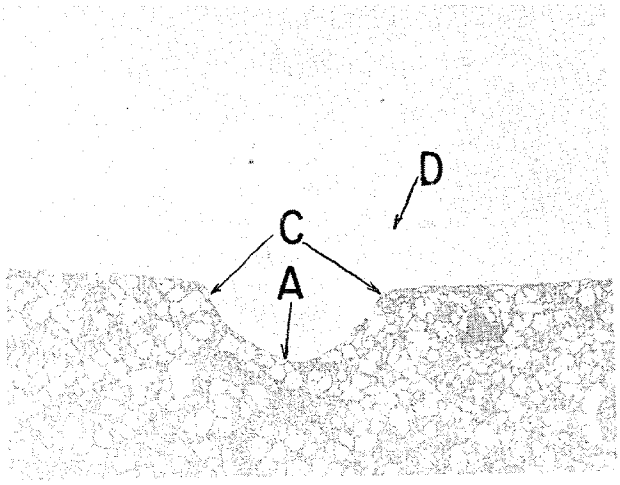
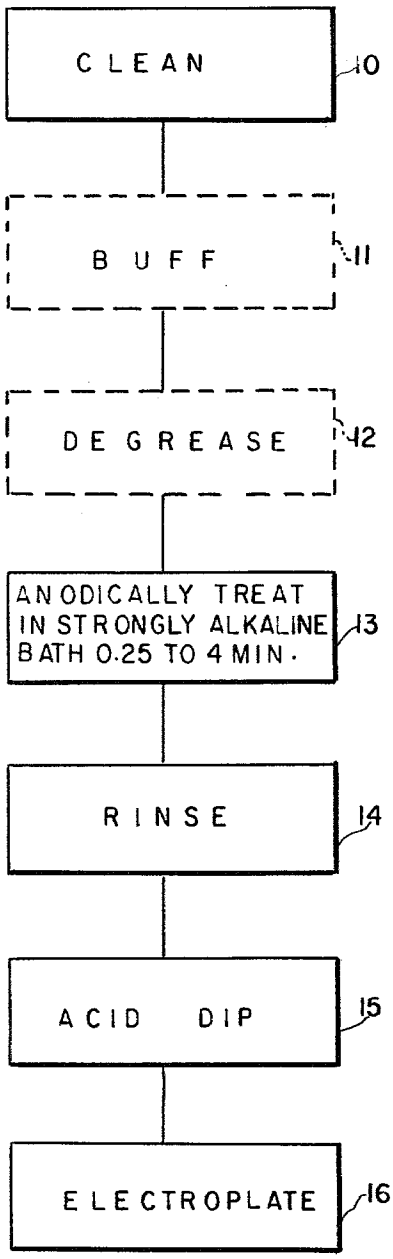


