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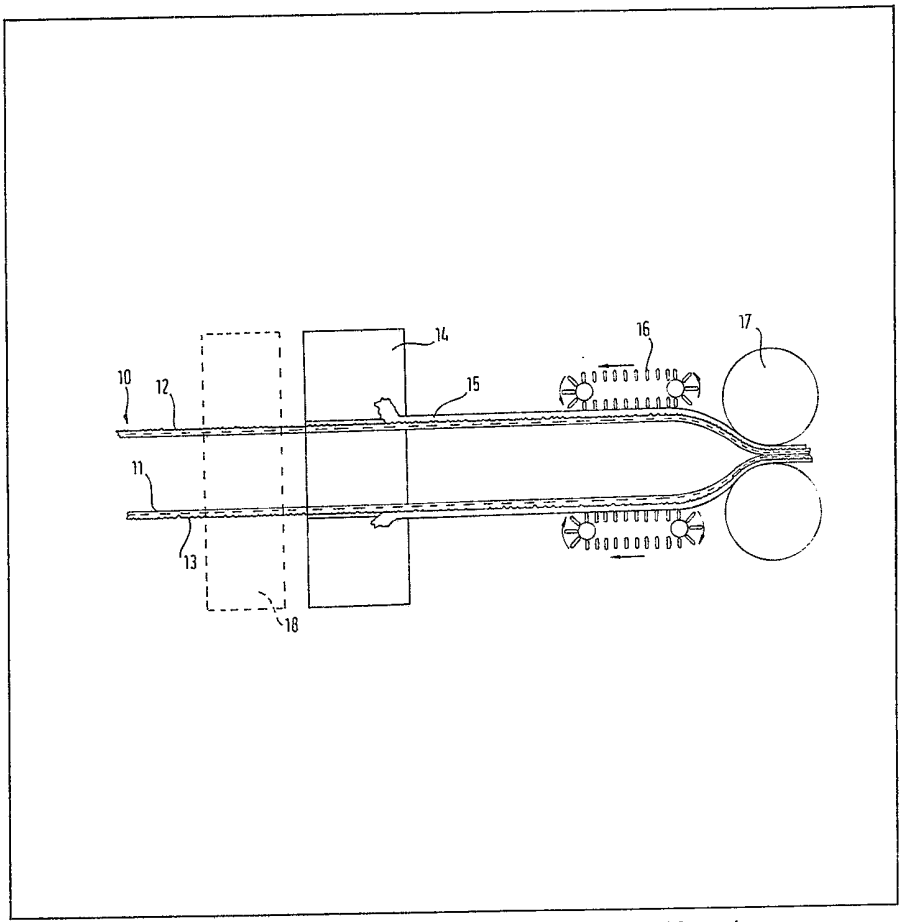
(54) **Improvements in or relating to manufacture of reinforced hose**

(57) The hose comprises an inner liner 11 of elastomeric material, a reinforcement structure 13 and an outer cover 15 of elastomer. The outer cover 15 is formed by extrusion and the heat imparted to the assembly of liner 11 and reinforcement structure 13 during said extrusion is utilised to effect simultaneously bonding of the liner 11 to the reinforcement structure 13, either by activating an adhesive on the liner and/or the reinforcement, or by softening of the liner.



The drawing(s) originally filed was/were informal and the print here reproduced is taken from a later filed formal copy.

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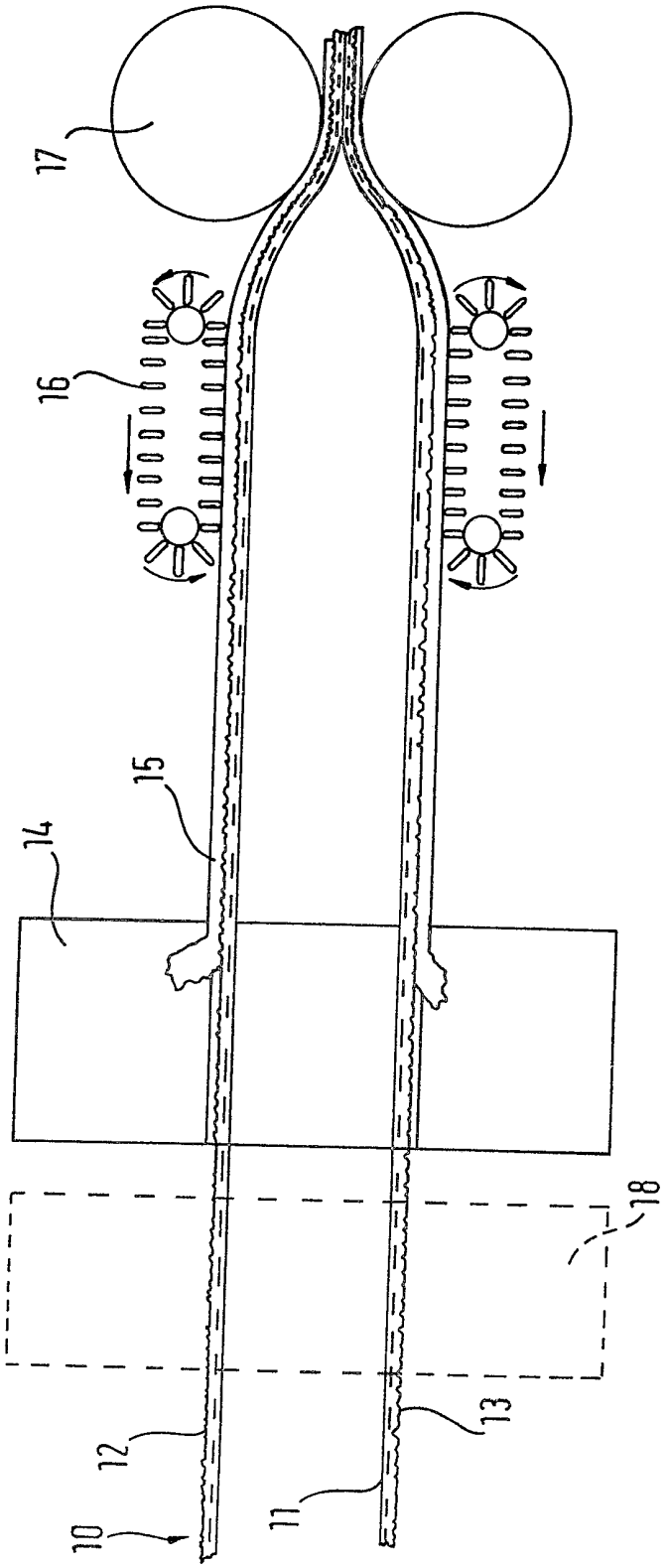

