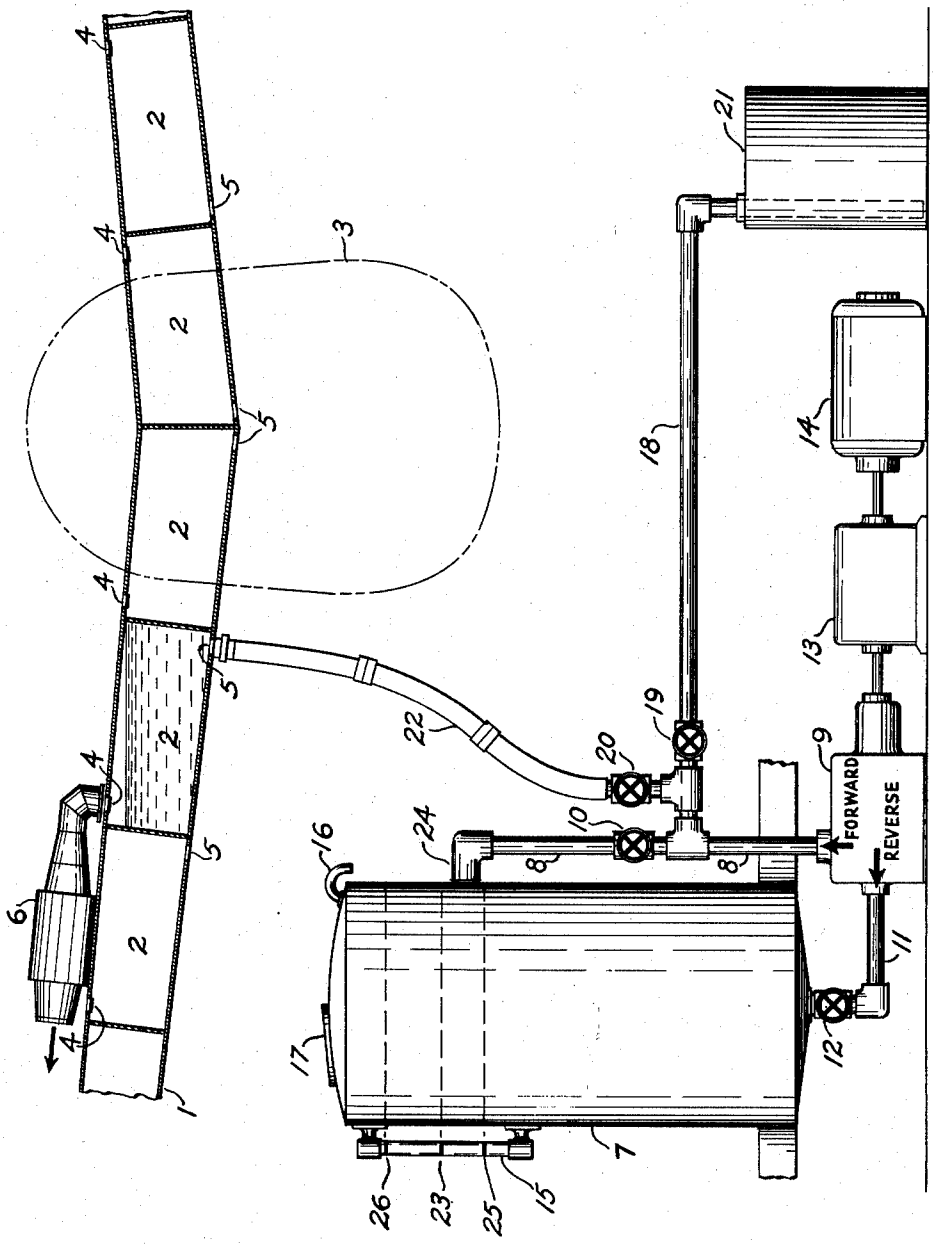
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PROCESSES FOR COATING THE INTERIOR SURFACES OF TANKS

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PROCESSES FOR COATING THE INTERIOR SURFACES OF TANKS

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My invention relates to processes for coating the interior surfaces of tanks, particularly the leakproof coating of metal gasoline tanks in the wings of aircraft.

It is an object of my invention to provide a more effective method of applying a coating to the interior surfaces of tanks.

Another object is to provide a method of controlling the thickness of the coating being applied, the thickness being variable as desired.

Still another object is to eliminate the possibility of air bubbles forming in or under the coating and causing eventual impairment thereof.

A further object is to ensure complete coverage of the more inaccessible areas, i. e. corners, crevices, underneath and between structural members such as hat beams, channels, etc., common in the wing tanks of airplanes.

Still a further object is to facilitate the thorough drying and setting of the coating after application.

