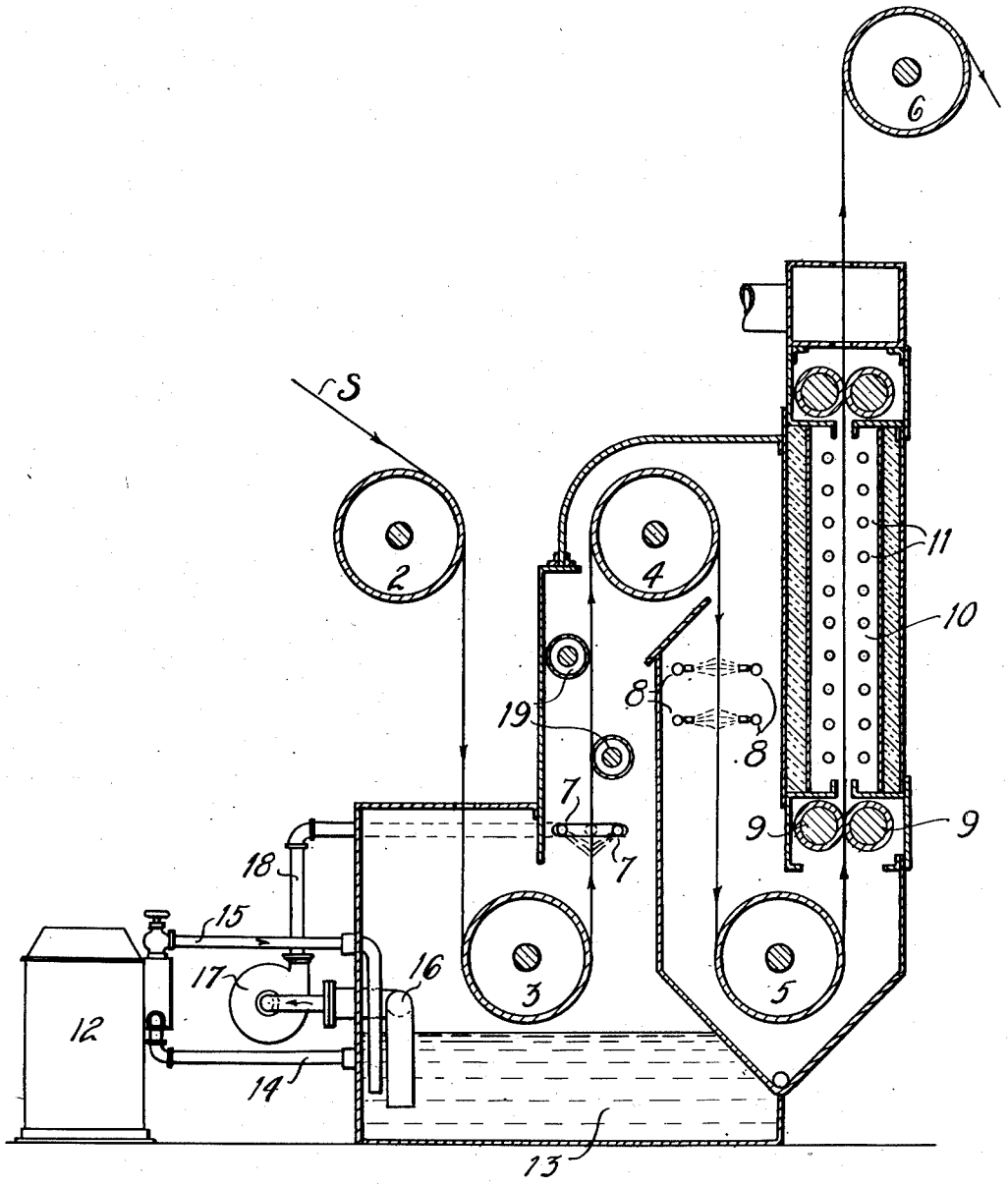
Dec. 25, 1951 W. S. ALLEN 2,579,777

METHOD OF SURFACE LUBRICATION OF METAL PRODUCTS

Filed April 6, 1949



INVENTOR.
William S. Allen
BY
Donald G. Dalton
HIS ATTORNEY

Patented Dec. 25, 1951

2,579,777

UNITED STATES PATENT OFFICE

2,579,777

METHOD OF SURFACE LUBRICATION OF METAL PRODUCTS

William S. Allen, Pittsburgh, Pa., assignor to United States Steel Company, a corporation of New Jersey

Application April 6, 1949, Serial No. 85,750

4 Claims. (Cl. 117—134)

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This invention relates to improvements in the method of surface lubrication of metal products, such as tin plate and the like.

