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METHOD OF APPLYING PROTECTIVE COATINGS TO SHEETS

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1 Claim. (Cl. 91—68.1)

My invention relates to a method of applying protective coatings to sheets, and more particularly to a method of applying a protective coating to a galvanized steel sheet. This application is a continuation in part of my co-pending application Serial No. 144,029, filed May 21, 1937, patented March 21, 1939, Patent No. 2,150,929.

It is an important purpose of my invention to provide means for overcoming the difficulty that has previously existed in the utilization of galvanized metallic sheets having a heavy coating of galvanizing, which was, that when the sheets were bent, the coating of zinc at the bend would tend to crack and peel, or flake off. As pointed out in the above mentioned patent, the bending of a sheet to form a flange, or seam, would, due to this tendency of the zinc, damage the galvanizing coating so seriously that it would render the coating at least partially ineffective where the bends required to form such flanges, or seams, were made, and as a result the advantage of the heavy galvanized coating on the sheet was largely lost. This, as has been pointed out in said above mentioned application, is true because a sheet, the galvanized coating of which had been ruptured by the bending operation, would be no better than an uncoated sheet, as far as resistance to oxidation, or other corrosion, was concerned, at the rupture, although the remainder of the sheet would be still well coated. While other more expensive and difficult-to-perform methods have been attempted for overcoming this difficulty, my invention has for its purpose the provision of means for protecting a sheet that has been fabricated, in a manner so as to prevent any corrosion thereof at a bend, or bends, even though the original zinc coating may have been ruptured or damaged in making the bend.

It is a further important purpose of my invention to provide a protective coating at the bend, or bends, in a galvanized metallic sheet, that will be even more resistant to corrosion, due to certain causes, than the galvanized sheet was before bending or fabrication thereof, and which will resist every kind of corrosion equally as well, as does the galvanized sheet at the portions thereof that have only the heavy galvanizing coating thereon applied prior to its fabrication. By fabrication of the sheet is meant any bending, cutting or punching operation, or other such operation, that may be performed on the sheet after the same has been rolled and galvanized.

My improved method of providing a protective coating on the sheet can be utilized, for not only protecting, or making the sheet more resistant to corrosion, at a bend therein where the galvanizing coating may have been damaged, or ruptured, but may be utilized to give a better protective coating against certain types of corrosion, or due to certain causes, over the entire area of the sheet, if this is desired, the treatment of the sheet to obtain this greater protection against corrosion being given to the sheet after it has been rolled and galvanized and fabricated, as defined above. Thus in a tank that is filled with a liquid that may have an undesirable corrosive effect on the usual zinc coating used on a galvanized sheet, the entire inner surface of the tank sections or sheets, fabricated to a shape and size and punched with suitable holes for securing the sections together, may be treated to make the same more resistant to corrosion, as well as the bends therein, if there be any in the section. Of course, if it is only desired to cure a defect in the coating at a bend in a sheet, it is only necessary to treat the zinc coated sheet on the sides of the bends which are outermost, that is, on the outside of the bends. This is true because the zinc coating is not injured on the inner side of the bend, as it is due to its lack of tensile strength that the rupturing, or damaging, of the zinc coating occurs.

As has been pointed out in the above mentioned patent, the zinc coating on a galvanized iron or steel sheet, comprises an inner coating, that is a ferrous zinc alloy, adjacent the iron and a pure zinc layer overlying the ferrous zinc alloy, the thickness and depth of this pure zinc coating, or layer, depending upon the number of times that the sheet is run through the galvanizing bath, or other details of the process of galvanizing, which are not of importance here. The heavier the coating of zinc obtained on the sheet the greater the difficulty in preventing cracking of the galvanizing or zinc coating, due to making a sharp bend in the sheet or performing other operations on the sheet that might rupture or crack the same, this being due to the fact that the tensile strength of the zinc is very much less than that of either the steel or the ferrous zinc alloy. My invention entirely overcomes the difficulty resulting from the rupturing of the zinc coating of a sheet at a bend or similar place, and makes the sheet more resistant to corrosion, even though the coating may have been cracked at the bend, at the places where it is treated according to my method, than it was prior to fabrication, and particularly re-

sistant to corrosion due to sulphur compounds present in certain oils and similar materials, that may be confined in tanks that are manufactured out of galvanized sheets, such as above referred to.

