

April 27, 1948.

W. LANGER

2,440,339

TUBE OF FLEXIBLE COMPOSITE SHEET MATERIAL AND THE MANUFACTURE THEREOF

Filed Nov. 24, 1942

2 Sheets-Sheet 1

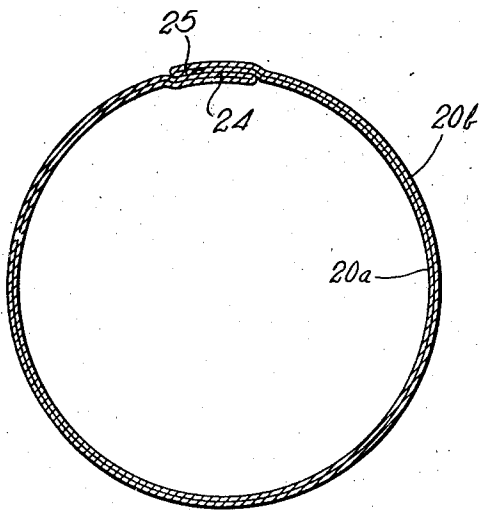


Fig. 1.

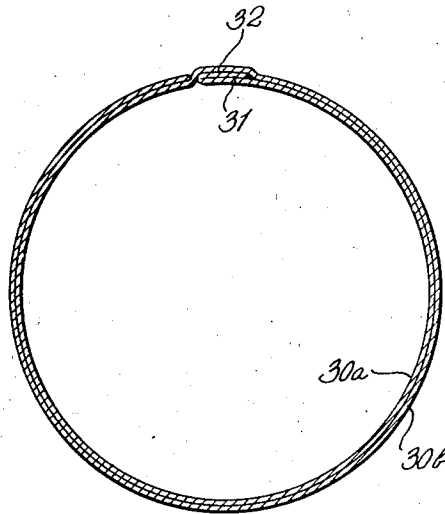


Fig. 3.

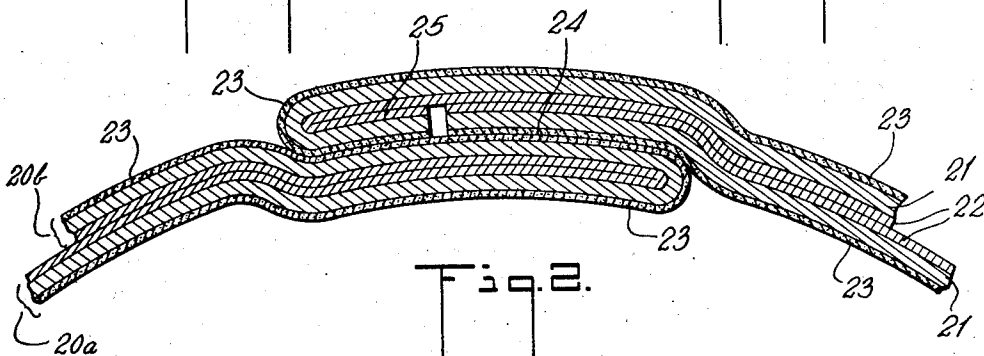


Fig. 2.

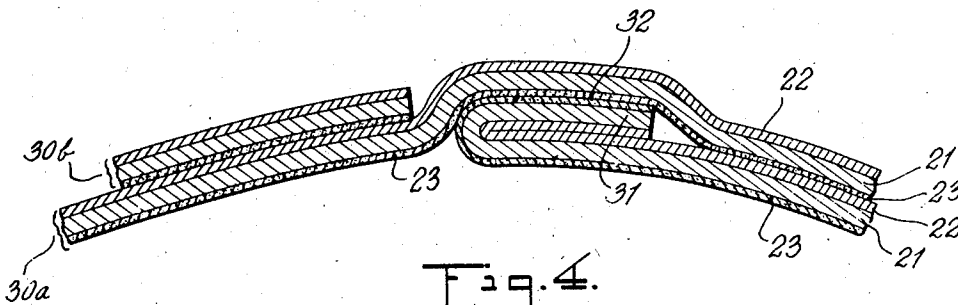


Fig. 4.

