

UNITED STATES PATENT OFFICE

2,293,580

PROCESS FOR THE TREATMENT OF IRON-CONTAINING SURFACES AND PRODUCT THEREOF

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No Drawing. Application May 13, 1939,
Serial No. 273,582

6 Claims. (Cl. 117—134)

This invention relates to the protection of ferrous metal surfaces against corrosion or rusting. More particularly the invention relates to the temporary protection of steel sheet, wire, and similar articles against rusting due to moisture condensation during shipment and storage.

It is well known that after an article having a ferrous metal surface is manufactured, such as steel sheet or wire, the surface is very susceptible to rusting upon storage unless subjected to a surface treating process such as coating same with mineral oil or the like. Commercial wool fat (lanolin) has been widely used for this purpose and is considered superior to the mineral oils. However, lanolin has the objectionable feature of developing an offensive odor on aging. Also the layer of lanolin must be relatively thick in order to properly inhibit rust formation. This thickness of layer has a disadvantage where the sheets are to be painted or printed as it interferes with these processes. A film of lanolin thin enough to be painted over or printed upon satisfactorily no longer possesses adequate corrosion resistance, and from commercial operations it has been apparent that there is no film thickness of lanolin which will prove satisfactory both for prevention of corrosion and for direct application of adherent paint coatings or ink compositions. Similarly, although mineral oil is cheap and easy to apply to a metal surface, an adherent paint coating or ink layer cannot be directly laid down on a metal surface so treated. Thus steel sheet that has been coated with mineral oils to prevent corrosion must be pretreated in order to remove said oil prior to a painting, printing or lithographing step. By the invention herein disclosed, disadvantages of prior art processes have been overcome.

This invention has as its object a protective treatment for a ferrous metal surface which treatment will adequately protect the surface against rusting and at the same time permit the surface to be painted, lithographed or printed on without further processing. Another object is to produce a protective layer or film on a metal surface which coating does not have or develop an offensive odor. A further object is to provide a method for treating bright ferrous metal surfaces to inhibit corrosion resulting from condensed moisture. Another object is to produce new and useful products by the application of this invention. Other objects will be apparent from the reading of the following description of the invention.

These objects are accomplished by depositing on a ferrous metal surface a thin continuous layer of a mixture of acids selected from the group of straight-chain saturated aliphatic monocarboxylic acids having from 6 to 16 carbon atoms and preferably a mixture which will form

homogeneous non-crystalline films under ordinary conditions of temperature.

The following examples set forth certain well-defined instances of the application of this invention. They are, however, not to be considered as limitations thereof since many modifications may be made without departing from the spirit and scope of the invention.

Example 1

Cold rolled 20-gauge steel sheet is cleaned in a vapor degreaser and then dipped briefly in a 2% solution of coconut oil fatty acids in toluol. The sheets are drained on removal from this solution and dried in a rack at room temperature.

Example 2

Bright steel wire is drawn in the usual manner, and after leaving the final die is passed between felt pads kept saturated with a 4% solution of coconut oil fatty acids in a mixed solvent comprising four parts of toluol and one part of acetone. The wire is then coiled and packaged for storage or shipment.

Example 3

The steel sheet treated according to Example 1 is lithographed by standard processes and fabricated into metal containers. The sheet requires no cleaning or other treatment preparatory to lithographing, and exhibits pronounced oleophilic properties which impart excellent ink receptivity and retention.

Example 4

Sheet steel treated as in Example 1 with a 4% solution of coconut oil fatty acids in toluene was exposed to continuous condensation of moisture at the same time that steel sheet similarly treated with a mineral oil type of protective material was undergoing exposure. The following table indicates the relative value of the two treatments.

Treatment of the steel	Corrosion rating ¹		
	1 week	3 weeks	6 weeks
Untreated.....	4	3	1
Coconut oil fatty acids (4% in toluene).....	10	9	8
Mineral oil (4% in toluene).....	6	3	1

¹ Rating: 10=no visible rust; 0=surface entirely covered by rust.

Example 5

Cold reduced 24-gauge steel sheet is cleaned by scrubbing in an alkali silicate solution, rinsed with fresh water and dried in a current of hot air. The sheet while still warm is passed between cloth rolls saturated with a xylol solution containing 2% coconut oil fatty acids and 2%

dodecyl acid phthalate. The solvent evaporates readily during a short travel on belt conveyors and the sheets are then inspected and stacked for shipment.