This is accomplished by amalgamating mercury with the protective coating at the bend in the sheet at which the rupture of the galvanizing coating may have occurred, or with the coating over the surface of the sheet that is desired to be protected against corrosion, such as a sheet used in a tank, the inner surface of which is to be particularly well protected against corrosion. Mercury and amalgams of mercury are particularly resistant to corrosion and are not affected by hydrogen sulphide as is zinc, the same being particularly resistant to corrosion due to acids, such as sulphuric acid, and other acids, and compounds, that may be encountered in the use of fabricated galvanized steel or iron sheets. While metallic mercury can be used to produce an amalgam coating on a galvanized sheet, this entails considerable difficulty, because the mercury, being so extremely mobile and having such high surface tension, has a tendency to form into globules or drops and run off the sheet, thus being difficult to handle and easily lost. An amalgam of mercury can be applied to the sheet in a much more satisfactory manner and it is one of the important purposes of my invention to provide a protective coating on a sheet that has zinc thereon, by spreading or applying, an amalgam of mercury and a metal that freely dissolves in mercury, or readily amalgamates therewith, to the surface to be protected. I have found that an amalgam of the consistency of soft putty, of a creamy character, if rubbed on the metal at the place where it is to be protected, such as a rupture in the coating on the sheet, causes a certain amount of the amalgam to adhere to the surface of the sheet, both at the zinc coated area and the area where the coating has been ruptured. Due to the character and consistency of the amalgam, the excess can be readily removed with a cloth, or in a similar manner, and saved for future use. Preferably, a tin-mercury amalgam is utilized for this purpose, producing a tin-zinc-mercury amalgam coating.

Specifically it is a purpose of my invention to provide a method of forming a corrosion resisting coating on a galvanized metallic sheet, comprising making a putty-like amalgam of mercury and tin, spreading said tin-mercury amalgam over the zinc coating on said sheet wherever desired, whether at ruptures therein or otherwise, and leaving the amalgam, adhering to the sheet, undisturbed thereon long enough that it will be amalgamated with the zinc on the sheet, to form the tin-zinc-mercury amalgam coating referred to above. When this occurs it can be readily recognized, as the coating will at first be soft and can be rubbed off with the fingers, but after twenty-four to forty-eight hours, the coating will be just as hard and have a similar appearance to that on the sheet before the amalgam was applied thereto. When this occurs, the tin-mercury amalgam has penetrated the zinc coating at least down to the ferrous zinc alloy at the surface of the steel or iron, and formed, with the zinc on the sheet, a zinc-tin-mercury amalgam. The action above described proceeds more rapidly in warm weather than in cold, the rate at which penetration of the zinc by the amalgam occurs being a function of the temperature and thickness of the zinc coating. The method further comprises a method of applying mercury to a galvanized metallic sheet to amalgamate with the zinc coating thereon, by spreading a soft putty-like amalgam of mercury and tin, or similar metal, on the area of the sheet over which the mercury is to be amalgamated with the zinc.

Other objects and advantages of my invention will appear as the description of the same proceeds. I desire to have it understood, however, that I do not intend to limit myself to the particular details described, except as defined in the claim.

My improved method is carried out on galvanized sheets that have been fabricated to the desired size and shape, by bending, die-shaping, cutting and punching operations, or any of these that may be necessary to produce the article, or sections of an article, of the desired shape from the sheet of metal. After the sheet has been fabricated, it is cleaned at the places at which the protective coating is to be provided thereon, usually by means of dilute hydrochloric acid, or a solution of tin chloride, or antimony chloride, or lead chloride, or zinc chloride, or cyanide of soda to remove zinc oxide, oil and dirt from the galvanized sheet. This cleaning solution may be applied with a brush or swab of some character, and the excess may be removed with a cloth, or any other suitable means. When it is desired to apply the protective coating only at or adjacent a ruptured area on a galvanized sheet, or an area that may have been damaged to the extent of injuring the protective coating, or rupturing the same, the galvanized sheets are cleaned only on the outer sides of all bends therein, or any other area at which the coating may have been ruptured, or damaged, and areas adjacent these bends, or other areas where the damage may have occurred. A zone at the place at which the rupture in the zinc coating may exist will thus be cleaned, and also a zone on each side thereof.

A putty-like amalgam of mercury and a metal readily dissolving therein, or amalgamating therewith, such as tin, is made up prior to cleaning the sheets, or is made up in quantity, to be used whenever necessary, said amalgam having such proportions of the metal, such as tin, and mercury therein, as to produce a soft putty-like material of a consistency of thick paste, or cream. The proportions of mercury and the other metal amalgamating therewith that are used to produce this soft putty-like coating material, will vary with the metals used and with the atmospheric temperature existing, as the material must, of course, be of the soft, creamy putty-like character at the temperature at which it is applied to the sheet. Thus in the winter time, when a lower temperature is encountered, both in the atmosphere and in the sheets themselves, a larger proportion of mercury to the tin, or similar metal, must be used to produce the soft putty-like coating material. I have found that sixty per cent of mercury and forty per cent of tin by weight will produce an amalgam of the desired consistency in the summer time, while in the winter time when the temperatures are exceedingly low, it is frequently necessary to utilize an amalgam made for this purpose, that is made up of one part by weight of tin to two parts by weight of mercury, and that, if exceedingly low temperatures are encountered, even one part by weight of tin to three parts by weight of mer-