INVENTOR

Walter Langer

BY

Kearney Kearney
ATTORNEYS

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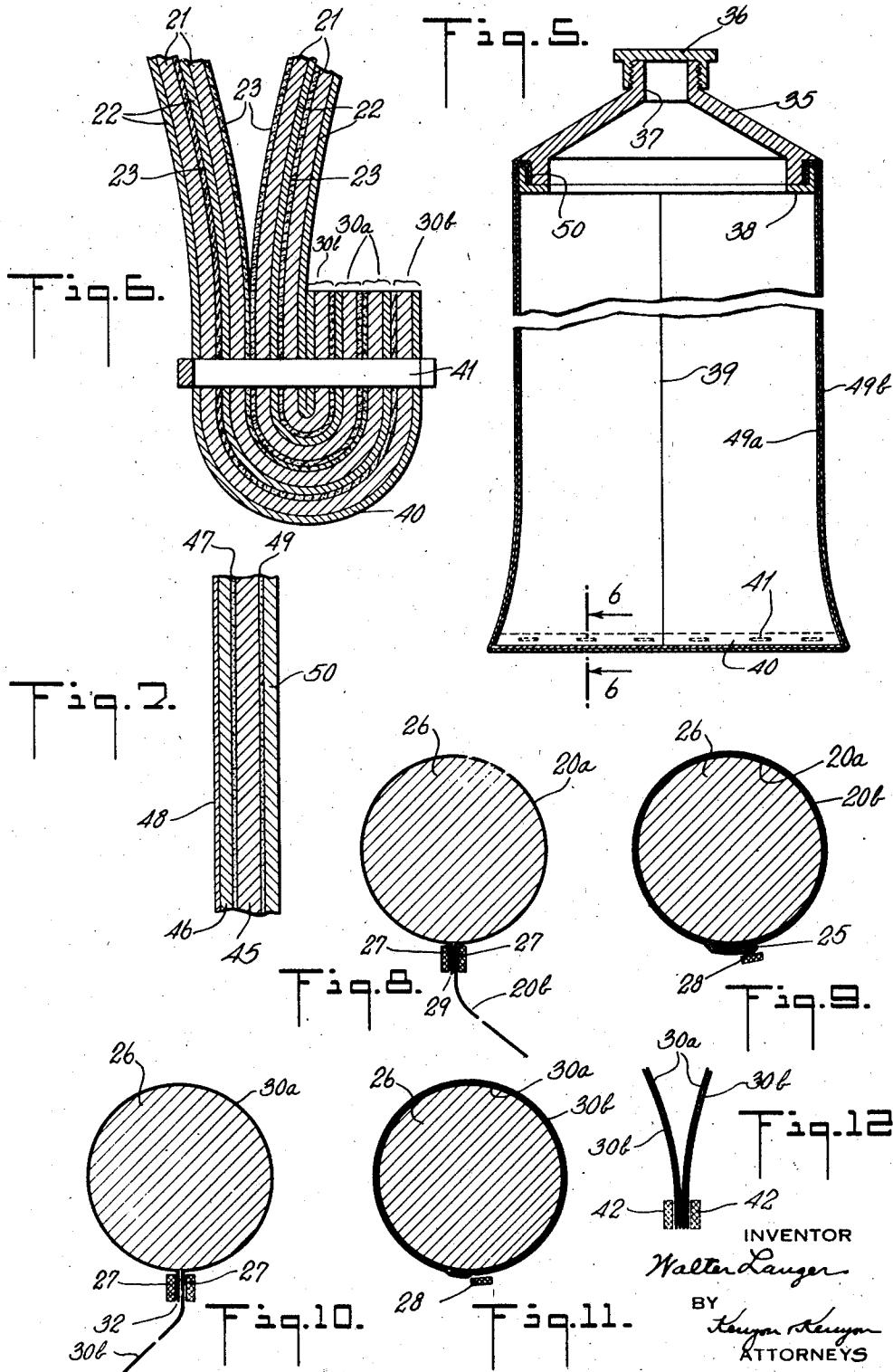
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TUBE OF FLEXIBLE COMPOSITE SHEET MATERIAL AND THE MANUFACTURE THEREOF

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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

2,440,339

TUBE OF FLEXIBLE COMPOSITE SHEET
MATERIAL AND THE MANUFACTURE
THEREOF

Walter Langer, New York, N. Y.

Application November 24, 1942, Serial No. 466,724

8 Claims. (Cl. 138—53)

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This invention relates to collapsible tubes made of flexible composite sheet material. It is of a particular utility for use as the tube portion of so-called "tubes" which are extensively used for packaging drugs, cosmetics, paints, etc., for example, toothpaste, cold cream, oil colors and the like.

Heretofore collapsible tubes of the character aforesaid for packaging materials of a plastic or pastelike consistency have been made with a relatively rigid head portion and a tube portion of flexible sheet material that is secured to the head portion, the tube portion being made of tin or of a tin alloy. Usually both the head and tube portions are composed of tin or tin alloy. However, it has also been proposed to substitute other materials for tin or tin alloys in both the head portion and the tube portion of tubes of the type in question. Thus it has been proposed to use paper, cellulose films, etc., as the flexible sheet material of the tube portion of collapsible tubes. It has also been proposed to use various molded plastic materials, wood, metal, etc., as the head portion of such tubes. However, collapsible tubes which utilize as a substitute some material other than tin or tin alloys have not been successful commercially due to a number of factors. Thus, when paper, sheet cellulose or the like is used as the flexible sheet material of the tube portion, the sheet material is not sufficiently impermeable either to water or to oils, regardless of the type of impregnating or coating materials heretofore suggested for rendering such sheet material impermeable. Moreover, regardless of the original impermeability of the sheet material, it tends to develop cracks and flaws during manufacture and assembly of the tube and as a result of flexure during usage. Moreover, many materials react disadvantageously with the contents of the tube and this greatly limits the type of substance that can be used in direct contact with the contents of the tube.

As aforesaid, one of the problems incident to providing a flexible sheet material other than an all-metal sheet such as a sheet composed of tin or tin alloy is that of providing impermeability to water and to oil. When the flexible sheet material contains as a base some substance other than metal, e. g., paper, fabric, sheet cellulose, or the like, impermeability can be afforded by providing adherent to a surface thereof and integral therewith a metal foil. Metal foil can be made extremely thin while preserving its impermeability to water and to oil. In my application Serial No. 464,034, filed October 31, 1942, for Collapsible

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tube, said application having been abandoned, I have disclosed the employment of crepe metal foil integrally bonded with a base sheet of paper, fabric, sheet cellulose, or the like as the tube portion of collapsible tubes.