Fig. 2

INVENTOR.
JOHN EDWIN BRIDE
BY Hammond & Littell
ATTORNEYS

Fig. 3



INVENTOR.
JOHN EDWIN BRIDE
BY
ATTORNEYS

Aug. 24, 1965 J. E. BRIDE 3,202,589

ELECTROPLATING

Filed Sept. 12, 1963 3 Sheets-Sheet 3

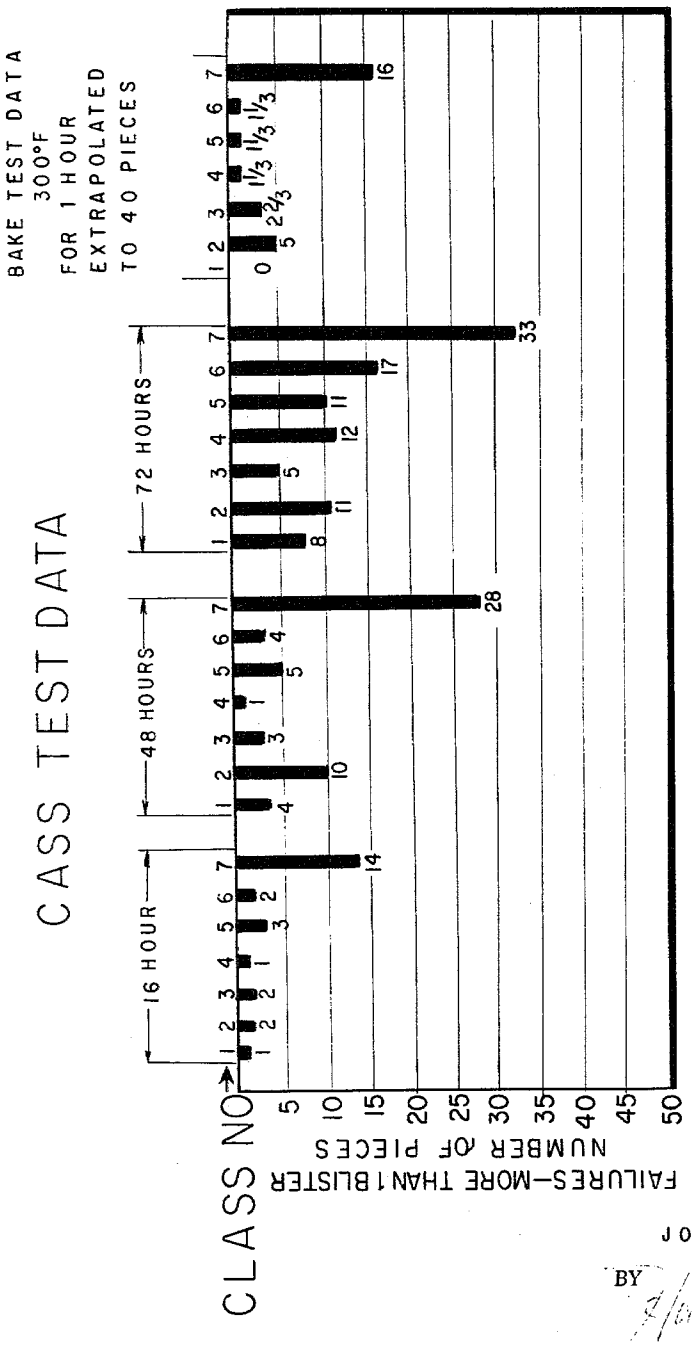


Fig. 4

INVENTOR.
JOHN EDWIN BRIDE

BY

ATTORNEYS

United States Patent Office 3,202,589 Patented Aug. 24, 1965

3,202,589

ELECTROPLATING

John Edwin Bride, Mentor, Ohio, assignor to Diamond Alkali Company, Cleveland, Ohio, a corporation of Delaware

Filed Sept. 12, 1963, Ser. No. 308,590
6 Claims. (Cl. 204—32)

This invention relates to a method of reducing blistering and plating failures on electroplated zinc base die castings and similar articles. Zinc base die castings usually run 90 to 98% zinc with other alloying metals making up the remainder of the composition.

Electroplated zinc base die castings enjoy a large use in fields where mechanical strength of the part is important and the service conditions are severe, such as continued outdoor exposure, and any reduction in service failure will greatly improve the life and acceptance of these products. When used for automotive hardware, kitchen and bathroom hardware, marine hardware, and fixtures and many other fields, electroplated zinc base die castings often develop surface blisters or imperfections which lead to progressive deterioration of the plate and either mar the appearance of the piece or require its replacement long before the object to which it is attached reaches the end of its useful life.

The problem of reducing blistering and improving the life and utility of electroplated zinc base die castings has been before the industry for many years. Thus, F. F. Oplinger in an article entitled "Platting and Heating of Zinc Base Die Castings," Vol. 28, pages 70 to 80 of the Proceedings of the American Electroplaters Society (1940) discusses at length the failure of electroplated zinc based die castings by blistering when subjected to baking at 250° to 350° for the purpose of fixing lacquer coats thereon and recommends as a precaution heating to 225° to 250° F., use of mild anodic electrocleaning, followed by weak acid treatment as the steps to be taken to reduce blistering of electroplated zinc base die casting. However, in spite of these precautions and care taken in the normal production of electroplated zinc base die castings, blistering of the plate an similar failures of the surface of the electroplated metals, and rejects caused thereby, have continued to plague the industry to the present time.