With the commercial development of electrolytic tin plate, the dry character of such tin plate has caused the container industry difficulty. The industry had adapted their manufacturing methods, machinery and lacquers to accommodate the lubricated tin plate formerly produced by the hot-dip process, and have found that the dry electrolytic tin plate was difficult to assort and handle, was susceptible to scratches and marking, and provided different enameling and printing characteristics.

Various methods have been tried in an endeavor to supply the desired lubrication to the tin plate, but have proved unsatisfactory for one reason or another. Generally, those methods which have been tried heretofore have been incapable of control and for the most part have produced non-uniform and excessive lubrication which also is highly objectionable.

An object of the present invention is to provide improved methods of applying lubricant coatings to metal surfaces and overcoming the objections of previous coating methods.

A further object of the invention is to provide improved methods of applying to metal surfaces lubricant coatings which are continuous, uniform, non-smeary and the weight of which can be controlled.

A further object of the invention is to provide improved methods of applying lubricant coatings to metal surfaces in which lubricant globules first are deposited on the surface from a lubricant-in-water emulsion and subsequently the surface receives a water spray which removes excess emulsion and coalesces the globules that are attached to the surface leaving a uniform lubricant film of controlled weight.

In a lubricant-in-water emulsion, the lubricant globules carry like electric charges and hence repel one another. As hereinafter explained, the lubricants used in practicing the present invention are of the class which have a greater affinity for the metal surface than the aqueous phase of the emulsion has for this same surface. Consequently when the emulsion flows against this surface, some lubricant globules adhere to the surface and some remain as free globules in the overlying layer of emulsion. The surface shortly becomes covered with a layer of adhered globules, which however retain their electric charge and repel the free globules. Thus while the globules form a layer of lubricant of

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substantially constant thickness, they do not form a continuous film since they remain as separate droplets. I am aware of previous attempts to apply lubricant coatings to metal surfaces from emulsions in which the water is evaporated after the globules are deposited, but such attempts have not been successful for the reason that the overlying layer of emulsion also dries and thus the film thickness cannot be controlled.

According to the present invention, after the surface receives the emulsion spray, it receives a water spray which washes away all of the emulsion except the lubricant globules which actually are adhering to this surface. The water spray also unbalances the forces which maintain the globules as separate droplets and thus enables them to coalesce and form a continuous film. I believe their coalescing is due to a breaking of the emulsion, either through removal of the emulsifying agent, or in the case of acid emulsions through dilution of the acid content, or both, but I do not wish to limit the present invention to any particular theory.

The single figure of the drawing shows diagrammatically one form of apparatus suitable for performing the improved method of the present invention. In this figure tin plate S, in strip form, has been coated and otherwise finished except for the application of a lubricant coating. The strip moves through a series of vertical passes between rolls 2, 3, 4, 5 and 6. In an upward pass between rolls 3 and 4, emulsion flows onto both sides of the strip from low pressure sprays 7, following which water from low pressure sprays 8 floods the strip during its travel in the downward pass between rolls 4 and 5. The spray pressure must not be so great that it washes away adhered globules. Finally the strip passes upwardly through squeegee rolls 9 and through a drying chamber 10, which may be equipped with steam coils or pipes 11.

The emulsion preferably is homogenized continuously in a homogenizing unit 12 in fluid circuit with a reservoir 13 which contains a supply of the emulsion. Supply and return conduits 14 and 15 connect said reservoir with the homogenizing unit. The emulsion is drawn from the reservoir 13 through a suction conduit 16 and pump 17, and is supplied to the sprays 7 through a conduit 18, the surplus from said sprays and the strip falling into reservoir 13 for reuse.