Steel sheet so treated was exposed to continuous moisture condensation in comparison with similar steel sheet treated with a heavy mineral oil type of protective agent. The improvement in rust resistance obtained by the former treatment is aptly illustrated by the following table.

Treatment of the steel	Corrosion rating ¹		
	1 week	2 weeks	3 weeks
Untreated.....	4	3	1
Mineral oil (heavy film rubbed on).....	8	3	1
Coconut oil acids (2% plus dodecyl acid phthalate (2%) in xylene).....	10	9	8.5

¹ The rating as here given is an arbitrary figure which is based on the figure 10 for complete absence of rusting and 0 for complete rusting over the whole surface of the panel.

A mixture of any acids selected from the group consisting of saturated aliphatic straight-chain monocarboxylic acids having from 6 to 16 carbon atoms which forms a homogeneous film may be used in the protective compositions of this invention. In the case of the longer-chain compounds such as those of 14 and 16 carbon atom chain lengths there is a tendency of the compound to crystallize under ordinary temperature conditions and by this crystallization to form a discontinuous film. In order to avoid such crystallization it is preferred to admix the long-chain compounds with acids of shorter chain lengths. It is therefore necessary that these various acids be used in combination with each other. They also may be used in combination with long-chain alkyl acid esters of polycarboxylic acids. This combination of acids and acid esters produces a specially desirable mixture for the treatment of ferrous metal surfaces.

The most practical source of the acids that are used in this invention is from coconut oil. These coconut oil acids may be used as such in their normal mixed state or they may be separated and subsequently mixed with any of the acids selected from the group of straight-chain saturated aliphatic monocarboxylic acids having from 6 to 16 carbon atoms. The coconut oil acids consist largely of dodecanoic and tetradecanoic acids in a proportion which indicates that the oil is principally dilauromyristin. As palm kernel oil has a composition similar to coconut oil, it too may form a valuable source of the acids.

Other steel sheets which were treated with coconut oil acids as described in Example 1 were stored in the presence of sulfuric acid mist emanating from a metal pickling tank nearby. At the end of three days' storage steel sheet treated with a 4% solution of coconut oil acids in toluol was free from rust while untreated sheet and sheet treated with a 4% solution of lanolin in toluol was severely rusted and unusable without cleaning.

Extended storage in a steel warehouse of untreated steel sheets and steel sheets treated respectively with a 4% solution of coconut oil acids and a 4% solution of lanolin in toluol demonstrated the marked superiority of coconut oil acids as a protective agent for bright steel. The untreated steel was rusted so heavily as to be unusable without cleaning, and the steel treated with lanolin showed numerous spots of rust, 75

while the sheets treated with coconut oil acids were completely free from rust.

It has also been found that the mixture of acids obtained from coconut oil is much superior to the individual fatty acids as a protective agent for ferrous metals. The following table shows the degree of protection against corrosion given to polished steel panels by various pure fatty acids in comparison with coconut oil acids during exposure to continuous condensation of moisture. The various acids were applied to steel as a 4% solution in an acetone/toluene solvent mixture.

Treatment of steel surface	Corrosion rating ¹		
	2 days	1 week	2 weeks
Control (no treatment).....	8	6	5
Coconut oil fatty acids.....	10	10	9.5
Capric acid.....	10	9.5	6
Myristic acid.....	9.5	8	6
Palmitic acid.....	9	6	5
Stearic acid.....	9	7	6
Arachidic acid.....	10	6	5

¹ Rating: 10=no rusting on metal surface; 0=panel surface entirely rusted.

Steel sheet treated with the mixture of fatty acids is also more suitable for painting without removal of the protective layer of acids than steel treated with either lanolin or mineral oil. This is illustrated in the following table where the force necessary to remove paint films from variously treated metal surfaces is given.