In the manufacture of tubes consisting entirely of metal such as tin or tin alloy, the tube can be made of seamless construction. Elaborate mechanisms for producing thin tubular metal bodies which are seamless are resorted to in order to eliminate the difficulties that are incident to the occurrence in the tube body of a collapsible tube of a longitudinally-extending seam. While, as a manufacturing operation, it is less expensive to wrap thin sheet metal about a mandrel and cause the metal to adhere at a longitudinal seam, no satisfactory method has been proposed, so far as I am aware, for producing a permanent and liquid-tight seam. When a metal foil is used as a surfacing for a sheet of paper or the like, production of seamless tubing is not possible and it becomes necessary to provide a longitudinal seam. Attempts have heretofore been made to seal overlapping ends of composite sheet material carrying metal foil on one side thereof by means of an adhesive. However, in attempting to bond the inner or non-metallic surface of the sheet material with the outer metal foil surface, the adhesion is defective. The seam tends to pull apart and points of leakage are likely to develop. This is very undesirable, not only due to possible loss of contents of the tube, but also from the point of view of gradual drying out and hardening of the contents of the tube, so that the contents become unusable. Moreover, any oily material which exudes gradually from a tube is highly objectionable due to its soiling tendency.

It is a purpose of this invention to provide a tube construction and a method of making tubes whereby a permanent liquid-tight seam is provided utilizing flexible composite sheet material containing metal foil. It is a further purpose of this invention to provide a liquid-tight seal at one end of a tube of flexible sheet material.

According to one feature of the present invention, a sheet of flexible composite sheet material—comprising a strain-resisting sheet of non-metallic sheet material, one surface of which carries integrally therewith a layer of metal foil, the opposite surface being non-metallic—is formed into a tube which is characterized by a longitudinally-extending seam and which is further characterized by the fact that, in the region of the seam, longitudinally-extending portions of the non-metallic surface of the flexible composite

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sheet material are brought into juxtaposition and are bonded together face-to-face with adhesive material that is between the juxtaposed portions of the non-metallic surface of the sheet. In preferred construction, the flexible composite sheet material extends beyond the primary seal in the zone of initial juncture of the flexible composite sheet material so as to provide an extension which is wrapped about the tube for a substantial distance, the end of the extension being bonded to the surface of the tube. Preferably, the extension is wrapped in such direction that the non-metallic surface of the strain-resisting sheet is outermost and is carried about the tube beyond the region of the primary seal, the end of the extension being turned under to provide a non-metallic surface which is made adherent to the exposed non-metallic surface of the extension. Alternatively, the extension may be wrapped about the tube in the opposite direction, namely, so that the metallic surface is outermost, and the non-metallic surface thereof made adherent to exposed metal surface of the tube.

In the manufacture of tubes having the structure aforesaid, it is preferable to employ, at least in the region where the sealing is to take place, an adhesive of the heat-sealing type. Such adhesive may be thermoplastic resin such as a vinyl resin or a thermo-setting resin such as a phenol-aldehyde type resin. According to this invention, the flexible composite sheet material is made into a tube and in the zone of initial juncture of the flexible sheet material the juxtaposed non-metallic surfaces thereof are subjected to heat with the heat-sealing adhesive therebetween, thus producing an impervious and permanent seal in this zone. Thereafter, when an extension of the flexible composite sheet material is wrapped about the tube, the end thereof can likewise be made adherent by employment of heat using a heat-sealing type of adhesive between the surfaces to be bonded together.

It is a further feature of this invention that the end of the tube may be conveniently sealed so as to provide a liquid-tight seal at the end of the tube by pressing together opposite sides of the tube with a heat-sealing type of adhesive between the surfaces to be bonded together. When the interior of the tube is lined with a material such as paper, fabric, sheet cellulose or the like, a very permanent and highly impervious seal can be provided at the end of the tube utilizing a heat-sealing type of adhesive.

It is an advantage of the present invention that metals more generally available than tin may be used. For example, lead or aluminum foil may be used. Lead is objectionable when used in direct contact with the contents of tubes when the tubes contain materials such as toothpaste, cold cream or the like which are to be introduced into the mouth or applied to the skin due to tendency of material in the tube to absorb lead with the resulting possibility of lead-poisoning. Aluminum foil is attacked by alkaline materials and cannot be used except in connection with the packaging of non-alkaline material. In using the construction of the present invention, the lining of the tube is composed of the strain-resisting sheet material together with suitable impregnating and bonding materials which prevent the contents of the tube from coming in contact with the metal foil.

Especially when a plurality of layers of non-metallic sheet material are used which are impregnated with insoluble impregnating materials

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and which are bonded together with insoluble bonding materials, the contents of the tube can be effectively prevented from contacting with the metal foil layer of the flexible composite sheet material in such way as to contaminate the contents of the tube. For example, on the inner side of the primary strain-resisting sheet, a sheet of waterproof sheet cellulose may be made adherent by an insoluble adhesive. The primary strain-resisting sheet is made adherent to the metal foil by another layer of insoluble adhesive material. Moreover, the outermost surface of the waterproof sheet cellulose layer can be given a coating of insoluble material. Preferably, this exposed coating on the non-metallic side of the flexible composite sheet material is composed of a thermoplastic material which can be used to effect a seal merely by application of heat in the manner hereinabove mentioned.

In connection with the foregoing, it is to be noted that, not only throughout the body portion of the tube, but also in the region of the seal, the contents of the tube are at all times out of contact with the metal foil. With the ordinary type of overlapping seam, the edge of the metal foil comes in contact with the contents of the tube even though the metal foil is lined.

