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# UNITED STATES PATENT OFFICE

RALPH J. WIRSHING AND HENRY R. FAAS, OF DETROIT, MICHIGAN, ASSIGNORS TO GENERAL MOTORS RESEARCH CORPORATION, OF DETROIT, MICHIGAN, A CORPORATION OF DELAWARE

## CORROSION-RESISTING COATING

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The invention relates to means for protecting metal surfaces against deterioration and more particularly to the protection of ferrous metal surfaces exposed to agencies tending to cause rust, corrosion or tarnishing.

The covering of metal surfaces with coatings which are themselves resistant to atmospheric and other corrosive agencies is generally employed for the purpose both of protecting the base material and of providing a surface of pleasing appearance as well as of non-tarnishing properties. Of recent years chromium has been widely recognized as particularly useful for a surface coating because of its high resistance to corrosion by ordinary atmospheric agencies.

Chromium alone, when applied to surfaces such as those of ferrous metal, does not, however, provide effective protection of the underlying metal against rust or like deterioration and numerous combinations of chromium with other metals, successively or simultaneously applied, have been proposed in the effort to combine the desirable properties of chromium as a surface finish with adequate protection of the base metal.

Our experiments have led to the discovery that most extraordinary results are secured by the combination with an outer coating of chromium of an underlying layer containing tin. The effect is very greatly enhanced if another layer, preferably of copper or nickel or both, be interposed between the chromium and the tin. As an example of the remarkable effects of such a combination of coatings, it has been found that a steel plate coated with successive layers of copper, nickel and chromium, (hitherto regarded as a highly effective rust-resistant coating), failed under the salt spray test after 120 hours, whereas a plate of steel coated first with a layer of tin of only 0.00004 inch in thickness, followed by layers of nickel or copper and of chromium of substantially the same thicknesses as in the first mentioned test, showed no signs of failure after 264 hours under the salt spray.

The coating of tin may be applied either electrolytically or by any other suitable method, as by dipping the ferrous article in molten tin. The tin may also be mixed with other metals to some extent without destroying the beneficial effect of the tin. This is especially true if the admixed metal is somewhat related to tin in its properties. Remarkable results in resisting rust have been obtained, for example, by plating chromium, with or without an intermediate layer of nickel and/or copper, over ordinary terne plate. While the tin and chromium layers, without additional coatings, give very remarkable protection to the ferrous base, even better results are obtained by the interposition of one or more additional protective metals as copper or nickel. This is especially desirable when a bright finish is to be secured on the chromium surface, as it is difficult to plate chromium with a bright surface over tin. Therefore, when the final chromium surface is to be bright, we prefer to interpose between the tin and chromium a layer of one or more metals which may be given a bright surface upon which bright chromium may be plated. Nickel and/or copper are suitable for this purpose.

Very satisfactory results have been obtained from coating the ferrous metal base with tin, copper and chromium in the order given. However, inasmuch as the copper coating is etched by chromic acid, it is desirable, when a bright surface finish of chromium is desired and a chromic acid bath is to be used, to coat the copper with a metal resistant to the corrosive effects of chromic acid and buff the same before depositing the final coating of chromium. For this reason the coating of nickel over the copper is preferred.

If the tin is applied electrolytically it may be plated from a bath containing stannous chloride or sodium stannate. The copper may be plated from a copper cyanide bath, the nickel from a nickel acetate bath and the chromium from a chromic acid bath. Other baths, however, may be substituted for these as desired.

We claim:

1. An article of ferrous metal having thereon an inner coating containing tin and an outer coating of chromium.

2. Structure as set forth in claim 1 includ-

ing between the tin and chromium a coating upon which bright chromium may be electrolytically deposited.

3. Structure as set forth in claim 1 including between the tin and chromium a coating comprising copper.

4. Structure as set forth in claim 1 including between the tin and chromium a coating of copper and another of nickel.

In testimony whereof we affix our signatures.

RALPH J. WIRSHING.
HENRY R. FAAS.