Treatment of metal	Force required to remove paint film after soaking for six hours in water
	Lbs./sq. in.
Untreated.....	13.5
Sulfonated oil (4% in alcohol).....	3
Lanolin (4% in toluene).....	5
Coconut oil acids (4% in toluene).....	16

The acids are applied normally from solutions prepared with organic solvents. Naphtha fractions corresponding to xylol and toluol are quite satisfactory, and volatile aliphatic hydrocarbon solvents, for example, those derived from petroleum fractions, and chlorinated aliphatic solvents, for example, carbon tetrachloride, chloroform, perchlorethylene and trichlorethylene, may also be used. A boiling point under 150° C. is preferred in order to facilitate evaporation at room temperature, but a wide choice of solvents is available within this range. When rapid drying is desired, low-boiling materials such as acetone or alcohol may be mixed with the less volatile hydrocarbon liquids.

Dilute solutions are best suited to the practice of this invention, and 2-10% concentrations are ordinarily used. When an extremely thin surface layer is desired a concentration as low as 0.5% may be used, and in certain other cases as much as 20% may be required. Solutions more concentrated than this tend to deposit thick films which offer no advantage in corrosion resistance and which are undesirable because of "greasy" feel and possible interference with subsequent decorating and/or fabricating steps. It is only necessary that the surface shall be completely covered with the proper amount of solution, which is usually quite small. Both the solution and the article to be treated may be at room temperature, or the rate of drying may be increased by heating one or both to some

moderate temperature below the boiling point of the solution. The treated metal should not be wiped dry, but should be permitted to dry by evaporation of the solvent. This may be done in an enclosed system designed to recover the solvent vapors or may be allowed to take place in the open air.

Although these mixtures will usually be applied to metal surfaces by means of a solution using such well known processes as dipping, spraying, wiping, and brushing, it will be desirable at times to use other methods of application. A material which melts at reasonably low temperatures and which undergoes no decomposition in the region of its melting point may be applied in the liquid form without a diluent of any kind, provided that the application of the material is so regulated that the final protective film conforms to the desired thickness limits. These materials may also be applied to the metal surface as a finely divided solid and the protective layer be formed by fusing the solid particles to a continuous coating at a suitable temperature. The protective agent may also be emulsified or dispersed in a liquid which is not a true solvent and applied to metal surfaces in this form, with the evaporation of the carrier occurring subsequently. It also may be preferred in certain cases to provide metal articles with a protective surface layer by permitting the condensation of vapor of a particular mixture to occur on the metal surface.

The acids may be applied in any manner that will produce a thin continuous layer over the surface treated. It is thought that in this thin film the molecules of the acids are oriented with respect to the surface. The film must be thick enough to give adequate protection if applied merely for the purpose of resistance to corrosion. As the film materially assists in the application of oil-base coating compositions such as, for example, printing and lithographing inks and oil-base paints, presumably due to the oleophilic properties imparted to the metal, a coating even thinner than that which would give adequate protection against corrosion may be used. In the accomplishment of the latter, however, the coating must not be so thick as to interfere with the later application of oil-base compositions. From the point of view of the prevention of corrosion the thickness of the coating need not be restricted.

When a paint film is subsequently to be applied it is preferred that the film or layer of anticorrosion deposited on the metal surface be of such a thickness that one pound will coat approximately 20,000 square feet of metal. (This thickness may be readily obtained by dipping a steel sheet in a 4% solution of the protective agent.) Films of a thickness such that one pound will coat approximately 10,000 square feet, or of a thickness such that one pound will coat approximately 80,000 square feet, may also but less preferably be used. These thicknesses may be obtained by dipping a sheet of steel into 8% and 1% solutions of the agents, respectively.

These compounds are particularly well adapted to the protection of ferrous metal articles, such as bolts, nuts, nails, wire, sheets, tools, fine machinery parts, bearings, cutlery, gears, fire arms, metallic cases, etc., and to the treatment of ferrous metal articles which have been provided with a surface coating of some other metal or alloy, such as chromium, copper, nickel, cadmium, zinc, brass, aluminum, tin, lead, etc. In addition to

such uses, these compounds may be applied to the surfaces of other metals and alloys, particularly those used for structural shapes and articles of commerce. Among such metals and alloys are zinc, brass, bronze, aluminum, tin, copper, pewter, lead magnesium, cadmium, "duralumin," nickel, etc. Because the treatment does not interfere with subsequent painting or lithographing, an important use is the protection of steel sheet which is to be fabricated later into lithographed containers or painted lockers, cabinets and the like.

