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METHOD OF MAKING FORMED, PLATED ARTICLES

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This invention relates to a method of making formed, 15
plated articles.

In a known method of making a formed, plated article such, for example, as an automobile bumper, a flat steel strip is formed in dies into the shape desired for the bumper. This leaves die marks on the steel bumper. The die marks are removed by polishing and then the bumper is nickel-plated. If the die marks were not removed, the nickel-plating would not be satisfactorily smooth. Instead of simply nickel-plating the formed bumper from which the die marks have been removed by polishing, one may first plate it with copper before plating it with nickel.

In accordance with the present invention, a flat steel strip is plated with zinc, the zinc coated strip is then formed into a bumper, the die marks formed in the zinc coating in forming the bumper are then removed by dipping the zinc coated formed bumper in acid to strip off the zinc coating and the formed steel bumper is then plated with nickel. In a preferred embodiment of the invention, a flat steel strip is plated with nickel or copper or with a layer of nickel and then with a layer of copper, the coated strip is then plated with zinc, the zinc coated strip is thereafter formed into a bumper, the zinc coating is stripped from the formed bumper and the formed bumper is plated with nickel.

In our process, the die marks made in forming the bumper are formed in the zinc coating which is thereafter dissolved off of the bumper to remove the die marks, thereby eliminating the necessity of polishing steel to remove die marks. The following examples illustrate various ways in which our process can be carried out.

Example I

A flat steel strip of suitable dimensions, say 25" x 125", is subjected to the following steps:

1. The steel strip is polished with a mixture of abrasive and grease. The abrasive preferably is 240 grit size.

2. The abrasive and grease are removed by an alkaline cleaning step in which the strip is made an anode in an alkaline solution and an electric current is passed from the strip through the alkaline solution to a cathode. A suitable alkaline solution is an aqueous solution containing:

	Ounces/gal.
NaOH	4
Na ₂ CO ₃	6
Na ₃ PO ₄	1.5

The bath preferably is maintained at a temperature of about 190° F. and an anode current density of about 45 to 75 amperes per square foot is employed. The strip is then rinsed in water, dipped for about 10 to 15 seconds in an acid solution containing 15% by volume of hydrochloric or sulphuric acid and then water rinsed.

3. The strip is then coated electrolytically with a zinc plate having a thickness of about 0.0001"—0.0006". In

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forming the zinc coating, an aqueous solution of the following composition may be employed:

	Ounces/gal.
ZnSO ₄ ·7H ₂ O	40
ZnCl ₂	2
Zn(C ₂ H ₃ O ₂) ₂	2

The bath is maintained at a pH of about 3.5 to 5, a zinc anode is employed, the temperature of the bath is maintained at about 100° F. and the cathode current density is about 20 to 60 amperes per square foot.

4. The zinc plated strip is then given a phosphate coating by dipping or spraying. A bath of the following composition may be employed:

	Grams per liter
Zinc	11.0
P ₂ O ₅	9 to 9.5
NO ₃	18
Na ₂ O	1.5
Ni	0.1
Cu	0.03
NaNO ₂	1 to 1.5

The bath is preferably used at a pH of 2.8 to 2.9 and at a temperature of about 68 to 75° F. with an immersion time of 3 to 5 minutes.

5. A drawing compound such, for example, as "Drawcote" is then applied to the phosphate coated strip. This drawing compound consists essentially of sodium stearate and sodium borate.

6. The strip is then formed into a bumper, which forming step leaves die marks on the zinc coating.

7. The formed bumper is then subjected to an anodic alkaline cleaning to remove the phosphate coating and drawing compound. The alkaline cleaning solution may be the same as that given in Step 2 of this example except that the Na₃PO₄ is omitted. The anodic current density and the temperature of the bath may be as given in the above step.

8. The formed bumper is then dipped in acid to remove the zinc coating which carries the die marks. A suitable solution is either hydrochloric acid or sulphuric acid of 15 to 20% strength. The immersion time for removing the zinc coating of the thickness above given is approximately ½ minute. This acid treatment leaves a black residue of zinc oxide on the steel bumper.