Further purposes, features and advantages of this invention will be apparent in connection with the following description of certain embodiments of this invention which are shown for illustrative purposes only in the accompanying drawings, wherein

Figure 1 is a transverse section of a tube of flexible composite sheet material according to this invention;

Fig. 2 is a fragmentary section on a greatly enlarged scale of the seam portion of the tube shown in Fig. 1;

Fig. 3 is a transverse section of an alternative embodiment of the present invention;

Fig. 4 is a transverse section on a greatly enlarged scale of the seam portion of the tube shown in Fig. 3;

Fig. 5 is a longitudinal sectional elevation of a collapsible tube showing a tube portion of flexible composite sheet material according to the present invention attached at one end to a head portion and sealed at the other end;

Fig. 6 is a fragmentary sectional view on a greatly enlarged scale taken on the line 6-6 of Fig. 5;

Fig. 7 is a fragmentary sectional view on a greatly enlarged scale of a preferred type of flexible composite sheet material for use according to the present invention;

Fig. 8 is a transverse section of tubing that illustrates a preliminary step in the manufacture of a tube of the type shown in Figs. 1 and 2;

Fig. 9 is a transverse section of tubing that illustrates a step that follows the step illustrated in Fig. 8;

Fig. 10 is a transverse section of tubing that illustrates an initial step in the manufacture of the embodiment of the present invention shown in Figs. 3 and 4;

Fig. 11 is a transverse section of tubing that illustrates a subsequent step that follows the step illustrated in Fig. 10; and

Fig. 12 is a fragmentary sectional elevation of the closed end of the tubing which is illustrative of the step employed in sealing the end portion of a tube according to the present invention.

Referring to Figs. 1 and 2, the sheet material used in fabricating the tube is flexible composite

sheet material which comprises a strain-resisting foundation sheet 21 which, for example, may be of fibrous character such as paper, fabric or the like. Integrally carried by one surface of the strain-resisting sheet 21 is a layer 22 of metal foil. On the opposite side of the flexible composite sheet material is a coating which is normally non-sticky but which, when subjected to heat, becomes sticky and adhesive and is adapted to act as a bonding material. This coating 23, for brevity, will be referred to as an adhesive coating. The coating 23 presents the interior surface of the tube and is therefore referred to as being on the inner side of the flexible composite sheet material. The metal foil 22 is referred to as being on the outer side of the flexible composite sheet material.

Referring to the composite sheet material as a whole, the surface of the composite sheet material opposite to the metal foil 22 is referred to for the sake of brevity as the "non-metallic" surface of the flexible composite sheet material. The "non-metallic" surface of the flexible composite sheet material does not present a metal surface or a metal surface carrying adhesive directly on metal. The "non-metallic" surface of the flexible composite sheet material is the surface presented by a non-metallic sheet of paper, fabric, sheet cellulose or the like, either coated or non-coated with adhesive or other coating.

Referring to Fig. 1, no attempt is made to show the different layers 21, 22 and 23 of the composite sheet material, although it is to be understood that the sheet material of the tube shown in Fig. 1 is of the character shown on a greatly enlarged scale in Fig. 2 and described hereinabove. In Fig. 1, the inner or primary tube-forming layer of the flexible composite sheet material is indicated by the reference character 20a and the outer layer which is an extension of the layer 20a is indicated by the reference character 20b.

The inner layer 20a of the flexible composite sheet material is formed as a tube and, in the zone of initial juncture of the flexible composite sheet material, it is to be noted that longitudinally extending portions of the non-metallic surface of the flexible composite sheet material are brought into juxtaposition and are sealed face-to-face by the adhesive material 23. This sealed seam in the zone of initial juncture of the flexible composite sheet material is referred to as the primary seal and is indicated in Figs. 1 and 2 by the reference character 24.

The flexible composite sheet material, which is folded back on itself at the primary seal to provide the juxtaposed portions of non-metallic surface that are sealed face-to-face, is carried back from the region of the primary seal 24 and is wrapped about the primary tube (consisting of the layer 20a) to provide the extension 20b, and it is to be noted that in this extension the adhesive layer 23 is outermost. The extension 20b is carried about the outside of the tube beyond the region of the primary seal 24 until the end thereof overlies non-metallic surface of the extension of the flexible composite sheet material. The end of the extension has an inwardly turned portion 25 which presents a non-metallic surface portion that is in juxtaposition with a portion of the non-metallic surface of the extension 20b, these portions of the non-metallic surface being bonded face-to-face by the adhesive coating 23.

Referring to Figs. 8 and 9, the steps in the manufacture of a tube of the structure shown in Figs. 1 and 2 may be conveniently carried out by wrapping the composite flexible sheet material to form

the primary layer 20a of the tubing about a mandrel 26. In the zone of initial juncture of the flexible composite sheet material, the flexible composite sheet material is bent outwardly with longitudinally-extending portions of the inner non-metallic surface thereof in juxtaposition. The inner non-metallic surface of the flexible composite sheet material is, as aforesaid, provided with a coating which is of the heat-sealing type. Therefore, by use of suitable heated members 27, the primary seal 24 can be made by pressing the juxtaposed portions of the non-metallic surface of the flexible composite sheet material together, utilizing the members 27 which, being heated, cause the adhesive of the coating 23 to become activated so as to bond the juxtaposed portions face-to-face. Since each of the opposed non-metallic surfaces of the flexible composite sheet material carries the coating 23, the heat-sealing step can be carried out effectively with only an extremely brief application of heat and pressure. After the primary seal 24 has been formed in the manner illustrated in Fig. 8, the extension 20b is wrapped about the mandrel 26 as shown in Fig. 9, and the turned-over end portion 25 of the extension 20b can be bonded in place by use of the heated pressing member 28 which presses the turned-under non-metallic surface of the flexible composite sheet material against the underlying non-metallic surface of the extension 20b, and, since both of these surfaces carries the adhesive coating 23, the end of the extension 20b is effectively and rapidly bonded in place.

The advantages of the construction and method shown in Figs. 1, 2, 8 and 9 are several. In the first place, the seal which is produced and which is relied upon both for maintaining the integrity of the tube and for preventing seepage of the contents therefrom is effected by an adhesive bond that is between non-metallic surface portions of the flexible composite sheet material. In this manner, an effective seal which is permanent and which is impervious to water and oils can be provided notwithstanding the employment of a composite flexible sheet material which carries a metal foil that inherently does not lend itself to permanent and impervious bonding by means of adhesive materials. Furthermore, the primary seal which is effected at the initial juncture of the flexible composite sheet material is such that the contents of the tube are sealed without coming in contact with the metal of the metal foil. It is to be noted that none of the edge portion of the metal foil comes in contact with the contents of the tube.