Treatment of steel sheet and other ferrous metal articles with the mixture of fatty acids described possesses the advantages of low cost, simplicity of operation, outstanding corrosion resistance, freedom from unpleasant odor, and adaptability to subsequent painting or lithographing. While other materials may demonstrate equal performance on one of these points, this mixture of fatty acids stands alone in combining all of these characteristics in a single product.

Besides providing an excellent surface for the application of oil-base compositions, the process disclosed herein, in fact, improves the paint adhesion properties of the metal surface as is seen from a study of the foregoing table. This is a specially important advance in the art because of the growing demand among manufacturers of metal containers and similar articles for a steel sheet which is corrosion resistant in storage and yet suitable for direct use in offset printing or roller coating without a cleaning or degreasing step.

It is apparent that many widely different embodiments of this invention may be made without departing from the spirit and scope thereof and therefore it is not intended to be limited except as indicated in the appended claims.

I claim:

1. As an article of manufacture a body having a surface containing iron in proportions capable of atmospheric corrosion, at least a part of said surface being rendered highly resistant to atmospheric corrosion by being coated with a thin, continuous, homogeneous film consisting of the mixture of straight chain saturated aliphatic monocarboxylic acids having from 6 to 16 carbon atoms, that is identical in composition to the mixture known as coconut oil acids, said film being characterized in that it has a minimum thickness of mixed acids corresponding to a spread of 80,000 sq. ft. per lb. of mixed acids and has a maximum thickness of mixed acids corresponding to a spread of 10,000 sq. ft. per lb. of mixed acids.

2. As an article of manufacture sheet steel having its surface rendered highly resistant to atmospheric corrosion by being provided with a thin, continuous, homogeneous film consisting of the mixture of fatty acids having from 6 to 16 carbon atoms and derived from a naturally occurring oil selected from the group consisting of coconut oil and palm kernel oil, said film being characterized in that it has a minimum thickness of mixed acids corresponding to a spread of 80,000 sq. ft. per lb. of mixed acids and has a maximum thickness of mixed acids corresponding to a spread of 10,000 sq. ft. per lb. of mixed acids.

3. A process for rendering a surface highly resistant to atmospheric corrosion, which surface contains iron in proportions capable of atmospheric corrosion, which comprises depositing on

said surface a thin, continuous, homogeneous film consisting of the mixture of straight chain saturated aliphatic monocarboxylic acids having from 6 to 16 carbon atoms that is identical in composition to the mixture known as coconut oil acids, which film is non-crystalline under ordinary atmospheric temperatures, said film being characterized in that it has a minimum thickness of mixed acids corresponding to a spread of 80,000 sq. ft. per lb. of mixed acids and has a maximum thickness of mixed acids corresponding to a spread of 10,000 sq. ft. per lb. of mixed acids.

4. The product in accordance with claim 2 being further characterized in that it has superimposed on at least a part of said coated surface an oil base coating composition.

5. As an article of manufacture, a body having a surface containing iron in proportions capable of atmospheric corrosion, at least a part of said surface being rendered highly resistant to atmospheric corrosion by being coated with a thin continuous homogeneous film consisting of the mixture of fatty acids having from 6 to 16 carbon atoms and derived from a naturally occurring oil selected from the group consisting of coconut oil

and palm kernel oil, said film being characterized in that it has a minimum thickness of mixed acids corresponding to a spread of 80,000 square feet per pound of mixed acids, and has a maximum thickness of mixed acids corresponding to a spread of 10,000 square feet per pound of mixed acids, said article being further characterized in that it has superimposed on at least a part of said coated surface an oil base coating composition.

6. The process for rendering a surface highly-resistant to atmospheric corrosion which surface contains iron in proportions capable of atmospheric corrosion, which comprises depositing on said surface a thin continuous homogeneous film consisting of the mixture of fatty acids having from 6 to 16 carbon atoms and derived from a naturally occurring oil selected from the group consisting of coconut oil and palm kernel oil, said film being characterized in that it has a minimum thickness of mixed acids corresponding to a spread of 80,000 square feet per pound of mixed acids, and has a maximum thickness of mixed acids corresponding to a spread of 10,000 square feet per pound of mixed acids.

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