Zinc base die castings are relatively soft and malleable, as compared with copper, brass and ferrous metals and are usually prepared for electroplating by cleaning the grease and dirt from the castings and buffing or polishing to remove burrs, die marks, sprue and ejector pin marks, and other roughness, so that the casting will accept a smooth electroplate. Buffing is usually done with buffing wheels or tumbling barrels or by hand, employing buffing compounds containing abrasives, such as for example, pumice, which are used to facilitate the smoothing of the surfaces of the castings. However, in addition to external protuberances such as burrs, die marks and other roughness, the normal die casting also has pits and depressions below the principal surface thereof, caused by gas pockets or other entrapments within the die. Thus the problem of smoothing the surfaces of the die castings by removal of external protuberances and pits and cavities in a buffing or polishing operation often results in a compromise in which the protuberances are removed and the pits and cavities (sometimes microscopic in size), are covered over by displacement of the surface metal, often with entrapment of buffing compound therein to form a smooth surface which will pass buffing inspection and will accept a smooth electroplate but will lead to subsequent blistering and failure of the electroplate when subjected to severe inspection tests or to baking, or when subjected to normal service conditions over several months.

One of the objects of this invention is to provide a relatively certain and inexpensive method of reducing blistering and causes of blistering failures in electroplated zinc base die castings.

Another object of this invention is to provide a method for electrolytically modifying the surface characteristics of zinc base die castings and at the same time removing surface oxides, so as to reduce blistering in electroplated articles produced therefrom.

Another object of this invention is to provide a process for cleaning and electrolytically modifying the characteristics of zinc base die castings in which unwanted materials lodged in pits and cavities in the surface of the die castings are removed and a clean, continuous surface is presented for acceptance of the subsequently applied electroplate so that the electroplate extends to and covers the bottom of the pits and cavities and does not merely temporarily cover over a pit containing displaced metals, dirt, or buffing compound.

Another object of this invention is to provide a process for the production of electroplated zinc base die castings, whereby blistering and blistering failures are reduced and a larger percentage of blistering-free and long-life electroplated zinc base die castings are produced.

Various other objects and advantages of the invention will become apparent as this description proceeds.

In the accompanying drawings, FIG. 1 is a photomicrograph at a magnification of 500 diameters showing a buffed and plated zinc base die casting with pits containing buffing compound and the surface smoothed over by displaced metal particles so that an apparently satisfactory electroplate is produced.

FIG. 2 shows a photomicrograph at a magnification of 250 diameters through a similar casting which has been cleaned with degreasing solvent, anodically treated in a strong alkaline electrolyte for surface modification, and electroplated, by the process of this invention, to provide an electroplate layer extending to the bottom of the pit.

FIG. 3 is a flow diagram showing a typical illustrative process for producing electroplated zinc base die casting according to a preferred method of practicing this invention, and

FIG. 4 is a chart showing the comparative results of a copper accelerated salt spray corrosion test referred to as the CASS test, (more specifically described hereinafter and in "Proceedings of the American Electroplaters Society," 46, page 159 (1959)) the data being taken on seven different classes of electroplated zinc base die castings, some produced under the process of this invention and some by the prior art processes.

It will be understood that the processes described herein are illustrative of various methods of practicing the invention but that the invention is not limited to the process herein specifically described, and that although it is primarily useful in preparing electroplated zinc base die castings, it may also be used in the preparation of other electroplated zinc base articles.

FIG. 1 illustrates one of the frequent causes of plating failures. This photomicrograph shows (at 500 diameters magnification) a cross-section through the electroplate of an electroplated zinc base die casting, which had been solvent cleaned, buffed, and then electroplated (without anodically treating in an alkaline bath). The points marked "A" represent pits in the original casting, which pits were filled with buffing compound and/or displaced metal and thereafter peened or smoothed over during the buffing operation, pocketing the buffing compound and/or displaced metal but presenting a smooth surface for electroplating and B represents a flaw in the electroplate where traces of the buffing compound or other foreign matter

are visible. In service, or under the more severe physical and chemical inspection tests, the points marked "A" are potential sources of blisters (one or more), and thus failures when subjected to such tests. The original pits were 1/500 the size shown in FIG. 1 and would be difficult to identify by visual inspection of the buffed casting.

FIG. 2 illustrates a cross-section at a magnification of 250 diameters through a zinc base die casting which has been subjected to anodic treatment in a strongly alkaline bath, prior to electroplating. In the anodic surface treating operation, the bottom A of the pit has been cleaned out, the edges C of the pit have been rounded off by the anodic electrolytic action, and the copper-nickel electroplate D has been deposited over the bottom as well as the edges of the pit so that there is less chance of blisters developing in the plate in service. The pit in the finished electroplated casting, being less than 1/250 the size illustrated, would be barely visible to the naked eye and would not constitute a rejectable flaw in the plated casting. This plated casting would have a long satisfactory service life. The plated casting of FIG. 1 could easily develop blisters within a day or two after plating and jeopardize the reputation of the manufacturer.

