

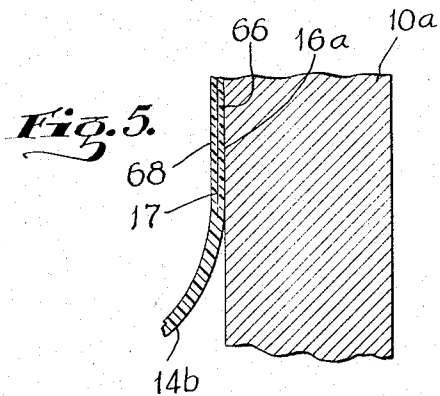
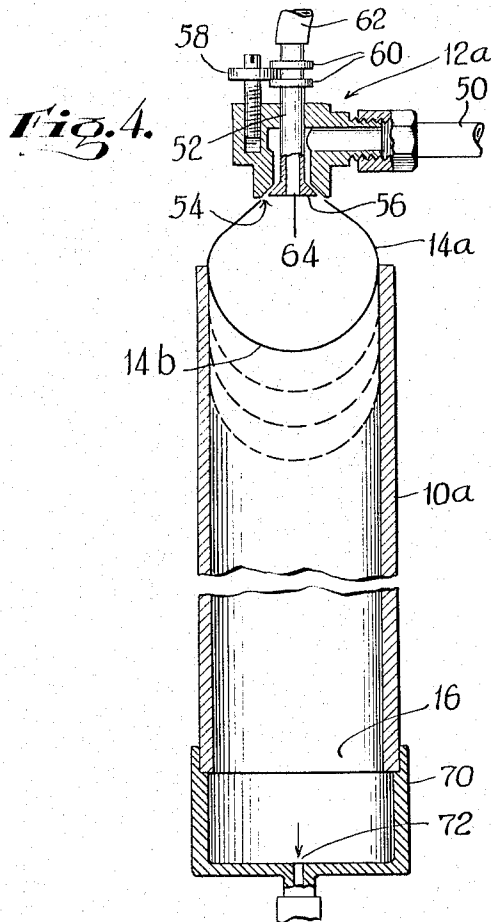
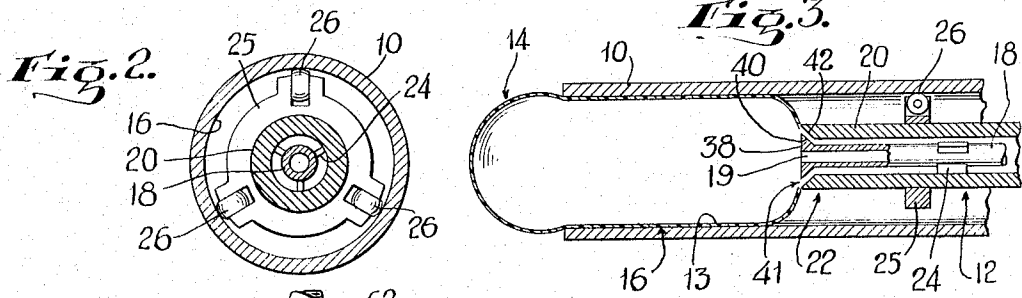
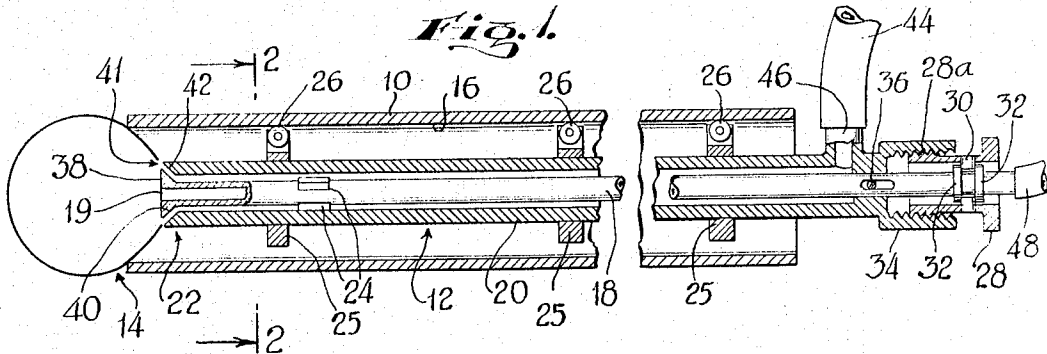
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APPARATUS FOR COATING TUBES