It is a further advantage of the preferred embodiment of this invention shown in Figs. 1 and 2 that the flexible composite sheet material is provided with an extension which is wrapped about the tube so that the end thereof may be bonded in place by a seal effected by juxtaposed non-metallic surfaces of the flexible composite sheet material. Furthermore, the employment of the wrapped-around extension of the flexible composite sheet material gives bulk to the wall of the tube so that it will have mechanical properties closely resembling the mechanical properties of tubing made entirely of tin or of lead-tin alloy of the type heretofore used in the packaging of plastic and semi-fluid materials. Moreover, a double thickness of the metal foil is provided so that, notwithstanding possible occurrence of a flaw in the metal foil, the secondary layer of metal foil will provide good insurance against the

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occurrence of points of permeability due to the possible occurrence of flaws in the metal foil.

The exterior of the tube shown in Figs. 1 and 2 may be provided with any suitable ornamentation. In this connection, the external coating of heat-sealing adhesive 23 provides an excellent base for the application of an ornamental paint, lacquer or the like such as are customarily used for ornamenting, and for providing suitable lettering, designs, etc., on collapsible tubes. No attempt in Figs. 1 and 2 has been made to show any such external ornamental layer.

Referring to Figs. 3 and 4, an alternative embodiment of this invention is shown. In this embodiment, the flexible composite sheet material may, for purposes of illustration, be similar to that shown in Figs. 1 and 2 and may comprise the strain-resisting sheet 21, the outer layer 22 of metal foil integral with the sheet 21 and an inner layer 23 of normally non-sticky adhesive. The inner or primary layer 30a of flexible composite sheet material is formed as a tube with the non-metallic surface of the flexible composite sheet material on the inside. At the zone of initial juncture of the flexible composite sheet material, there is a turned-back end 31 which presents a longitudinally-extending portion of non-metallic surface that underlies another longitudinally-extending portion of the non-metallic surface of the flexible composite sheet material, these non-metallic portions being integrally bonded together by the adhesive of the layer 23 to form the primary seal 32. The flexible composite sheet material is carried beyond the primary seal 32 with the layer 22 of metal foil outermost to provide the extension 30b which is wrapped around the tube and which terminates as shown in the region of the primary seal 32.

In making a tube such as that shown in Figs. 3 and 4, and referring to Figs. 10 and 11, the flexible composite sheet material may advantageously be wrapped about the mandrel 26 and the primary seal 32 effected by pressing together outwardly-extending portions of the flexible composite sheet material having non-metallic surfaces in juxtaposition. By pressing these juxtaposed portions together, using the heated pressing members 27, the adhesive in the coating 23 of the juxtaposed surfaces is activated and the primary seal is effected. The extension 30b is then wrapped about the primary layer 30a of the flexible composite sheet material and the end thereof is pressed in place by the heated pressing member 28 to bond the end thereof to the underlying flexible composite sheet material. If desired, in making this modification, the entire extension 30b may be hot-pressed against the layer 30a so as to cause the adhesive 23 to adhere to the underlying layer 30a throughout the full extent of the extension 30b, thereby providing greater stiffness to the wall of the tube. Also, if desired, additional adhesive material of the heat-sealing type may be employed adjacent the end of the extension 30b by application of the adhesive to the surface to which the end of the extension 30b is to become bonded. If desired, the outer surface of the tube may have an ornamental coating of paint, lacquer or the like applied thereto.

In Fig. 5, a tube of flexible composite sheet material is shown as constituting the tube portion of a collapsible tube, the tube portion being united to a suitable head portion. The head portion is preferably of the structure shown in my application Serial No. 464,034 hereinabove referred to. In Fig. 5, the head portion is shown

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for purposes of illustration as including a head body 35 having a removable cap 36 which acts as a closure for the passage 37 through the head body. The tube of flexible composite sheet material is attached to the head body by the clamping ring 38, the flexible composite sheet material being brought up over the outside of the clamping ring 38 and folded inwardly as shown so as to securely hold the tube portion in place with the composite sheet material between the peripheral face 50 of the head portion and the inside of the upstanding wall portion of the clamping ring. The tube portion is shown in Fig. 5 for illustrative purposes as being composed of two layers 49a and 49b of flexible composite sheet material and these layers may be disposed in the manner shown in Figs. 1 and 2 or in Figs. 3 and 4, or otherwise in accordance with the present invention. The tube portion is shown as including the longitudinally-extending seam 39 which may be of the type shown in Figs. 1 and 2 or the type shown in Figs. 3 and 4, or otherwise in accordance with the present invention.

In Fig. 6, closure means for the lower end of the tube is shown, the layers of flexible composite sheet material being disposed for purposes of illustration as shown in Figs. 3 and 4. The end of the tube is brought together to provide the fold 40, the fold 40 being held in place by the staples 41. Alternatively, a metal clip of usual construction may be used to hold the fold in place. It is of advantage according to this invention that the lower end of the tube may be sealed in a liquid-tight manner by means of the heat-sealing adhesive coating 23. Thus, as illustrated in Fig. 12, the walls at the lower end of the tube may be brought together so that portions of non-metallic surface carrying the heat-sealing adhesive are juxtaposed, and these juxtaposed portions may be pressed together by means of heated pressing members 42, thereby bonding together these portions of non-metallic surface of the flexible composite sheet material. Thereafter the sealed end portion of the tube may be folded over and secured by staples as shown in Fig. 6. It is apparent that when the flexible composite sheet material in the wall of the tube is disposed as shown in Figs. 1 and 2 the end of the tube may be heat-sealed in a similar manner.