While the exact preparation and plating procedure will vary in some details of the method, in different plating plants, and with different types of castings and different end uses therefor, a typical preparation and plating flow diagram is illustrated in FIG. 3, in which block **10** is intended to illustrate that the castings may be cleaned by any of the usual cleaning procedures necessary to remove dirt, mold coating compounds, shopgrease, etc., therefrom, such as the cleaning procedures described in the article by F. F. Oplinger previously referred to. Block **11**, shown in dotted lines, is intended to indicate that the casting may or may not be buffed by any of the known buffing procedures, such as buffing wheels, tumbling or the like. Even when buffing is practiced, the buffing time can usually be reduced, as the alkaline anodic electrolytic treating step (block **13**) following the buffing and just before the plating operation, does some, if not all of the smoothing accomplished by buffing. Block **12** also shown in dotted lines, is intended to indicate that degreasing by solvents, vapor or other degreasing procedure is an optional but usually desirable precautionary step, although with exceptionally clean castings, the degreasing could conceivably be omitted. The anodic surface treatment in a strong alkaline bath, block **13**, described in greater detail hereafter, is essential to get the improved results realized by the practice of this invention, as it cleans off burrs, and protuberances, cleans out pits, rounds off projecting corners and presents a clean surface both on the major surface and within the pits for accepting the electroplated metals. On buffed castings, the usual "touch up" buffing operation, following the main buffing operation, can be omitted, as the anodic surface treatment step in a strong alkaline bath makes further "touch up" buffing unnecessary.

After the anodic surface treatment, the castings must be rinsed free of the alkali and associated zinc salts forming the electrolyte in the anodic surface treating bath, as indicated by block **14**, and this is followed by an acid dip for example, in a 0.05 to 1% sulfuric acid solution, if the work piece is to be electroplated. The block **16** is intended to indicate any of the usual electroplating procedures to cover the exposed surface of the casting with a single or composite layer electroplate as illustrated in the following examples.

In order that those skilled in the art may better understand the principles involved in the present invention, the following specific examples are offered:

EXAMPLE 1

For the purpose of illustrating the application and effectiveness of this invention, 280 pieces of zinc base die castings having six different configurations were prepared as noted hereinbelow, electroplated and tested according to the CASS (copper accelerated salt spray) test method (ASTM-Specification B 287–57T) and 210 pieces of zinc base die castings having the same configurations as the CASS test pieces were prepared, as described hereinbelow, electroplated and tested for blistered plate by baking for one hour at 300° F.

The test pieces were divided into seven classes, with 40 pieces in each class for the CASS tests and 30 pieces in each class for the bake test. The classes were prepared for testing by the following method:

Class	Buff	Degrease	Surfaces anodically modified in strongly alkaline bath*	Electroplated
Class 1	No	Yes	Yes, 1.5 min	Yes.
Class 2	No	No	Yes, 1.5 min	Yes.
Class 3	Yes	Yes	Yes, 0.75 min	Yes.
Class 4	Yes	Yes	No	Yes.
Class 5	Yes	No	Yes, 0.75 min	Yes.
Class 6	Yes	No	No	Yes.
Class 7	No	No	No	Yes.

*Bath composition:
Total NaOH—571 g./l.
Zn—21.0 g./l.
Temp.—82°–85° F.
Anode current density—175 to 200 asf.
Potential—8 volts.

The plating conditions in all instances were controlled as nearly identical as is possible in commercial operations, only the preparation of the article for plating was varied. The plating of the articles, after preparation for plating, consisted of (1) a copper strike; (2) a copper plate; (3) a semi-bright nickel plate; (4) a bright nickel plate, and (5) a chromium plate. Between each of the plating operations, the parts were rinsed, and cleaned, where necessary, and all parts were plated, rinsed clean and replated in the same way. Details of the plating procedure are given hereinbelow.