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APPARATUS FOR COATING TUBES

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This invention relates to methods for coating the interior surface of tubes such as pipes, cans, and the like, and specifically to apparatus for applying such coatings. More particularly the invention relates to the coating of tubes by the laying down of a bubble of coating material along the interior of the tube.

Heretofore the principal methods of coating the interiors of tubes have been by a rotating spray within the tube or by centrifuging the tube with coating material therein. These prior art methods have not been entirely satisfactory, however, since it is difficult to control the coating thickness and the uniformity of coating along the interior of the tube in such methods as spraying. In the prior art methods of centrifuging, the cost of applying coatings has been relatively high. Precise alignment of the rotating tube must be maintained to keep the interior coating as uniform as possible, and the apparatus is expensive and the methods are time-consuming.

Thus these prior art methods have been quite expensive in use and somewhat limited in application. For example, it is prohibitively expensive to centrifuge a coating on the interior of a small tube such as a can.

Accordingly it is an object of the present invention to provide a method of applying a thin film coating to the interior of a tube.

Another object of the invention is to provide a method of the above character wherein the film is applied to the walls of the tube as a wall film of a bubble of coating material.

A further object of the invention is to provide a method of the above character wherein a bubble of coating material is drawn through the tube to deposit a coating film in the tube.

Another object of the invention is to provide a method of the above character wherein a bubble of coating material is forced through a tube by gas pressure to deposit a coating film as it progresses through the tube.

A further object of the invention is to provide apparatus for carrying out the above methods.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others, and the apparatus embodying features of construction, combination of elements and arrangement of parts which are adapted to effect such steps, all as exemplified in the following detailed disclosure, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawing, in which:

FIGURE 1 is a broken sectional side view of one embodiment of my tube coating apparatus.

FIGURE 2 is an end sectional view taken along lines 2-2 of FIGURE 1, looking in the direction of the arrows.

FIGURE 3 is a partial side sectional view of the apparatus in FIGURE 1 showing the application of the tube coating.

FIGURE 4 is a broken side sectional view of another embodiment of the invention.

FIGURE 5 is a partial enlarged sectional view of the tube wall and bubble film as the coating is being applied by the apparatus in FIGURE 4.

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In general the invention comprises the movement of a bubble of coating material through a tube to be coated, wherein the bubble of coating material is slightly oversized so that the walls of the bubble will contact and adhere to the interior surfaces of the tube, and advance along the tube. As shown in FIGURE 1, a tube 10 to be coated has bubble forming apparatus 12 centrally positioned therein. A bubble 14 of coating material is formed at the tube end, and as the apparatus 12 is withdrawn through the tube, further coating material is supplied through the bubble forming apparatus to apply the continuous bubble wall film to the interior of the tube as shown in FIGURE 3. As shown in FIGURES 1 and 3, the unconfined diameter of the bubble is slightly larger than the diameter of the tube through which it is to be drawn, thus ensuring application of the bubble film wall over the entire inner surface of the tube.

As shown in FIGURE 4 the bubble of coating material may also be forced through the tube 10a by bubble forming apparatus 12a to deposit a bubble film over the interior of the tube. In this embodiment gas pressure may be supplied to the interior of the bubble from the bubble apparatus 12a or the bubble of coating may be drawn through the tube by a partial vacuum created in the lower end 16 of the tube 10a. In this embodiment the liquid forming the coating material 66, 68 will be in liquid shear in the region 17 as it is deposited, as shown in FIGURE 5.