It is, of course, not essential that the head portion of a collapsible tube be of the structure shown in Fig. 5, although it is preferable to employ as the head portion to which the tube portion is secured a structure of any of the types described and covered in my said application Ser. No. 464,034. However, other types of head portion may be availed of. The head portion may be made of any suitable material such as formed plastic, wood, glass, metal, etc., as may be desired.

While the tube portion of flexible composite sheet material may be secured to the head portion merely by mechanical clamping, it is preferable in the practice of this invention to apply to the surfaces of the head portion that are to contact the flexible composite sheet material an insoluble cementary material. A thermoplastic cementary material such as a vinyl resin, or a sulfamide-formaldehyde resin is well suited for this purpose, although a cementary material of the heat-setting type may be employed, such as a phenol-aldehyde resin. Preferably, the insoluble cementary material is similar to that employed for the coating 23. Thus the clamping ring 38 and/or the peripheral face 50 of the

head body may be coated as by spraying, brush application, or the like with the insoluble cementary material. During or after assembly, the zone of the juncture between the tube body and the head portion of the collapsible tube may be heated to effect a heat-sealing of the cementary material, thus providing an impervious and permanent union between the head and tube portions of the collapsible tube. Especially when the assembled tube body presents a coating of the heat-sealing type both on the inside and on the outside, e. g., as in Figs. 1 and 2, the cementary adhesion of the surfaces of the flexible composite sheet material to the contacting portions of the head body is very effectively and quickly attained. In the embodiment shown in Fig. 5, this cementary adhesion is provided between the flexible composite sheet material and the peripheral face 50 on the one side and the upstanding wall of clamping ring 38 on the other side.

Referring to the foregoing embodiments of this invention, it is to be understood that they are merely illustrative and that embodiments of this invention may take a variety of forms. In the embodiments of this invention above described, the extension of the flexible composite sheet material that is carried beyond the region of the primary seal is wrapped around the tube so that the end of the extension occurs in the region of the primary seal. This is regarded as preferred construction, but is not essential. Thus the extension may be wrapped only part of the distance around the tube or may be wrapped throughout a plurality of turns about the tube. Likewise, the tube may be made without including the extension of the flexible composite sheet material that is wrapped about the tube. While the non-metallic surface of the flexible composite sheet material is shown disposed so as to provide the inner surface of the tube, it is possible to practice this invention utilizing the metal foil on the inside of the tube. However, it is regarded as preferable, especially when some material, such as lead, is employed as the metal foil, to use the non-metallic surface of the flexible composite sheet material as the interior of the tube and, at the initial juncture of the flexible composite sheet material, to seal together face-to-face portions of the non-metallic surface of the flexible composite sheet material without exposing any portion of the metal foil of the flexible composite sheet material to the contents of the tube.

The flexible composite sheet material may take several different forms. In Figs. 2, 4 and 6, the flexible composite sheet material has been shown as comprising a strain-resisting sheet, an adherent layer of metal foil, and on the side of the strain-resisting sheet opposite from the metal foil, a layer of heat-sealing adhesive. Preferably, however, the flexible composite sheet material is made as illustrated in Fig. 7. In this figure, the strain-resisting sheet is likewise composite in character and includes a sheet 45 which may be fibrous in character such as paper, fabric or the like. The sheet 45 has adherent thereto an essentially impervious sheet 46 such as sheet cellulose. Preferably, the sheet cellulose is of the waterproofed type so that it will be as nearly as possible impervious to liquids. For example, sheet cellulose which has had deposited thereon a film of insoluble soap or the like may be used. The sheet cellulose 46 is bonded to the sheet 45 by a suitable adhesive 47 which is insoluble and which may be, for example, a vinyl resin. The sheet 46 may carry an exposed coating 48 of heat-sealing

adhesive such as a coating of vinyl resin. Adherent to the other side of the sheet 45 by an adhesive 49 is the layer 50 of metal foil. The adhesive 49 is preferably an insoluble adhesive.

When the composite flexible sheet material is composed as shown in Fig. 7, the metal foil 50 is very effectively protected from the contents of the tube, the flexible composite sheet material being disposed so that the layer 48 of heat-sealing adhesive coating material is used as the inner surface of the tube. It will be noted that there are a plurality of layers of insoluble bonding material as well as a layer of waterproofed sheet cellulose material and a layer of fibrous material interposed between the interior of the tube and the metal foil. If desired, the sheet 45, if fibrous and absorbent, may be impregnated with an insoluble impregnating material.

In making the flexible composite sheet material, a variety of insoluble bonding agents may be used. For bonding the strain-resisting sheet to the metal foil, it is preferable to employ an adhesive resin such as polymerized vinyl acetate, vinyl acetate-vinyl chloride copolymer, sulfamide-formaldehyde resin, or the like. Such adhesives are both water- and oil-insoluble. For certain purposes, an asphalt adhesive may be used to bond the metal foil to the strain-resisting sheet material. Asphalt, while water-insoluble, has the disadvantage of being soluble in certain oils, however. For impregnating the strain-resisting sheet material and causing it to adhere to other lamina, cellulosic lacquer, drying oils, synthetic resins and the like may be employed such as those above mentioned. Adhesives of the character aforesaid may likewise be used as the inner coating for the flexible composite sheet material, since such adhesive materials provide a good normally non-sticky waterproofing coating and at the same time are thermoplastic so that opposed surfaces carrying the coating can be bonded together by heat-sealing.

