

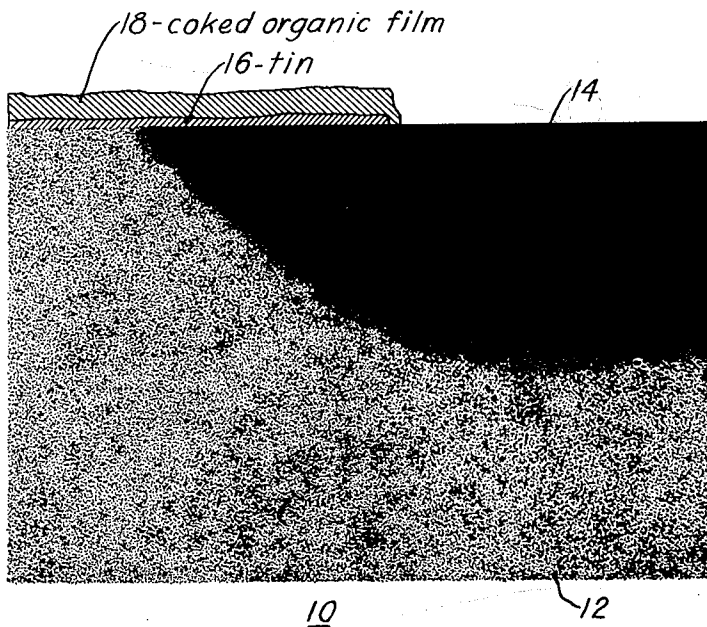
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NITRIDING HARDENING TREATMENT

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WITNESSES:

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NITRIDING HARDENING TREATMENT

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This invention relates to the hardening of metals by nitriding, and more particularly, to the selective nitriding of portions of the surfaces thereof.

Treatments are known in the prior art by means of which predetermined portions of a steel member may be nitrided while other portions may be kept free from such hardening treatment. Specifically, it has been known to electroplate tin upon the portions of a steel member which are to be kept free of hardening. This prior art treatment, however, entailed considerable difficulties. In particular, in order to electroplate tin upon the selected portions of the steel member, it was necessary to first apply a coating of some masking material which would prevent the tin from being deposited upon the areas which it was desired to harden by subjecting to subsequent nitriding treatment. The best tin plate electroplating baths are generally of a strong alkaline nature and are quite hot. Such masking materials as paraffin, tape, lacquer and the like did not provide satisfactory protection against the deposition of tin upon the areas to be kept free thereof due to the chemical reaction of the hot alkali upon the masking material. Frequently, the lacquer or tape would fail and additional manual treatment was required to remove the tin from these areas. The inspection and hand labor to make sure that the selected areas were kept from undesired tin plating added materially to the cost of the prior art process.

The difficulties did not end at this point. The tin plated areas would tend to drip or run slightly when exposed to the hot nitriding atmosphere. The dripping or running tin would cross into the areas intended to be kept free thereof. Accordingly, the production of a satisfactory nitriding stop in order that selective hardening of portions of steel members be accomplished, has not been entirely successful heretofore.

The object of this invention is to provide for restricting nitriding of metal surfaces to predetermined areas.

A further object of this invention is to provide for a non-running manually applicable nitriding stop.

Other objects of the invention will be obvious from the specification and the claims, as will be more fully disclosed herein.

For a fuller understanding of the nature and objects of the invention, reference may be had to the following detailed description taken in conjunction with the accompanying drawing, in

which the single figure is an enlarged cross-sectional view of a freshly nitrided metal member.

The requirements which a satisfactory nitriding stop must meet are ease of application, accurate and sure protection of designated areas, freedom from running of the stop composition over into other areas, and economy of the entire process. It has been discovered that a nitriding stop meeting these requirements may be prepared in the following manner. The base material which accomplishes the protecting of the surfaces of the metal member from the nitriding atmosphere is composed of comminuted or finely divided tin suspended in an evaporable liquid carrier in which is dissolved an organic film forming material. The comminuted tin in the liquid carrier may be applied manually as a coating to the predetermined portions of the member to be kept unhardened. After evaporation of the liquid, an organic film containing the comminuted tin is present on these surfaces. The member may be nitrided without further processing.

The nitriding stop composition may be rapidly and economically applied. The surfaces to be protected may be of any size or configuration. The stop composition may be brushed or sprayed on with great accuracy. By selecting a suitable viscosity liquid carrier and a rapid drying solvent the coating will not run, thus maintaining the original accurate application. During subsequent nitriding processing no running or flowing takes place. The composition and the mode of application thereof result in an easy and inexpensive process for restricting nitriding. Scrap and waste is negligible.