Other objects are apparent in the description of my invention as hereinafter set forth.

The present application is a continuation-in-part of my earlier application, Serial No. 521,478, filed February 7, 1944, for Processes for Sealing Metal Tanks and now abandoned, and I reserve such earlier date for all common subject matter set forth in said applications and claimed herein.

My improved process facilitates the application of a continuous coating, extending over the entire inner surface of the tank and including those areas behind hat beams, channels, etc., which cannot be satisfactorily reached by methods now in common use. This is accomplished by pumping a liquid through an opening at the bottom of the tank until all air in the tank is displaced by said liquid. In so doing, the air within the tank is dispelled through an opening at the top as the liquid rises. In this manner the liquid remains unagitated and the formation of air bubbles is avoided. After the tank is full, the liquid is pumped out through the same opening by reversing the pump, and the speed of draining is controlled by the manipulation of valves. While the liquid is being drained, a pressure drop within the tank above the liquid level is effected by a suction unit installed at an opening in the top of the tank. The speed of draining will control the thickness of the residual coating which remains on the inner surface of the tank, and that thickness is maintained by simultaneously reducing pressure within the tank, which causes the volatile solvent in the coating to evaporate. At the same time, the solvent vapors within the tank are dispelled and are not permitted to accumulate sufficiently to dissolve the said coating.

Prior to my invention, the methods of applying inner coatings to tanks included the methods of

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spraying, brushing and sloshing. The spraying process mixes air with the material to be sprayed. Ordinarily this air is released after the coating has been applied. In the case of viscous materials, however, air which has been mixed with the material being sprayed cannot be readily released after the coating has been applied. Also, the spraying process cannot produce a coating on inaccessible areas such as the inside of hat beams, etc. Spraying produces a heavier coating on surfaces which protrude and produces a thinner coat on the areas of recesses. Therefore, when applied by a spraying process, the coating is heaviest where thickness it not needed and vice versa. An example of this is a rivet head; the build-up of material would be on top of the rivet head instead of forming a fillet at the juncture of the head's edge and the tank surface. This is true regardless of how the spray gun may be maneuvered to satisfactorily fillet a rivet head or other joints which require filleting for proper sealing.

Brushing creates air bubbles in the body of the liquid since air is picked up when the brush is dipped into a container as well as during application of the liquid on a surface. These bubbles have a tendency to expand at high altitudes, sometimes bursting, resulting in a rupture of the coating. Also, brushing cannot be used to reach inaccessible places such as the inside of hat beams, nor can it produce a uniform coating which will be of sufficient thickness where needed.

Sloshing, which means partial filling of a tank and then rotating the tank, or partial filling of the tank and slopping the liquid into various areas, also admits air into the liquid, thus forming bubbles. This air is entrapped in the liquid during the splashing action which takes place. There is no control of the movement of liquid during sloshing, therefore, there is no control of the thickness of the film produced. A viscous liquid cannot be rotated in the tank because there is no control of the draining of the liquid. Therefore, a material with the consistency of a heavy syrup, if rotated, would produce a film that would be entirely unsatisfactory, together with the fact that the material may easily webb throughout the inside of the tank. Also, such a method is not practical for use with integral tanks in the wings of airplanes, because of the size and weight involved.

Other methods have been used which involve pumping a liquid coating material into the tank to be sealed, but these have not been entirely satisfactory for several reasons, including a lack of means for controlling the thickness of the coating, or for maintaining a proper consistency of the coating material during operation, as well as a means for eliminating the formation of air bubbles in or under the coating.

With my improved process, however, my controlled pump fill and drain method of application produces a film which is impossible to produce by any of the former methods of application. The coating is heavier at areas where that is desirable, fillets being formed around the heads of rivets, in corners, crevices, etc. This process of application is carried out in a relatively short time, and is therefore advantageous as a production process.

The accompanying drawing, which schematically illustrates a preferred arrangement for carrying out my invention is a composite view, including a sectional view of an airplane wing assembled to a fuselage, and an elevation, showing a general arrangement of apparatus.