It is not essential that the inner or non-metallic surface of the flexible composite sheet material be coated throughout with a heat-sealing type of adhesive. In such case, the heat-sealing type of adhesive may be used only in the region where opposed non-metallic portions of the surface of the flexible composite sheet material are sealed together. In such case, it is possible to use not only a thermoplastic adhesive but also an adhesive of the heat-setting type, such as a phenol-aldehyde resin which is adapted to become set upon application of heat.

For use in the flexible composite sheet material, a very thin metal foil can be employed, e. g. about .0005 inch or more in thickness. Preferably, the metal foil is about .00075 inch, or somewhat greater, in thickness. The metal foil is preferably creped as set forth in my application, Ser. No. 464,034, but this is not essential to the practice of the present invention. The metal foil can advantageously be made of lead which may, if desired, contain a very small amount of tin so as to improve its workability. When the flexible composite sheet material comprises strain-resisting sheet material and layers of impermeable cementitious bonding material, the contents of the tube are effectively prevented from contacting the lead, and by utilizing the special seam construction herein set forth, there is no danger of the contents of the tube contacting the lead foil in the region of the seam. However, other metal foils may be used such as tin, lead-tin alloys ranging from 1 to 99% of tin,

aluminum, silver, silver-cadmium alloys, etc. Other metallic surfaces, e. g., metallic films, are regarded as the equivalent of metal foil.

The strain-resisting sheet may, as aforesaid, be fibrous in character, such as paper, e. g., impregnated kraft paper, fabric or the like, or it may be a continuous sheet such as sheet cellulose. A glassine paper, preferably laminated with waterproofing material between the laminations, may also be employed. Such impervious glassine paper may be utilized to advantage in lieu of the layer of waterproofed sheet cellulose 46 referred to hereinabove in connection with Fig. 7.

The strain-resisting sheet of the character aforesaid is referred to broadly as "non-metallic" by way of contrast to the layer of metal foil that is adherent thereto. However, while this strain-resisting sheet is referred to as "non-metallic," this does not necessarily preclude the presence of an insoluble waterproofing material such as insoluble metal soaps or other salts or the presence of a filler or pigment material in the adhesive or in a coating for the strain-resisting sheet, which filler may be in the form of a metal oxide or the like.

While the flexible composite sheet material is shown in the drawings as of considerable thickness, the drawings have exaggerated the thickness of the flexible composite sheet material for purposes of clarity in the showing. As a matter of fact, the flexible composite sheet material can be made very thin and utilizing very little material. In such flexible composite sheet material, the metal foil is extremely thin and the amount of metal that is employed is only a minute fraction of metal required for making a tube having walls composed entirely of metal. Moreover, the present invention makes available inexpensive metal such as lead instead of a more expensive and rare metal such as tin. The flexible composite sheet material is very inexpensive to produce and can readily be formed into a tube in the practice of this invention.

While this invention has been described in connection with certain specific embodiments thereof, it is to be understood that this has been done for illustrative purposes only, and that the embodiments of this invention hereinabove described may be varied within the scope of this invention as defined in the following claims:

I claim:

1. A tube of flexible composite sheet material, said sheet material comprising a strain-resisting sheet of non-metallic sheet material the outer surface of which carries integral therewith a layer of metal foil, said tube being characterized by a longitudinally extending seam and by the fact that in the region of said seam longitudinally extending portions of the inner non-metallic surface of said flexible composite sheet material are brought into juxtaposition and bonded face-to-face by an adhesive to provide a primary seal which is the initial juncture of said flexible composite sheet material that provides the inner surface of said tube, the layers of said primary seal being integrally arranged in the superposed order metal foil, non-metallic sheet, bonding adhesive, non-metallic sheet, and metal foil, and by the further fact that one thickness of said composite sheet material is carried beyond said primary seal a substantial distance along the outer surface of said tube and is adherently bonded adjacent the end thereof to said tube to provide side wall of said tube extending substan-

tially completely thereabout so that the tube comprises a plurality of thicknesses of said composite sheet material substantially all around, said extension of said composite sheet material being adherently bonded to said tube as aforesaid by adhesive applied to the non-metallic surface thereof.

2. A tube of flexible composite sheet material, said flexible composite sheet material comprising a strain-resisting sheet of non-metallic sheet material the outer surface of which carries integrally therewith a layer of metal foil, said tube being characterized by a longitudinally extending seam and by the fact that in the region of said seam longitudinally extending portions of the inner non-metallic surface of said flexible composite sheet material are brought into juxtaposition and are bonded face-to-face by an adhesive to provide a primary seal which is the initial juncture of said flexible composite sheet material that provides the inner surface of said tube, the layers of said primary seal being integrally arranged in the superposed order metal foil, non-metallic sheet, bonding adhesive, non-metallic sheet, and metal foil, and by the further fact that one thickness of said composite sheet material is folded back on itself at said primary seal and is carried a substantial distance about the outside of said tube from said primary seal with said non-metallic surface of said flexible composite sheet material outermost to provide an extension which is wrapped at least once around said tube until the end thereof overlies the non-metallic surface of said extension, said end being turned under and adhesively bonded to an underlying portion of said extension so that non-metallic surface of said flexible composite sheet material adjacent the end of said extension is bonded face-to-face with non-metallic surface of said flexible composite sheet material also presented by said extension and with the layers of the composite material integrally arranged in the superposed order metal foil, non-metallic sheet, bonding adhesive, non-metallic sheet and metal foil.