After plating, the seven classes of plated casting were subjected to the CASS test and the bake test and the results of these tests are illustrated numerically and graphically in FIG. 4. In judging the failures, if more than one small blister, visible to the naked eye, appeared on the part after the test, this part was considered a failure. This test corresponds to an ASTM rating of 9.5 to 10 for acceptable parts.

From FIG. 4 it is clear that at the end of 72 hours of testing by the CASS test, the class 3 casting which had been buffed, degreased and the surfaces anodically treated in a strongly alkaline bath, as noted above, before plating showed fewer failures than any of the other castings, and that the class 1 castings which had been degreased and the surfaces anodically treated in a strongly alkaline bath, noted above, showed the next lowest number of failures. Under the bake test, the class 3 castings also showed up well, and in both tests, the class 7 castings had far too many failures.

The numerical summary of the tests, on the 40 pieces in each of the seven classes for the CASS test, and on the 30 pieces in each of the seven classes for the bake test, is as follows:

TABLE I

Class	CASS test data, 40 parts in each class, failures after 72 hours	Bake test data, 30 parts in each class, failures after baking at 300° F. for 1 hour
Class 1	8	0
Class 2	11	4
Class 3	5	2
Class 4	12	1
Class 5	11	1
Class 6	17	1
Class 7	33	12

As is apparent from Table I and FIG. 4, the castings in class 3, which have been buffed, degreased and anodically treated in a strongly alkaline bath for ¾ of a minute

have fewer failures in the electroplate, and the castings in class 1 (degreased, anodically treated in an alkaline bath, and plated), and in class 5 (buff, anodically treated in an alkaline bath and plated) have the next fewer failures.

EXAMPLE 2

Zinc base die castings having the composition:

		Percent
Aluminum		3.9–4.3
Magnesium		0.03–0.06
Copper	maximum	0.10
Iron	do	0.075
Lead	do	0.005
Cadmium	do	0.004
Tin	do	0.002
Zinc		Remainder

were cleaned by soaking in a proprietary cleaning compound of the commercial alkaline detergent type, jet spraying and rinsing, buffed by the use of high speed buffing wheels, degreased, and anodically treated in a sodium hydroxide-zinc oxide electrolyte containing 655 grams/liter of NaOH, 25 grams of zinc oxide per liter, and 2 grams of basic chromic sulfate per liter, maintained at a temperature of between 80° and 95° F. at an anode current density of 100 to 200 amps/sq. ft. for ¾ minute. The die castings constituted the anode of the electrolytic cell and magnetite coated cathodes were employed, although other cathodic materials such as platinum, steel, copper and other conductors may be used. The amount of basic chromic sulfate may vary from about 1.5 to 3 grams per liter.

At the end of the anodic surface treating operation, the castings were spray-rinsed and given an acid dip in a 1% by volume sulfuric acid solution and electroplated as follows:

(1) Copper strike: 4 volts, 3 minutes (110° F.)—
CuCN—4.1 oz./gal.
Free KCN—1.6 oz./gal.
pH 12.6

(2) Copper plate: 1.1 volts, 20 minutes (155° F.)—
CuCN—10.2 oz./gal.
Free KCN—3.3 oz./gal.
pH 13.5

Current interruption: 10 sec. on, 3 sec. off.

NOTE: Together with the usual leveling agents, wetting agents and porosity preventing agents.

Thereafter the copper-plated castings were rinsed and cleaned and (3), given a semi-bright nickel plate as follows:

Semi-bright nickel, 26 minutes (135° F.)—
$NiSO_4$-$6H_2O$—50 oz./gal.
$NiCl_2$-$6H_2O$—6.5 oz./gal.
H_3BO_3—7.0 oz./gal.
pH—4.0

NOTE: Together with leveling agents, wetting agents and porosity preventing agents.

and after rinsing given (4) a bright nickel plate as follows:

Bright nickel, 13 minutes (155° F.)—
$NiSO_4$-$6H_2O$—50 oz./gal.
$NiCl_2$.$6H_2O$—8.0 oz./gal.
H_3BO_3—7.0 oz./gal.
pH—4.0

NOTE: Together with leveling agents, wetting agents and porosity preventing agents.

This was followed by rinsing and (5) chrome plating as follows:

Chrome plate, 5 minutes (115° F.)—
CrO_3—50 oz./gal.
SO_4—0.28 oz./gal.