Referring to the drawing, the airplane wing 1, including built in fuel tanks 2, is shown assembled to the fuselage 3. The said tanks are provided with the customary filler ports 4 and drain ports 5. Atop the wing 1 is a suction unit 6, shown with its intake opening positioned over the filler port of the tank to be coated. This suction unit is preferably of the construction disclosed in my Patent 2,421,877. Located conveniently underneath the wing is the liquid coating material reservoir 7. Coupled to the side of the said reservoir is pipe 8, communicating with the pump 9, and provided with a valve 10, the said pump 9 being connected with the bottom of the reservoir by pipe 11 which is provided with a valve 12. The said valve 12, having no part in the actual coating operation, remains open at all times, except in cases of repairs. The pump 9 is shown connected to the gear box 13 which in turn is connected to the reversible motor 14. Shown mounted to the side of reservoir 7 is a liquid level gage 15, and atop the said reservoir are provided an air vent 16 and an inspection opening 17. Connected to pipe 8, immediately below valve 10, is a pipe 18 provided with valves 19 and 20, the said pipe 18 extending to the bottom of supply container 21. For illustrative purposes, the said supply container 21 is representative of a five gallon can, such as is commonly used for the shipping and storage of liquid and semiliquid materials. Extending between valve 20 and the tank 2 to be coated, is a flexible hose 22, made up of coupled sections so that it may be shortened or lengthened as desired.

The reservoir 7 is first charged with liquid coating material pumped into the bottom from the supply container 21. During this initial operation the valves 10 and 20 remain closed and valve 19 remains open. The pump is actuated in its reverse direction as shown on the drawing, and the liquid is pumped through the pipe 18, down the lower portion of the pipe 8, through the pump 9 and pipe 11, into the bottom of the said reservoir 7.

The pumping is continued until the liquid has risen to a level immediately below the orifice of the pipe fitting 24 as indicated by the mark 25 on the liquid level gage 15, at which time the pump is stopped. To prevent the entrapment of air and the consequent formation of air bubbles in the coating material, all air is purged from pipe 8. This is accomplished by closing valve 19, opening valve 10, and actuating the pump slowly in a forward direction until the liquid drawn from the bottom of the reservoir has displaced the air in said pipe 8 and begins to flow back into the reservoir through the orifice of fitting 24, at which time the pump is again stopped. This flow of liquid from fitting 24 may be observed by an operator, through the uncovered inspection opening 17. The reservoir charging operation is then resumed, by closing valve 10, opening valve 19, and actuating the pump 9 in its reverse direction, again pumping the liquid in through the bottom of said reservoir 7, until a pre-established maximum level as indicated at 26 has been reached. In the course of this initial operation, the contents of many five gallon cans, such as is represented by supply container 21, may be consumed. When necessary, due to thickening of the liquid coating material within the reservoir, pure solvent may be added in this same manner.

Immediately prior to the actual coating operation, the liquid coating material is thoroughly stirred to ensure an even mixture of its constituent parts. Valves 19 and 20 are closed and valve 10 is opened, leaving a clear passage through pipe 8. When the pump 9 is actuated, the liquid is pumped from the bottom of the reservoir 7, through pipe 11 and up through pipe 8, back into the said reservoir 7. Thus, the stirring is accomplished by subsurface circulated flow. It may be seen that with the reservoir filled, the circulated liquid rejoins the main body of liquid at a point underneath the surface level and the formation of air bubbles is avoided, since the surface is never disturbed. For this reason, the stirring operation is carried out only when the liquid level is above the minimum line 23, which is above the fitting 24. When the liquid level gage 15 indicates this minimum level, more coating material may be pumped into the bottom of the reservoir in the same manner as described for the initial charging operation.

Following the stirring operation, the flexible hose 22 having been coupled to the drain port 5 of the tank to be coated, and the suction unit 6 placed atop the wing 1 with its intake opening positioned over the filler port 4 of the said tank, the operator proceeds as follows:

The valves 10 and 19 are closed, and valve 20 is opened. Pump 9 is then actuated in its forward direction and the liquid coating material is pumped from the bottom of the reservoir 7, and up pipe 8, through the flexible hose 22 and into the tank to be coated 2, as illustrated. The pumping is continued until the tank is filled. In cases of complicated structure within the tank to be coated, i. e., hat beams, channel members, gussets, etc., it is desirable that the pumping operation be carried out intermittently, pausing at intervals to permit the liquid to flow into all corners, crevices, etc., thereby displacing all air as the tank is filled. In all cases, whether intermittent or continuous, this pumping action is carried out at a sufficiently slow rate to avoid agitation and subsequent formation of air bubbles. When the tank has been completely filled, the pump is stopped, and the liquid is preferably allowed to remain for several minutes, depending upon the complexity of the structure within the tank, as previously explained. The pump 9 is then reversed and the liquid is pumped from the tank back into the bottom of the reservoir 7. The rate of flow during the draining operation, is regulated by adjusting valve 20. Such regulation is important since it is the factor controlling the thickness of the residual coating deposited upon the surfaces of the tank when the nonadhering portion of the liquid coating material is drained therefrom. This procedure is based upon the fact that when the speed of drainage exceeds the rate at which the liquid coating material would normally flow from the

surfaces of the tank, a thicker coating will adhere to those surfaces. This portion of my process employs a well known principle, which may be clearly illustrated by plunging a spoon into a container of molasses. If the spoon is withdrawn slowly a thin coating of molasses will remain thereon, whereas if the spoon is withdrawn rapidly a thick coating will adhere; the thickness of the coating bearing a direct relationship to the speed of withdrawal.