The emulsion must flow on the strip for a sufficient interval for a complete layer of lubricant globules to adhere thereto. Damming rolls 19 can be employed to prevent drag-out and wastage of

the emulsion. The low pressures of the emulsion and water sprays are adjusted to flood the strip without disrupting the lubricant globules, and the homogenizing pressure is regulated to provide a suitable lubricant globule size. The operator can control all the foregoing variables readily on observation of the lubricant film which is deposited.

A lubricant film of about .01 to .30 grams of lubricant per base box, or about .000023 to .00069 grams per square foot has been found satisfactory for the purposes hereinbefore stated. Present methods of determining the weights of such lubricant films present some difficulty, but sufficiently accurate weights and comparisons have been made to fix the foregoing limits as satisfactory for the container industry.

The emulsion is of the lubricant-in-water type. The lubricant must be of the class which has a greater affinity for the metal surface than the aqueous phase of the emulsion has for this surface. This affinity is an inherent property of some lubricants, such as those which in their natural state contain compounds that have free carboxylic groups. The same affinity can be imparted to other lubricants by the addition of substances that have free carboxylic groups or their equivalents. A further essential for lubricating tin plate which is to be used in food containers is that the ingredients of the emulsion must be non-poisonous.

Examples of lubricants which I have found satisfactory and whose affinity is an inherent property are as follows:

Palm oil, cottonseed oil, corn oil, olive oil, cocoanut oil, lard oil, tallow, and similar fatty acid esters.

Examples of lubricants which I have found otherwise satisfactory and to which the necessary affinity can be imparted by the addition of substances that have free carboxylic groups are as follows:

Dibutyl phthalate, dibutyl sebacate, tributyl citrate, and similar organic plasticizers.

Additive substances for the second type of lubricants typically are intermediate and long chain aliphatic carboxylic acids. Specific examples are oleic acid, stearic acid, linoleic acid, myristic acid and palmitic acid. These additive substances may, if desired, be used with lubricants of the first type, although ordinarily they are not needed since usually they are present naturally in sufficient quantities. The optimum proportion of additive substance may be determined empirically for any particular lubricant and is adjusted to furnish a satisfactory adherence of the lubricant globules to a metal surface. For lubricants of the second type, I find 5 to 25 percent of the additive substance in the lubricant ordinarily furnishes satisfactory globule adherence. Some lubricants of the first type, such as highly refined cottonseed oils, contain as little as 0.3 to 0.4 percent free acids and yet ordinarily they have satisfactory globule adherence without addition of more acid.

Emulsifying agents can be classified as anionic, cationic, and non-ionic. For forming an emulsion from which an oil film can be deposited on a metal surface, any one of the three classes of emulsifying agents is operable. However, emulsions which are formed of hard water and are stabilized with anionic emulsifying agents precipitate insoluble soaps which form scums on the emulsion and smear the metal surface and also interfere with subsequent lacquer adhesion. Therefore the process of the present invention requires that the emulsion be acid. The emulsifying agent can be either cationic or non-ionic, provided it tolerates acidity.

In preparing the acid emulsions, the emulsifying agent can be selected from the long chain amines, carboxyl amides, phosphoric acid esters, or other cationic or non-ionic emulsifying agents. As an example, I have used with particular success Amine 220 which is a commercial product understood to be defined by the formula 1 hydroxyethyl 2 heptadecenyl glyoxalidine. Other specific examples of satisfactory cationic emulsifying agents are:

Oleic amide, castor amide, coconut amide, coconut amine, oleic amine, n-monododecylamine, and n-monohexadecylamine.

Specific examples of satisfactory non-ionic emulsifying agents are:

Diethylene glycol stearate, mannitan monopalmitate, mannitan monolaurate, and sorbitol monopalmitate.

With acid emulsions a weakly ionizable acid, such as acetic, citric or tartaric is preferable for furnishing the acidity. I have found that a pH of between 2 and 6 is sufficient to maintain a stable emulsion, and that acetic acid is particularly suitable for the purpose.

When the emulsion is prepared, the lubricant and emulsifier, with the additive substance if employed, are mixed and added to the water and acid. The water dilution preferably is such that the resulting emulsion contains from about 3 to 12 ml. of the lubricant per liter. The concentration of the emulsifying agent is sufficient to stabilize the emulsion without preventing adherence of the lubricant globules to the strip surface. I find that 0.5 to 6.0 parts of emulsifying agent per 100 parts of lubricant by volume furnish the desired characteristics.