9. The formed steel bumper is then anodically electropolished to remove the residue by passing an electric current from the strip through an aqueous solution containing phosphoric acid and sulphuric acid. A suitable bath for use in this electropolishing step is:

	Percent
Phosphoric acid	55 to 85
Sulphuric acid	0.1 to 4
Water	7 to 30
Trisodium phosphate	1 to 15
Sodium sulphate	at least 0.5

The solution may be used under widely varying conditions, the anode current density being as low as 25 or as high as 2,000 amperes per square foot and the temperature can be any temperature up to about 250° F. In the preferred method, an anode current density of about 285 amperes per square foot is employed and the bath temperature is about 100° F. The time for polishing the steel will vary depending upon the polish required, from about 1 to 20 minutes, the usual period being about 5 minutes.

10. The formed and polished steel bumper is then given an anodic alkaline cleaning employing the same bath and other conditions as given in step 7 of this example. The bumper is then water rinsed, acid dipped and water rinsed in the same manner as given in step 2 of this example.

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11. The formed bumper is then nickel-plated. A suitable aqueous bath may contain:

	Ounces/gal.
NiSO ₄	45-50
NiCl ₂	5-6
Boric acid.....	5-5.5
Coumarin.....	0.025
Lauryl sulphate.....	.05

A cathode current density of about 50 amperes per square foot is employed, the bath is maintained at a temperature of 130 to 135° F. and a nickel anode is used.

Example II

1. A flat steel strip is polished with abrasive and grease as in step 1 of Example I.

2. The strip is subjected to an anodic alkaline cleaning operation as in step 2 of Example I and is then water rinsed.

3. The steel strip is then anodically electropolished as in step 9 of Example I and is then rinsed in water.

4. The electropolished steel strip is then subjected to an anodic alkaline cleaning operation, a water rinse, an acid dip and a water rinse as in step 2 of Example I.

5. The strip is then electroplated with nickel as in step 11 of Example I to provide a nickel coating having a thickness of 0.0002"-0.0006" and the strip is rinsed in water.

6. The nickel-plated strip is then electroplated with zinc to provide a coating having a thickness between 0.0001" and 0.0006" as in step 3 of Example I.

7-11. The strip having an undercoat of nickel and an overcoat of zinc is then given a phosphate coating, a drawing compound is applied, the strip is formed into a bumper, the bumper is subjected to an anodic alkaline cleaning operation and the zinc coating is removed by an acid treatment, all in accordance with steps 4-8 of Example I.

12. The bumper is given an anodic electropolish in a phosphoric acid and sulphuric acid bath as in step 9 of Example I to remove the black zinc oxide residue.

13. The nickel coated bumper is subjected to a cathodic alkaline cleaning operation to activate the nickel. In this cathodic alkaline cleaning step, the same bath is used as in step 10 of Example I. The bumper is then water rinsed, acid dipped and water rinsed as in step 2 of Example I.

14. The nickel-plated bumper is then given an additional electroplate of nickel using the bath and other conditions described in step 5 of this example.

Comparing Examples I and II, it will be seen that Example II differs from Example I in the following respects. In step 3, the steel strip is given an anodic electropolish in addition to the polish with abrasive and grease accomplished in step 1. The steel strip is coated with nickel before the zinc coating is applied. After the zinc plate has been removed from the formed bumper and the bumper has been given an anodic electropolish, the nickel coated bumper is subjected to a cathodic alkaline cleaning step to activate the nickel coating so that it is better adapted to receive and bond with the nickel-plate applied in step 14.

Example III

The steps of this example are the same as in Example II except that an electroplate of copper, preferably 0.001" thick, is applied to the nickel-plated strip prior to coating the strip with zinc. Accordingly, when the zinc coating is dissolved off of the formed bumper, the bumper has an outer coat of copper and an undercoat of nickel. Nickel is then electroplated on the copper so that the bumper comprises a steel base, a coating of nickel, a coating of copper and a coating of nickel.

A suitable aqueous copper plating bath may contain:

	Ounces/gal.
CuSO ₄	32
H ₂ SO ₄	6

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A cathode current density of 40 to 50 amperes per square foot is employed and the bath preferably is maintained at a temperature of about 100° F.