At the beginning of the draining operation, and simultaneously with the starting of the pump, the suction unit 6 is actuated. The said suction unit serves a dual purpose; first, to reduce the pressure within the tank as the liquid is being drained, and second, to exhaust all vapors remaining in the tank. By so reducing the pressure, the volatile solvent remaining in the residual coating will be rapidly removed by evaporation, thereby causing the said coating to solidify while maintaining a uniform thickness. Removal of the vapors is also important, since they would otherwise tend to keep the residual coating in a flowing liquid state. The amount of pressure reduction required along with the corresponding adjustment of the suction unit, is pre-established in accordance with the design of the tank to be coated, as well as the boiling characteristics of the solvent used in the coating material.

When the nonadherent portion of liquid has been completely drained from the tank, the flexible hose 22 is uncoupled from drain port 5, which is allowed to remain open. The suction unit 6 remains in operation until all remaining vapors are removed, fresh air being circulated through the open drain port 5. The suction unit 6 is then removed and the tank remains open until the residual coating has thoroughly dried.

It may easily be seen that my process can be used in cases where only a portion of the tank is to be coated, by regulating the amount of liquid coating material introduced into the tank.

Where I use the term "liquid coating material" in this specification and appended claims, I desire to be understood as meaning any liquid coating material containing a volatile solvent, a residual coating of which possesses the necessary resistance characteristics to fulfill the requirements at hand. For example, where a leakproof coating for gasoline tanks is desired, I use a coating material which has resistance to gasoline; and in cases where the coating will be in contact with contents other than gasoline, I use a coating material which has the necessary properties to resist attack by such contents. To be operative with my process, however, the coating material will in all cases contain a volatile solvent.

A few examples of sealants for various purposes which I have used successfully are:

In tanks for the storage of petroleum fuels and oils—a composition containing an alkyd type resin dissolved in ethyl acetate, and an inert material suspended in the solution of resin and volatile ethyl acetate.

In tanks for the storage of water—a vinyl chloride resin dissolved in a ketone type of solvent.

In tanks for the storage of methyl ethyl ketone —a trihydroxy-palmitic acid resin dissolved in an alcohol type of solvent.

In airplane septic tanks which must be resistant to urine—a phenolic type of resin dissolved in an alcohol type of solvent.

In tanks for the storage of ethyl alcohol—a cellulose acetate resin dissolved in an acetate type of solvent.

Where I use the term "subsurface circulated flow" in this specification and appended claims, I desire to be understood as meaning the system of circulation which involves drawing liquid from the bottom of a reservoir and returning it to the reservoir at a level just below the surface of the main body of liquid.

My invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment, as above set forth, is therefore to be considered in all respects as illustrative and not restrictive, the scope of my invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What I claim as new and desire to protect by Letters Patent is:

1. The process of forming a continuous leakproof coating on the bottom and sidewalls of a metal tank having a top closure provided with an inlet opening; and the tank bottom having a drain opening: comprising the steps of pumping into the drain opening a coating liquid composed of an organic resin dissolved in a volatile solvent until the bottom and side walls are covered with the coating liquid; pumping out through the drain opening the residue of the coating liquid at a rate fast enough to leave an adherent coating of the desired thickness while simultaneously withdrawing through the inlet opening the volatile vapors arising from the liquid coating at a rate sufficient to reduce the pressure in the tank below atmospheric pressure and promote evaporation of the volatile solvent from the coating on the sidewalls; and subsequently passing air into the drain opening and out through the inlet opening to remove any residue solvent vapors from the tank.

2. The process of forming a continuous leakproof coating on the bottom, sidewalls and top of a closed metal tank adapted to store gasoline, the top having an inlet opening and the bottom having a drain opening: comprising the steps of pumping into the drain opening a coating liquid composed of an alkyd resin dissolved in ethyl acetate until the sidewalls and top are covered with the coating liquid; pumping out through the drain opening the residue of the coating liquid at a rate substantially faster than the coating liquid flows from the sidewalls under the action of gravity to thereby secure an adherent coating on the metal of adequate thickness, while simultaneously withdrawing through the inlet opening the volatile ethyl acetate vapor arising from the adherent coating at a rate sufficient to reduce the pressure in the tank substantially below atmospheric pressure to thereby promote the rapid evaporation of the ethyl acetate and hasten the setting of the adherent coating.

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