A coating film applied in accordance with my invention will be quite uniform because of equalizing surface tension in the bubble wall before the coating is applied. Further, the film can be made extremely thin while maintaining uniform thickness over the interior of the tube. The thickness of the applied coating may be varied by adjusting the viscosity and temperature of the coating material as it is supplied by the apparatus as the bubble is moved through the tube. In both embodiments the bubble film is pressed into contact with the tube interior by providing a bubble having a "free" or unconfined diameter larger than the diameter of the tube to be coated.

The invention will now be described in more detail. Referring now to FIGURES 1-3, it will be seen that the tube 10 to be coated has the coating apparatus 12 in position to apply a bubble film coating 13 to its interior surface 16. The coating apparatus comprises two coaxially positioned conduits 18, 20 for feeding coating material and gas to the bubble forming end portion 22. Conduit 18 supplies a slight gas pressure to the interior of the bubble and is centered within conduit 20 by centering lugs 24. Conduit 20, through which the coating material flows, is centered within the pipe by a number of centering rollers 26 journaled in a ring bracket 25.

The gas conduit 18 is axially adjustable within conduit 20 by means of a threaded control 28 having lugs 30 which engage shoulders 32 on conduit 18. Threaded portion 28a of control 28 engages threads in sleeves 34 which is an extension of conduit 20. Conduit 18 is keyed at 36 to keep it from rotating during axial adjustment.

As best seen in FIGURES 1 and 3, the bubble forming end 22 of the apparatus comprises a horn-shaped end 38 of conduit 18, the exterior flaring surface 40 of which is generally parallel to the end surface 42 of conduit 20 to form an annular opening 41 therebetween. Thus axial movement of conduit 18 will vary the width of opening 41 to permit more or less fluid to pass to the bubble wall.

Coating material is supplied from a source (not shown) through a flexible conduit 44 which communicates with the interior of conduit 20 through a fitting 46. Slight gas pressure inside the bubble is supplied as required through a flexible conduit 48 which is fitted to the end

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of gas conduit 18. It should be understood that the rate of flow of coating material through conduit 44 and of gas flow through conduit 48 may be regulated by appropriate valves (not shown). The rate of flow of material depends on such factors as rate of application of the coating and the temperature and viscosity of the coating material, and the setting of the annular opening 41 at the end 22 of the apparatus. The rate of gas flow through conduit 48 and subsequently through conduit 18 also depends upon the rate of application of the coating and the properties of the bubble wall which is formed. In some instances opening conduit 48 to the atmosphere will be sufficient, since air will be drawn into the bubble and coated portion of the tube as shown in FIGURE 3, when the apparatus is moved through the tube to be coated.

Operation of the embodiment shown in FIGURES 1-3 is as follows. First the apparatus 12 is positioned in the tube as shown in FIGURE 1 with the end 22 adjacent the end of the tube 10. The width of the annular opening 41 is set by control 28 and the feed rate and temperature for the coating material is set. A bubble 14 is formed by passing a plate or blade (not shown) over the opening of conduit 18. A slight increase in gas pressure through conduit 18 will form the bubble and control of gas pressure within the bubble will keep it at a "free" diameter slightly larger than the interior diameter of the tube to be coated. As shown in FIGURE 3, the coating apparatus 12 is then withdrawn through the tube while coating material is supplied through the opening 41 and gas is supplied through the opening 19 of conduit 18 to the interior of the bubble. Since the bubble is slightly oversized, pressure inside the bubble causes it to adhere to the interior of the tube 10 as the coating apparatus 12 is withdrawn. The centering rollers 26 keep the apparatus substantially centered within the tube as the apparatus 12 is moved therethrough.