Example IV

This example is the same as Example III except that nickel is electroplated on the copper coating before the strip is plated with zinc. Accordingly, after the bumper has been formed from the flat strip and the zinc coating has been removed, the bumper comprises a steel base, a coating of nickel, a coating of copper and a coating of nickel so that, if desired, no further nickel-plate need be applied after the zinc coating has been removed.

In all of the examples, the steps corresponding to steps 4 and 5 of Example I can be omitted, although it is preferred to employ these steps. In other words, it is not essential that the zinc plated strip be provided with a phosphate coating or that a drawing compound be employed in forming the strip into a bumper but these steps are desirable.

In the known method of making bumpers in which a bumper is formed from a flat steel strip and the nickel-plated is applied after the bumper has been formed, the bumper, due to its shape, contains pockets or cavities which are difficult to reach in the electrodeposition of the nickel. These difficulties are overcome or minimized in accordance with Examples II-IV of the present invention wherein the nickel-plate is applied to the flat steel strip prior to forming the strip into a bumper.

We have referred to the formation of an automobile bumper but, of course, it will be understood that the invention may be applied to producing various other kinds of formed and plated articles.

The invention is not limited to the preferred embodiments but may be otherwise embodied or practiced within the scope of the following claims.

We claim:

1. The method of making formed, plated articles, which comprises electroplating a coating of nickel on a polished flat steel strip, electroplating a coating of zinc on the nickel coating, forming the coated strip into an article, dissolving off in an acid solution from the formed article the zinc coating containing imperfections resulting from the forming operation, subjecting the nickel coated formed article to a cathodic alkaline cleaning operation to activate the nickel, contacting the formed article with an acid, and electroplating a nickel coating on the formed article.

2. The method of making formed, plated articles which comprises electroplating a coating of nickel on a polished flat steel strip, electroplating a coating of zinc on the nickel coating, forming the coated strip into an article, dissolving off in an acid solution from the formed article the zinc coating containing imperfections resulting from the forming operation, subjecting the nickel coated formed article to an anodic electropolishing operation in an acid aqueous bath containing phosphoric acid to remove residue resulting from dissolving off the zinc coating, subjecting the nickel coated formed article to a cathodic alkaline cleaning operation to activate the nickel, contacting the formed article with an acid, and electroplating a nickel coating on the formed article.

3. The method of making formed, plated articles, which comprises electroplating a coating of nickel on a polished flat steel strip, electroplating a coating of zinc on the nickel coating, applying a phosphate coating and a drawing compound to the zinc coating, forming the coated strip into an article, subjecting the formed article to an anodic alkaline cleaning operation to remove the phosphate coating and drawing compound, dissolving off in an acid solution from the formed article the zinc coating containing imperfections resulting from the forming operation, subjecting the nickel coated formed article to an anodic electropolishing operation in an acid aqueous bath containing phosphoric acid to remove res-

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idue resulting from dissolving off the zinc coating, subjecting the nickel coated formed article to a cathodic alkaline cleaning operation to activate the nickel, contacting the formed article with an acid, and electroplating a nickel coating on the formed article.

4. The method of making formed, plated articles, which comprises polishing a flat steel strip with a mixture of an abrasive and grease, subjecting the polished strip to an anodic alkaline cleaning operation to remove the abrasive and grease, subjecting the steel strip to an anodic electropolishing operation in an acid aqueous bath containing phosphoric acid, anodically cleaning the strip in an aqueous alkaline bath, contacting the strip with an acid, electroplating a coating of nickel on the flat polished strip, electroplating a coating of zinc on the nickel coating, applying a phosphate coating and a drawing compound to the zinc coating, forming the coated strip into an article, subjecting the formed article to an anodic alkaline cleaning operation to remove the phosphate coating and drawing compound, dissolving off in an acid solution from the formed article the zinc coating containing imperfections resulting from the forming opera-

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tion, subjecting the nickel coated formed article to an anodic electropolishing operation in an acid aqueous bath containing phosphoric acid to remove residue resulting from dissolving off the zinc coating, subjecting the nickel coated formed article to a cathodic alkaline cleaning operation to activate the nickel, contacting the formed article with an acid, and electroplating a nickel coating on the formed article.

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