3. A tube of flexible composite sheet material, said flexible composite sheet material comprising a strain-resisting sheet of non-metallic sheet material the outer surface of which carries integrally therewith a layer of metal foil, said tube being characterized by a longitudinally extending seam and by the fact that in the region of said seam longitudinally extending portions of the inner non-metallic surface of said flexible composite sheet material are brought into juxtaposition and bonded face-to-face by an adhesive to provide a primary seal which is the initial juncture of said flexible composite sheet material that provides the inner surface of said tube, the layers of said primary seal being integrally arranged in the superposed order metal foil, non-metallic sheet, bonding adhesive, non-metallic sheet, and metal foil, and by the further fact that one thickness of said flexible composite sheet material is carried beyond the region of said primary seal about the outside of said tube with the side carrying the metal foil outermost to provide an extension which extends substantially completely around the tube and which is adhesively bonded adjacent the end thereof to said tube.

4. A tube of flexible composite sheet material said flexible composite sheet material comprising a fibrous strain-resisting sheet the outer surface of which carries integrally therewith a layer

of metal foil, said tube being characterized by the fact that said strain-resisting sheet comprises integrally bonded with the surface thereof that is opposite to the surface thereof carrying the metal foil an essentially non-porous cellulosic sheet material and said tube being further characterized by a longitudinally extending seam and by the fact that in the region of said seam longitudinally extending portions of the inner non-metallic surface of said flexible composite sheet material are brought into juxtaposition with adhesive material therebetween and are bonded together face-to-face by said adhesive material thereby providing at said seam layers integrally arranged in the superposed order metal foil, non-metallic sheet, bonding adhesive, non-metallic sheet, and metal foil.

5. A method of making a tube utilizing flexible composite sheet material that comprises a strain-resisting sheet of non-metallic sheet material one surface of which carries integrally therewith a layer of metal foil, the opposite surface of said flexible composite sheet material being non-metallic, said method comprising wrapping said flexible composite sheet material about a mandrel with the non-metallic surface thereof on the inside, bringing longitudinally extending portions of said non-metallic inner surface of said flexible composite sheet material into juxtaposition in the region of initial juncture of said flexible composite sheet material and with heat-sealing adhesive material between said juxtaposed portions, applying heat to seal together said juxtaposed portions of non-metallic surface of said flexible composite sheet material face-to-face, carrying an extension consisting of one thickness of the flexible composite sheet material beyond said region of initial juncture and wrapping same substantially completely about the previously formed tube with the folding back on itself of one thickness of said composite sheet material at said region of initial juncture, bringing the non-metallic surface of said extension adjacent the end of said extension into juxtaposition with underlying peripheral surface of the tube with heat sealing adhesive between the last mentioned juxtaposed surfaces, and applying heat to seal together said last mentioned juxtaposed surfaces by means of said heat sealing adhesive therebetween.

6. A method of making a tube which comprises preparing flexible composite sheet material that comprises a fibrous strain-resisting sheet, a layer of metal foil integral with one side of said fibrous sheet, and integral with the opposite side of said fibrous sheet an exposed coating of heat-sealing adhesive material, forming said flexible composite sheet material into a tube with said coating of heat-sealing adhesive on the interior, bringing longitudinally extending portions of inner surface presenting said coating of said heat-sealing adhesive into juxtaposition in the zone of initial juncture of said flexible composite sheet material, pressing said juxtaposed portions together and applying heat thereto to bond together face-to-face said juxtaposed portions presenting said coating of heat-sealing adhesive material, carrying an extension consisting of one thickness of said flexible composite sheet material beyond said region of initial juncture and wrapping same substantially completely about the previously formed tube with folding back in itself of one thickness of said composite sheet material at said region of initial juncture, bringing surface

of said extension presenting said coating of heat-sealing adhesive that is adjacent the end of said extension into juxtaposition with underlying peripheral surface of said tube, and applying heat to seal together said last mentioned juxtaposed surfaces by means of said coating of said heat-sealing adhesive.

7. A method of making a tube utilizing flexible composite sheet material that comprises a strain-resisting sheet of non-metallic sheet material one surface of which carries integrally therewith a layer of metal foil, the opposite surface of said flexible composite sheet material being non-metallic, said method comprising forming said flexible composite sheet material into a tube with said non-metallic surface innermost, bringing longitudinally extending portions of said non-metallic surface of said flexible composite sheet material into juxtaposition in the region of initial juncture of said flexible composite sheet material and with heat-sealing adhesive material between said juxtaposed portions, applying heat to seal said juxtaposed portions face-to-face to provide a primary seal, wrapping an extension of the flexible composite sheet material about the previously formed tube with the non-metallic surface thereof outermost until the end of said extension overlies said exposed non-metallic surface of said flexible composite sheet material, turning under the end of said extension, and bonding the non-metallic surface of said turned-under end of said extension to underlying non-metallic surface of said extension of said flexible composite sheet material by a heat-sealing adhesive, heat being applied to effect said bond.

8. A method of making a tube utilizing flexible composite sheet material that comprises a strain-resisting sheet of non-metallic sheet material one surface of which carries integrally therewith a layer of metal foil, the opposite surface of said flexible composite sheet material being non-metallic, said method comprising forming said sheet material into a tube, bringing longitudinally extending portions of said non-metallic surface of said flexible composite sheet material into juxtaposition with heat-sealing adhesive material therebetween, applying heat to bond together face-to-face said juxtaposed portions of said non-metallic surface of said flexible composite sheet material carrying an extension consisting of one thickness of said flexible composite sheet material beyond the region of initial juncture of said sheet material and wrapping same about the previously formed tube with folding back in itself of one thickness of said composite sheet material at said region of initial juncture, bringing the non-metallic surface of said extension adjacent the end of said extension into juxtaposition with underlying surface of said tube with heat-sealing adhesive between the last mentioned juxtaposed surfaces, and applying heat to seal together said last mentioned juxtaposed surfaces by means of said heat-sealing adhesive therebetween.

WALTER LANGER.

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