The weight of the lubricant film can be varied by varying the proportion of either the lubricant or the emulsifier within the critical range stated. I have found that the weight of deposited lubricant varies inversely with the ratio of emulsifier to lubricant, and that varying either the lubricant or the emulsifier content provides an excellent method of controlling the weight of the lubricant film within the weight range hereinbefore stated.

The following are specific examples of emulsions which I have found suitable for producing surface lubrication of electrolytic tin plate within the range of lubricant weights suitable for such tin plate. The proportions of lubricant, additive substance and emulsifying agent are in parts by volume, and acetic acid is employed to furnish the pH values indicated:

Example 1

Cottonseed oil	100
Amine 220	.5
pH	2–6
ml. Oil per liter	3.8

Example 2

Palm oil	100
Amine 220	1.75
pH	2–6
ml. Oil per liter	4

Example 3

Palm oil	100
N-monododecyl amine	8.3
pH	2–6
ml. Oil per liter	11.4

Example 4

Palm oil	100
Mannitan monopalmitate	8
pH	2–6
ml. Oil per liter	12

Example 5

Cottonseed oil	100
Amine 220	1.75
pH	2–6
ml. Oil per liter	3.8

Example 6

Dibutyl sebacate	75
Oleic acid	25
Amine 220	3/4
pH	2–6
ml. lubricant per liter	6

Example 7

Dibutyl phthalate	95
Palmitic acid	5
Amine 220	1.2
pH	2–6
ml. lubricant per liter	5.7

Example 8

Tributyl citrate	77
Stearic acid	23
Amine 220	1.2
pH	2–6
ml. lubricant per liter	4

After such emulsions are applied to the tin plate in the manner stated, the tin plate is washed to remove substantially all unattached globules of lubricant, leaving only the attached globules which adhere to the surface. The washing step also functions to unbalance those forces which maintain the attached globules of lubricant as individual droplets, whereupon these droplets coalesce and flatten to form a substantially continuous uniform film. Following this washing step, the product is dried by any suitable means.

While my improved method has been shown and described herein in connection with electrolytic tin plate, the same is not to be limited thereto. Since the lubricant-to-metal adhesion tension does not vary in appreciable amount for different metals, obviously the herein described method may be employed for similarly lubricating other metal products.

The present application is a continuation-in-part of my co-pending application Serial No. 735,637, filed March 19, 1947, now abandoned, and which in turn was a continuation of my application Serial No. 503,723, filed September 24, 1943, also abandoned. The present application does not cover specifically such lubricants as dibutyl phthalate, dibutyl sebacate, and tributyl citrate, which require the use of additive substances, for the reason that methods utilizing such lubricants form the subject of a divisional application Serial No. 224,411, filed May 3, 1951.

Various changes and modifications are contemplated within the scope of the following claims.

I claim:

1. The method of surface lubrication of metal strip and the like which comprises applying to the strip surface a lubricant-in-water emulsion having a pH value of 2 to 6 produced by a weakly ionizable organic acid and consisting of 3 to 12 ml. of lubricant per liter of emulsion and 0.5 to 6.0 parts of an emulsifying agent per 100 parts of lubricant by volume, the lubricant being selected from the class which consists of palm oil, cottonseed oil, corn oil, olive oil, cocoanut oil, and lard oil, the emulsifying agent being selected from the class which consists of cationic emulsifying agents and non-ionic emulsifying agents and being an agent which tolerates acidity, the concentration of emulsifying agent being sufficient to stabilize the emulsion without preventing adherence of lubricant globules to the strip surface, lubricant globules thus adhering to the strip surface as separate droplets, washing the emulsion bearing strip with a low pressure water spray, which removes the excess emulsion and coalesces the adhering lubricant droplets into a continuous film, and drying the strip surface.

2. A method as defined in claim 1 in which the lubricant is cottonseed oil.

3. A method as defined in claim 1 in which the lubricant is palm oil.

4. A method as defined in claim 1 in which the lubricant is cocoanut oil.

WILLIAM S. ALLEN.

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