A second embodiment of the invention is shown in FIGURES 4 and 5 wherein bubble forming apparatus 12a may be fixed in relation to the tube 10a to be coated. In this embodiment coating material is metered through conduit 50 while gas is fed to the interior of the bubble 14a through conduit 52. Similar to the embodiment shown in FIGURES 1-3, the annular opening 54 around the horn-shaped end 56 of conduit 52 is adjusted through adjusting screw 58 which engages collars 60 on conduit 52.

The rate of flow of coating material through conduit 52 will again depend on the viscosity and temperature of the material to be applied as well as the width of the opening 54 and the rate of application of the bubble film to the interior walls of the tube 10a. In this embodiment gas pressure is supplied through conduit 62 to conduit 52 and subsequently to the interior of the bubble 14a. Since it is the gas pressure which moves the bubble through the tube to be coated, the rate of gas supply will be governed primarily by the wall thickness and strength of the bubble 14a which is to be forced through the interior of the tube 10a.

In operation a bubble film is formed over the end opening 64 of gas conduit 52 by means of a plate or blade and the bubble is expanded by gas pressure and while still slightly smaller in diameter than the tube 10a, one end of the tube is positioned around the bubble. Gas pressure is then increased to expand the bubble against the walls of the tube. A further increase in gas pressure causes the bubble end wall 14b to progressively move down the tube as shown by dashed lines, thus depositing a coating of the bubble film wall on the interior of the tube. Care should be taken in positioning the bubble forming apparatus 12a close enough to the tube end so that expansion of the bubble does not occur outside the tube.

As shown in FIGURE 5, the coating material will be in shear within the interior of the elongated bubble as the deposited film 66 of the coating material adheres to the surface 16a of tube 10a. The shear line is illustratively

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shown at 17 wherein the more fluid material 68 rides over the already deposited film layer 66 as coating material is fed to the bubble as it is moved down the length of the tube 10a by gas pressure.

As shown in FIGURE 4, the gas pressure required to move the bubble 14a through the tube may also be supplied by placing a suction head 70 around end 16 of the tube 10a wherein a partial vacuum is created ahead of the bubble wall 14b through opening 72 to pull the bubble through the tube to be coated.

The invention provides a very uniform coating over the interior of the tube due to equalizing of the bubble wall thickness by surface tension as the bubble is formed prior to being deposited on the tube wall. Further, the thickness of the coating to be applied can be varied by the temperature, viscosity or rate of application of the coating material as it is laid onto the interior of the tube.

A great number of materials may be used for such coatings such as various types of plastics, elastomers, and the like. In some instances the coating material may be a molten metal or glass, in which case the materials of the bubble forming and applying apparatus are designed to function at the high temperatures at which the material remains molten.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in carrying out the above method and in the construction set forth without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention which, as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. Apparatus for applying a coating to the interior of a tube comprising, in combination,

(A) a first conduit for liquid solidifiable coating material having

(1) a connection to a source of liquified coating material,

(2) and an open end portion,

(B) a second conduit for gas positioned within said first conduit, said second conduit having

(1) centering means thereon for maintaining said second conduit coaxial with said first conduit,

(2) a connection to a source of gas,

(3) and an open end portion,

(C) said end portions of said conduits forming an annular extrusion orifice therebetween for the passage of coating liquid around the open end of the second conduit,

(D) support means positioning the first conduit relative to the tube

(1) with associated means for adheringly applying a bubble of the coating material extruded through the orifice first to the interior of one end of the tube and then progressively down the remainder of the interior surface of the tube while liquid coating material is continuously extruded through the orifice to expand the bubble along the length of the tube

(E) and control means adjustably connecting the conduits for varying the width of the annular extrusion orifice between the ends of the conduits.

2. Apparatus as defined in claim 1 wherein

(C)(1) said control means comprises

(a) an inwardly bevelled edge around the end of said first conduit,

(b) a horn shaped enlargement on the end of said second conduit within said bevelled edge, and

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(c) means for varying the axial position of said second conduit with respect to said first conduit to vary the distance between said bevelled edge and said horn shaped end.

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