This procedure was used to produce the composite electroplate on the castings used in the tests described in Example 1 and in illustrated FIG. 4 and Table I.

EXAMPLE 3

Cleaning and electropolishing of unbuffed parts

Unbuffed zinc base die castings were immersed 2 to 5 minutes in an 8-oz./gal. solution of a commercial line, soak cleaner maintained between 165 and 175° F. for the purpose of cleaning and wetting the surface. After rinsing in hot water followed by cold water, the castings, while still wet, were placed in an 18-gallon electropolishing bath containing 665 g. NaOH/l. and 100 g. ZnO/l., and then electropolished at 300 amp./sq. ft. for the maximum time for obtaining optimum appearance.[1] After being rinsed in hot water, the parts were dipped for about 10 to 20 seconds in a 1 percent by weight sulfuric acid solution. The parts were then rinsed in cold water in preparation for the plating sequence. This is the procedure which was used to prepare the casting illustrated in FIG. 2 for electroplating.

Copper plating

The zinc die castings were immersed with "current on" in a copper strike bath of the following composition:

	Oz./gal.
Sodium cyanide, NaCN	3.5
Copper cyanide, CuCN	2
Sodium carbonate, Na_2CO_3	2
Rochelle salts	2

Free sodium cyanide was maintained between 1.0 and 1.7 oz./gal. The temperature of the copper-strike bath was maintained between 122 and 130° F., and the work bar was agitated 15 ft./min. About 0.00005 inch (0.05 mil) of copper was deposited in 2 to 3 minutes at a current density of 60 amp./sq. ft. The parts were rinsed in cold water.

Copper plating was continued in a high-efficiency, bright-plating copper bath of the following composition:

	Oz./gal.
Copper cyanide, CuCN	11
Potassium cyanide, KCN	9.5
Sodium cyanide (sulfide-free NaCN)	6.0
Potassium hydroxide, KOH	3.0
Potassium carbonate, K_2CO_3	8.0

NOTE: Together with leveling agents, wetting agents, and porosity preventing agents.

Plating conditions were as follows:

Temperature	172 to 180° F.
Cathode current density	42 amp./sq. ft.
Agitation	Work bar at 15 ft./min. plus air.
Anodes	Oxygen - free, high conductivity, oval-shaped, copper anodes.

The plating time was predetermined for each part by employing duplicate samples, and depended on the specified thickness range required by the supplier for the significant recessed area.

Duplex-nickel plating

The freshly copper-plated parts are rinsed in warm water, dipped in a 10 percent sulfuric acid solution, rinsed in cold water, and nickel plated in a semibright-plating nickel bath having the following composition:

Nickel sulfate, $NiSO_4.6H_2O$	oz./gal.	42.5
Nickel chloride, $NiCl_2.6H_2O$	oz./gal.	5.8
Boric acid, H_3BO_3	oz./gal.	5.9

[1] Optimum appearance is defined in terms of the number of minutes of electropolishing before porosity is observed. It is necessary to follow electropolishing with the required thicknesses of electrodeposits to facilitate this determination. Electropolishing time will ordinarily be between 0.25 and 8 minutes.

Wetting agent (2% solution Na lauryl sulfate) ——percent by volume——	0.6
Leveling agent, coumarin ——lb./100 gal——	0.6 to 1.1

Plating conditions were as follows:

pH	4.0 to 4.4.
Agitation	Work bar at 23 ft./min.
Anodes	Carbon type, rolled, oval, 99+ percent nickel in cotton anode bags.
Temperature	126 to 130° F.
Cathode-current density	60 amp./sq. ft.
Plating time	Plating time will vary with the type of casting being plated and the minimum thickness of plating required by the plating specification. It is best determined by employing duplicate samples and basing the plating time on the time required to satisfactorily plate each different type of casting.

The part was transferred at 15 amp./sq. ft. (raised to full plating current after complete immersion) to the bright plating nickel bath having the following composition:

Nickel sulfate.$6H_2O$ ——oz./gal——	42.0
Nickel chloride, $NiCl_2.6H_2O$ ——oz./gal——	6.3
Boric acid, H_3BO_3 ——oz./gal——	6.1
Wetting agent (2/ solution Na lauryl sulfate ——percent by volume——	0.4
Leveling agent, coumarin ——oz./gal——	Less than 0.5

Plating conditions were as follows:

pH	4.0 to 4.4.
Agitation	Work bar at 6 ft./min.
Anodes	Carbon type, rolled, oval, 99+ percent nickel in nylon anode bags.
Temperature	134 to 138° F.
Cathode current density	60 amp./sq. ft.
Plating time	Plating time will vary with the type of casting being plated and the minimum thickness of plating required by the plating specification. It is best determined by employing duplicate samples and basing the plating time on the time required to satisfactorily plate each different type of casting.