cury are desirable. The relative proportions of the metal amalgamating with the mercury that have to be utilized, are dependent upon the melting points of the metals that are amalgamated with the mercury, and the temperature encountered. Thus, if the mercury is heated, when the tin is added thereto, as much as fifty-five percent tin can be included in the putty-like amalgam. Thus the paste-like amalgam used in my method may contain between 45% and 75% mercury by weight, depending upon the temperature at which the same is applied to the sheet.

In making up the putty-like, or creamy, paste-like amalgam, it is necessary that the metal that is to be dissolved in the mercury, or amalgamated therewith, is in a finely divided condition when it is to be amalgamated with the mercury. The tin, or similar metal, can be in the form of any small particles, such as shavings, turnings, cuttings, or in the form of a powder or granules. The finely divided tin, or similar metal, is stirred into the quantity of mercury that is to be utilized to make the amalgam in the proportions necessary substantially within the limits above referred to. At ordinary room temperatures, it is unnecessary to heat the mercury to cause the tin to be dissolved, unless a relatively large quantity of tin is to be incorporated in the amalgam. After a thorough stirring of the finely divided tin in the mercury, the amalgam is formed. However, if low temperatures are encountered, at which the mercury will have a more sluggish character, and at which the amalgamation will not as readily occur, or in case it is desired to speed up the amalgamation of the mercury and the tin, or similar metal, or increase the proportion of tin to be included in the putty, above that readily amalgamating with the mercury at room temperature, the mercury may be heated for this purpose, keeping the temperature of the mercury well below that at which it would vaporize.

The soft putty-like amalgam of tin and mercury produced as referred to above, is applied to the cleaned area, or zone, of the galvanized sheet, by brushing or rubbing the same onto the cleaned area of the sheet with a cloth, or similar member, this rubbing or brushing operation spreading the tin-mercury amalgam over the cleaned area of the sheet and causing a thin layer thereof to adhere to the outer surface of the zinc coating on the sheet, and in case there is a rupture or damaged area in the sheet, from which the zinc has been entirely, or substantially entirely, removed, the tin-mercury amalgam will adhere to the sheet at this point also. As soon as the tin-mercury amalgam contacts the zinc coating on the sheet, it begins to react therewith to amalgamate the zinc in the zinc coating with some of the mercury in the tin-mercury amalgam. Accordingly, in brushing the amalgam back and forth over the ruptured area, some of the zinc of the galvanizing coating will be caused to be spread over the ruptured area, and any loose flakes or particles of zinc will be dissolved in the tin-mercury amalgam, amalgamating with the mercury therein.

The action between the zinc and the tin-mercury amalgam will continue until the tin-mercury amalgam has penetrated the entire zinc coating of the sheet down to, at least, the ferrous zinc alloy at the surface of the iron or steel of the sheet. After the zinc is amalgamated with the mercury, the resulting amalgam that is produced will gradually become stiffer and harder, as the greater the amount of other metal amalgamated with the mercury, the harder or stiffer the amalgam will become. As a result, the penetration of the zinc by the mercury-tin amalgam will eventually produce a zinc-tin-mercury amalgam protective coating on the sheet over the entire surface to which the tin-mercury amalgam has been applied, which has lost the soft character of the tin-mercury amalgam and will become as hard as the zinc coating originally on the sheet.

Thus the amalgam, when first placed on the sheet treated in the above manner, will be soft enough that it can be rubbed off on the fingers to a certain extent, and after at least twenty-four hours the coating at the area to which the amalgam has been applied will be hard enough that none of the same will rub off and the sheet can be handled without any damage to the amalgam coating, just as readily as was the case with the zinc coating originally on the sheet. Also, after several days the sheet will have substantially the same appearance as it did before any amalgam was applied thereto, and none of the coating can be rubbed off, even though it may be rubbed persistently for a considerable period of time. The action of dilute sulphuric acid and other dilute acids, on the zinc and tin will be retarded to such an extent that the amalgamated galvanized sheet produced by my method, can be successfully used where an ordinary galvanized sheet would have such a short life that its use would be impractical.