Tin which has been comminuted to 100 mesh or finer has been employed with successful results. The finer the tin the easier the application and the more uniform the results. Tin of a fineness of, for example, 200 mesh tin dust, is readily available on the market and may be employed in preparing the stop composition without any further processing. Tin particles of a size coarser than 100 mesh, for example, 50 or 60 mesh may be used if viscous liquid carriers or a thoroughly agitated dipping bath be employed in the coating process. For spraying, finer tin particles, under 200 mesh may be incorporated in the liquid carrier. In any event the particle sizes suitable will depend on the ease of obtaining an even distribution upon coating.

The comminuted tin is combined with a liquid carrier which has organic film forming materials dissolved therein. A good liquid carrier is trans-

parent lacquer. A satisfactory transparent lacquer is one containing 20% or less of cellulose nitrate dissolved in a rapid drying solvent, such as amyl phthalate, amyl acetate, acetone and similar solvents. Another successful liquid carrier for the tin dust consists of shellac dissolved in wood alcohol in the usual proportions suitable for brushing. Cellulose acetate lacquers and other lacquers consisting of alkyd resins and the like may be used with success. The desirable requirement of the liquid carrier is that it be readily applied, as by brushing, upon metal surfaces. Rapid drying of the brush lacquer is a desirable requirement in order that the liquid carrier set rapidly upon the surfaces on which it has been brushed with a minimum of flowing or running onto adjacent surfaces. Rapid drying also expedites the nitriding process as a whole.

It has been found that the amount of tin dust in the lacquer is critical. The dilution of the tin dust beyond a certain minimum quantity per unit volume of liquid carrier will not yield the desired results. It has been found that for best results, one gram of the comminuted tin dust for 5 cubic centimeters of the liquid carrier is approximately the least amount of tin which may be placed in the carrier and still obtain satisfactory protective stop results. Greater quantities of tin dust than this minimum have been found to yield consistently good results. A convenient method of measuring out a consistently satisfactory stop composition is to measure out one volume of tin dust for every 5 volumes of lacquer or other liquid carrier. This quantity of tin dust is well within the minimum requirement.

The tin dust and the liquid carrier, such as cellulose nitrate lacquer, are thoroughly stirred to obtain a good suspension of the ingredients. The liquid has a syrupy consistency. It is not advisable to employ a thinner unless an excess of tin dust has been used and the liquid carrier contains a high proportion of film forming material. Occasionally pitting has been produced in work in which a thinner was added to the liquid carrier.

The metal member to which the nitriding stop composition is to be applied is precleaned thoroughly by using hot alkaline washes or solvent cleaners well known to the art. The metal part is washed and thoroughly dried thereafter. The metal member is then treated with a tin dust-cellulose nitrate lacquer mixture, for example, by applying the mixture with a soft brush to the areas which are to be kept free from subsequent hardening. Spraying on the composition or dipping the member into the composition are feasible modes of application. The edges of the member to which the stop composition is to be applied should be given special attention. A good layer of the composition should be placed on these edges. The mixture of tin and the liquid carrier should be thoroughly agitated during the application of the composition in order to obtain a uniform mixture. By the use of rapid drying solvents the lacquered area will set and not flow within a short period of time. It is desirable that the film that remains after the drying out of the solvents be allowed to thoroughly harden by not touching or handling until quite hard. Ordinarily the lacquer is dry enough after ten minutes of air drying so that the coated member may be handled. Stacking of coated members is not advisable until drying in air has taken place for forty-five min-

utes. In case oven drying is employed a lesser time will produce a good hard tin carrying film on the member. The stop composition coating consists of a dry, hard organic film containing a uniform distribution of a quantity of the comminuted tin dust. The coating is somewhat brittle due to the quantity of tin present therein and it is not advisable to treat the members roughly prior to nitriding. If some portions of the coating are thin or a flake has been knocked off, retouching with tin bearing composition should be performed.

The liquid carrier may contain pigments and other material in addition to the organic film forming substance either for purposes of identification or because of the lower cost of the material. In the subsequent operations, the film forming material will be destroyed. Therefore, there is no particular requirement placed upon it except uniformity in thickness and uniformity of distribution of tin on the areas to be protected.