Chromium plating

Parts were thoroughly spray rinsed followed by a watertank rinse immediately after bright nickel plating. They were then placed in a conventional chromium plating bath (entering at 2.5 volts and maintained for 15 seconds) of the following composition:

Chromic acid ——oz./gal——	33
Sulfuric acid ——oz./gal——	0.3

Chromic to sulfuric acid ratio	100/1

Plating conditions were as follows:

Temperature	108 to 114° F.
Cathode-current density	150 amp/sq. ft.
Anodes	7 percent tin-lead.
Agitation	None.

EXAMPLE 4

Various other steps for cleaning and electroplating may be used as will be understood by persons skilled in the art, and the following conditions for electropolishing have been found satisfactory under different operating conditions, for producing clean and bright castings for subsequent electroplating.

Composition of electrolyte, grams/liter NaOH	Anode current density, amps/ft.^{2}	Applied current, amps.	Contact time, min.	Temp., °F.
500	200	2.5	4	73–75
550	200	2.5	4	73–75
600	200	2.5	4	73–75
665	200	2.5	4	73–75
550	200	2.5	4	73–75
550	400	4.5	4	73–75
600	100	1.5	4	73–75
600	200	2.5	4	73–75
600	400	4.5	4	73–75
665	100	1.25	4	73–75
665	200	2.5	4	73–75
665	400	5.0	4	73–75
665	200	2.5	4	76
665	200	2.5	4	97–99

Preferably the sodium hydroxide electrolyte should have a concentration of 450 to 900 grams NaOH per liter, with the preferred range between 572 and 763 gr./ltr. The temperature of the electrolyte may be varied between 60 and 220° F. current densities of 50 to 800 amps/ft.^{2} may be used with the preferred range around 175 to 200 amps/ft.^{2}. The time for the electropolishing may be between ¼ minute to 8 minutes or more. A voltage of about 8 volts is preferred.

In place of sodium hydroxide, other alkali metal hydroxides such as potassium, lithium, calcium and rubidium hydroxides may be used, but sodium hydroxide is preferred because of its ready availability and lower cost.

Other materials such as anti-foaming agents, oxidizing agents, to avoid deposition of zinc at the cathode and other bath-modifying agents may be added to the electropolishing electrolyte if desired.

I claim:

1. The method of reducing blistering and plating failures on electroplated cast zinc base articles which comprises cleaning and degreasing the article, subjecting the article to electrolytic polishing in an electrolytic cell in which the article is the anode, the electrolyte is comprised substantially of an aqueous alkali metal hydroxide solution in the amount between about 450 and 900 grams of alkali metal hydroxide between about 20 and 100 grams of zinc oxide and between about 1.5 and 3 grams of basic chromic sulfate per liter of solution maintained at a temperature between about 60 and 220° F., the cathode is a conducting material, and the current passing between the anode and the cathode has a current density of between 50 and 800 amperes per square foot and is maintained at a voltage of about 8 for a period of about 0.25 to 8 minutes, to polish the article and clean out any surface pores therein, rinsing the electrolyte from the electropolished article and subjecting the article to electroplating in an electroplating cell to plate the article and the electropolished exposed bottom of any surface pores thereon, until the desired composition and thickness of plate has been deposited on said article.

2. The method of reducing blistering and plating failures on electroplated cast zinc base articles which comprises cleaning, buffing and degreasing the article, sub-

jecting the article to electrolytic polishing in an electrolytic cell in which the article is the anode, the electrolyte is comprised substantially of an aqueous alkali metal hydroxide solution in the amount between about 450 and 900 grams of alkali metal hydroxide, about 20 and 100 grams of zinc oxide and the trivalent chromic ion equivalent of about 1.5 and 3 grams of basic chromic sulfate per liter of solution maintained at a temperature between about 60 and 220° F., the cathode is magnetic coated, and the current passing between the anode and the cathode has a current density of between about 50 and 800 amperes per square foot and is maintained at a voltage of about 4 to 11 volts for a period of about 0.25 to 8 minutes, to polish the article and clean out any surface pores therein, rinsing the electrolyte from the electropolished article, acid dipping the electropolished article and subjecting the article to electroplating in an electroplating cell to plate the article and the electropolished exposed bottom of any surface pores thereon, until the desired composition and thickness of plate has been deposited on said article.