While my improved method is particularly adapted for use to prevent corrosion at ruptures in coatings on galvanized sheets at bends therein, or similar places, it is obvious that under certain conditions it would be desirable to apply the cleaning step and the coating step, not only to the area of a sheet on the outer side of a bend at and adjacent the bend, but also to the entire surface of the sheet, that is innermost when it is put in place as a wall portion of a container that is subjected to the corrosive action of sulphuric acid, or other sulphur compounds, which are ordinarily found in oil tanks, or similar receptacles. These sulphur compounds cause a corrosive action on the zinc coating of the sheet as ordinarily provided in oil and similar tanks. However, by utilizing my protective coating, including the tin-mercury amalgam, and applying it to the inner surface of an oil tank, or the sections of an oil tank, made up of sheets that have been bent, cut and punched, this undesirable corrosive action is avoided entirely.

The tendency of the sulphur compounds, when acting on the zinc-tin-mercury amalgam coating, is to cause the mercury in the amalgam to form a protective film on the surface that is exposed to the action of the dilute sulphuric acid, or hydrogen sulphide, or other sulphur compounds, this causing some slight loss of some of the other metals from the coating, such as the zinc and tin, but the mercury arresting this loss substantially immediately, due to the film forming action that it has.

There is substantially no loss of mercury in the carrying out of my method, because, if there is any excess of amalgam applied to the sheet, such excess can be removed with a cloth, such as the cloth by means of which the putty-like amalgam has been rubbed on the sheet, and the part thus removed saved for use on another sheet or other portion of the sheet. While it is immaterial whether the amalgam coating is of the same composition throughout, it has been found that

if the soft putty-like tin-mercury amalgam, above referred to, is utilized, some of the mercury in the tin-mercury amalgam will amalgamate with the zinc immediately, forming a zinc-tin-mercury amalgam, and some of the tin-mercury amalgam will be present without any zinc in it at first, this being on the top surface of the coating. However, if the tin-mercury amalgam is left in contact with the zinc coating for twenty-four hours or more, and an excessive amount of the tin-mercury amalgam is not used, sufficient of the mercury will amalgamate with the zinc that all of the zinc will become amalgamated with mercury, and the resulting coating will be a tin-zinc-mercury amalgam, from the outer surface thereof to at least the ferrous zinc alloy at the surface of the metal of the sheet. Due to the fact that the zinc requires a much larger amount of mercury to be amalgamated with the same to produce a soft putty-like amalgam, than does the tin, this amalgamation of the mercury with the zinc, when completed, causes the coating to have a hard character, similar to that of the zinc, instead of a soft putty-like character, such as the tin-mercury amalgam had before it was applied to the sheet.

The application of the putty-like tin-mercury amalgam to the sheet that has previously been galvanized results in the dissolving of the zinc on the sheet in the mercury of the tin-mercury amalgam, but the resulting liquefaction of the coating material on the sheet takes place through the thickness of the zinc coating thereon at such a slow rate that the structure of the zinc coating on the sheet is not altered, although the composition changes from substantially pure zinc to a zinc-tin mercury amalgam as the amalgamating process proceeds through the coating. As a result the characteristic spangles of the galvanized sheet remain after the amalgamation is completed, the sheet having substantially the same appearance two or three days after the amalgam has been applied thereto as it had before any application of amalgam was made thereto.

When a putty-like amalgam containing 40% tin and 60% mercury by weight is utilized for application to a galvanized sheet that has a coating thereon of zinc that amounts to one ounce per square running foot, or one-half ounce per square foot surface on each side of sheet, the amalgam resulting will contain approximately 65.8% zinc, 13.7% tin and 20.5% mercury. With heavier coatings of zinc the percentage of zinc will, of course, be higher, and of course, the percentage of tin will be less where an amalgam containing a larger percentage of mercury is utilized. As in all cases the amount of zinc in the amalgam will be over 50%, the coating will not lose the characteristics of a zinc coating completely, but will be modified in its corrosion resisting characteristics to a considerable extent by the mercury contained therein, and to a lesser extent by the tin contained therein.

One of the advantages of my method of providing an amalgam coating on a galvanized sheet over the use of metallic mercury for this purpose, in addition to the fact that it is much more easily and cheaply carried out, is that metallic mercury will dissolve the zinc on the sheet in a manner to destroy the crystalline structure of the zinc coating, while by using the putty-like amalgam in my method, the appearance of the galvanizing coating remains unchanged.

What I claim is:

The method of repairing a rupture in the zinc coating of a galvanized metallic sheet, comprising spreading a soft, creamy, putty-like amalgam of mercury and tin containing from 45% to 75% mercury by weight over the surface of said sheet at and adjacent said rupture, rubbing the resulting amalgam over said rupture, removing all the excess amalgam from said sheet and permitting the resulting amalgamation, over the entire area over which the same was spread, to proceed undisturbed throughout the thickness of said zinc coating over said area until a hard amalgam coating over said area having the spangled appearance of the galvanizing coating on said sheet, is produced.

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