The metal member to be nitrided with the coating of stop composition carrying tin applied to the predetermined portions of the surface is placed within the nitriding apparatus. A common nitriding apparatus consists of an enclosed container within which a partially dissociated ammonia atmosphere circulates. Other types of nitriding apparatus may be used. The temperature during the nitriding operation is generally over 500° C. At this temperature the organic film forming material begins to char and evolves decomposition gases. The tin particles melt and apparently gravitate to the metal surface directly below on which they form a bright tin coating. This tin coating is not very thick but it has been found to be highly effective for the purpose. The film forming organic material chars and remains as a carbonaceous coating above the tin. It has been found that the tin does not flow and remains highly localized during the nitriding process, even though it is molten during the operation. It is believed that the charred material has a blotter effect on the molten tin and thus prevents running of excess tin.

After the nitriding operation, the member is cooled and removed from the nitriding apparatus. The lacquer appears as a dry, crumbly coating. It is easily removed by wire brushing. The use of a motor-driven brush will rapidly remove the carbonaceous film and produce a burnished corrosion-resistant tin coating below. The protected areas are easily identified by the tin coating thereupon. The hardened layers will be those free from the tin. Since the tin adhering to the metal protects the metal from corrosion, as does the nitriding, the completed piece is preferably left with the tinned surfaces intact.

Referring to the figure of drawing showing a cross-sectional view of a metal member which has been subjected to the nitriding treatment, the figure is a reproduction of a photo-micrograph made at the boundary between the protective stop composition coating and the adjacent hardened surface. The metal member 10 has two distinct areas after the nitriding hardening treatment. The area 12 consists of the normal unhardened steel body. The darker area 14 corresponds to the area hardened by the nitriding treatment. At the upper left portion of the surface, the tin layer 16 is visible upon the surface 12. Due to the fact that the nitriding gases

penetrate equally far in every direction from a given point on a surface penetrable thereto, the nitriding case extends in an arc back underneath the tin coating for a distance substantially equal to the depth of the case. This under-penetrating effect is of the order of a few thousandths of an inch and therefore is practically negligible. Above the tin layer 16 is the carbonaceous, dry crumbly layer of carbonized organic substance. This carbonized layer 18 appears to prevent the flow of the tin away from the surfaces upon which the stop composition has been brushed. It will be evident from the figure of the drawing that the protection rendered by the tin and coating composition is specific and areas of any configuration may be treated with the composition with greater accuracy as regards hardening than has been heretofore possible.

It is readily apparent that the instant process is much more satisfactory than any prior art process in that only a single operation is required in order to place the stop composition upon the predetermined areas. Once applied, nothing further need be done to the member except to place it within the nitriding apparatus. The stop composition is more satisfactory than most prior art processes, in that its protection has been highly successful. There have been no failures of the coating so far. Accordingly, the scraping of pieces of metal due to the inadvertent nitriding of some area which it was intended to keep soft, is eliminated.

While tin dust has been specifically designated for incorporation into the liquid carrier, other tin bearing materials may be employed with success in the process. Alloys of lead and tin, for example, which contain more than 25% tin, may be used. Alloys of tin other than the tin-lead alloys, which contain over 50% tin, may also be introduced in comminuted form into the liquid carrier. In addition, mixtures of these tin bearing alloys with each other or tin may be employed with success. The fundamental requirement is that the carrier contain sufficient of the tin or tin bearing material as previously described. Unless the alloying element has nitriding restricting properties allowance for the amount of alloying element should be made in adding the required amount of tin alloy to the carrier.

While the specific objects of the invention are to produce a nitriding restricting composition, in some cases the composition may be made use of to produce a straight tinning of metal. The coated member is heat treated at a high temperature, preferably in a reducing atmosphere. The carbon is brushed off and tinning has been rapidly effected.

Since certain changes may be made in the above invention and different embodiments of the invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or taken in connection with the accompanying drawing, shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. In the method of hardening by nitriding of selected portions of the surfaces of a metal article, the steps which comprise, in combination, applying a coating composed of organic film forming resinous solids in solution in a solvent and carrying tin in comminuted form to the portions of the surface of the article to be kept free of hardening, drying the coating to produce an adherent organic resinous film containing the comminuted tin and subjecting the film carrying metal article to nitriding treatment at elevated temperatures whereby the organic resinous film is carbonized and retains the tin in melted state as substantially applied to protect the underlying surfaces from hardening.

2. In the method of hardening by nitriding of selected portions of the surfaces of a metal article, the steps which comprise, in combination, applying a coating composed of organic film forming resinous solids in solution in a solvent and carrying at least one gram of tin in comminuted form for each five cubic centimeters of solution to the portions of the surface of the article to be kept free of hardening, drying the coating to produce an adherent organic resinous film containing the comminuted tin and subjecting the film carrying metal article to nitriding treatment at elevated temperatures whereby the organic resinous film is carbonized and holds the tin in a melted state as substantially applied to protect the underlying surfaces from hardening.

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