3. The method of reducing blistering and plating failures on electroplated cast zinc base articles which comprises electropolishing said articles in an electrolytic cell in which the article is the anode, the electrolyte is comprised substantially of an aqueous solution of sodium hydroxide in the amount between about 572 and 763 grams per liter and about 20 and 100 grams of zinc oxide and the trivalent chromic ion equivalent of about 1.5 and 3 grams of basic sulfate per liter maintained at a temperature between about 73 and 100° F., the cathode is a conducting material, and the current passing between the anode and the cathode has a current density of between about 100 and 200 amperes per square foot and is maintained at a voltage of about 8 for a period of about 0.75 to 8 minutes, whereby the surface of said article is evened, corners are rounded out and pits are freed of foreign matter to provide clean metal over the entire surface of said article and thereafter subjecting the article to electroplating in electroplating cells to plate the article over the electropolished surface and the bottom of said pits, until the desired composition and thickness of plate has been deposited on said article.

4. The method of reducing blistering and plating failures on electroplated cast zinc base articles which comprises electropolishing said articles in an electrolytic cell in which the article is the anode, and the electrolyte is comprised substantially of about 600 to 700 grams per liter of an aqueous sodium hydroxide solution, containing about 20 to 30 grams per liter zinc oxide and about 1.5 to 3 grams per liter of basic chromic sulfate maintained at a temperature between about 80 and 95° F., the cathode is a magnetite coated material, and the current passing between the anode and the cathode has a current density of between about 100 and 200 amperes per square foot and is maintained at a voltage of about 8 for a period of about 0.75 to 1.5 minutes, whereby the surface of said article is evened, corners are rounded out and pits are freed of foreign matter to provide clean metal over the entire surface of said article and thereafter subjecting the article to electroplating in electroplating cells to plate the article over the electropolished surface and the bottom of said pits, until the desired composition and thickness of plate has been deposited on said article.

5. The method of reducing blistering and plating failures in electroplated cast zinc base die castings which comprises subjecting the casting to electropolishing in an electrolytic cell in which the casting is the anode and the electrolyte comprised of an aqueous solution of an alkali metal hydroxide of the group consisting of sodium and potassium hydroxides in an amount between about 600 to 700 grams per liter, zinc oxide in an amount between about 20 and 30 grams per liter and basic chromic sulfate in an amount of about 2 grams per liter, maintained at a temperature between about 75 to 100° F., the cathode is a conducting material and the current passing between the anode and the cathode has an anode current density of 100 to 200 amps/sq. ft. for a period of about 0.75 to 2 minutes after the castings have been buffed and before electroplating to clean the buffing compounds out of depressions in the castings and round out the corners of said depressions, and after electropolishing said buffed castings, rinsing, acid dipping and electroplating said castings.

6. The method of electropolishing cast zinc base articles which comprises, subjecting the article to electropolishing in an electrolytic cell in which the article is the anode, the electrolyte is comprised substantially of an aqueous alkali metal hydroxide solution in the amount between about 450 and 900 grams of alkali metal hydroxide, between about 20 and 100 grams of zinc oxide and the trivalent chromic ion equivalent of between about 1.5 and 3 grams of basic chromic sulfate per liter of solution, maintained at a temperature between about 60 and 220° F., the cathode is a conducting material, and the current passing between the anode and the cathode has a current density of between 50 and 800 amperes per square foot and is maintained at a voltage of about 8 for a period of about 0.25 to 8 minutes, to polish the article and clean out any surface pores therein.

References Cited by the Examiner

Graham: "Electroplating Engineering Handbook"; 2nd edition, 1962; pages 68–82, 107–125, 186, 190–193, 198.

Plating, volume 45, 1027–1037 (October 1958).

WINSTON A. DOUGLAS, *Primary Examiner.*

MURRAY TILLMAN, *Examiner.*