SPECIFICATION

Improvements in or relating to hose

This invention concerns improvements in or relating to hose and in particular to hose of the type comprising an inner liner of fluid impermeable elastomeric material, a tubular reinforcement structure and an outer cover of elastomeric material.

Up to now a conventional method of manufacturing hose of the above-described type has involved forming an assembly of the reinforcement structure and outer cover, pulling an inner liner through the assembly and subsequently inflating the liner with steam under pressure to effect bonding of the liner to the reinforcement structure.

A disadvantage of this method is that the steps of applying the outer cover and bonding the inner liner to the reinforcement structure are separate and it is necessary to lay out the hose assembly for inflation. As a result a large floor area is required to carry out the process especially where long lengths of hose are to be made.

According to one aspect of the present invention we provide a method of hose manufacture comprising providing an assembly of a tubular reinforcement structure and an inner liner of elastomeric material with an extruded outer cover of elastomeric material, the heat imparted to the hose assembly during said extrusion being sufficient to effect bonding of the liner to the reinforcement structure.

The assembly is internally supported by a mandrel during application of the outer cover. Preferably the mandrel is formed by a pressurised fluid medium, for example air at a pressure in therange 20 to 60 p.s.i. The pressure of the fluid medium is selected together with the pressure of the extruded cover material to ensure sufficient adhesion is obtained between the hose components.

The outer cover preferably comprises a solidifiable elastomeric material, i.e. a non-vulcanisable material, so that subsequent heating of the coated assembly to effect curing of the outer cover is not required. The cover material may be a low modulus polymer, for example polyvinyl chloride (PVC) or a thermoplastic elastomer, for example polyurethanes (PU), having a softening point of at least 100°C. It has been found that polyurethanes having a melt temperature of at least 200°C are particularly suitable for use as the cover material since high abrasion and cut resistance may be obtained for cover thicknesses as low as 0.01".

The liner may comprise natural or synthetic rubber. The synthetic rubber may be a vulcanisable rubber such as styrene butadiene rubber (SBR), nitrile rubber (NBR) or a thermoplastic rubber such as Hytrel (Registered Trade Mark - a block polyester-polyether copolymer comprising the terephthalates of ethylene, tetramethylene, polyoxypropylene and polyoxytetramethylene glycols) or an ethylene vinyl acetate (EVA) block copolymer.

The reinforcement structure may be made from natural or synthetic textile material, for example polyester, rayon, polyamide, polypropylene or cotton or mixtures thereof. Alternatively the reinforcement structure may be made from a suitable non-textile material for example glass fibre or metallic material such as wire. The reinforcement structure may be knitted, woven, braided or non-woven, for example the reinforcement may comprise a spiral or helical winding.

The assembly of reinforcement structure and liner may be formed by pulling a given length of liner through a preformed reinforcement structure of corresponding length.

The liner material may adhere to the reinforcement structure to effect bonding of the liner to the reinforcement structure, for example where the liner comprises a thermoplastic rubber the heat imparted to the hose assembly during the extrusion of the outer cover may be sufficient to soften the liner material which adheres to the reinforcement structure.

More preferably bonding of the liner to the reinforcement structure is effected by an adhesive which is activated by the heat imparted to the hose assembly during extrusion of the outer cover. The adhesive may be applied to the outer surface of the liner prior to forming the assembly of inner liner and reinforcement structure. Alternatively or in addition the adhesive may be applied to the outer surface of the reinforcement structure. Where the adhesive is applied to the reinforcement structure only, for example by extrusion, the adhesive is selected to have a sufficiently low viscosity at the operating temperature that substantially complete impregnation of the interstices of the reinforcement structure occurs with the result that on subsequent activation the adhesive bonds both the liner and the cover to the reinforcement structure.

The adhesive may be a thermoplastic adhesive, for example an SBS copolymer, or a chemical adhesive, for example Daltoflex 635 (ex. I.C.I.) with an isocyanate curing agent such as Suprasec GL (ex. I.C.I.) which is activated by the temperature and pressure conditions which it experiences during extrusion of the outer cover.

Alternatively elastomeric polymer copolymers such as Grilesta D515 (ex. Grilon) are suitable dry adhesives.

According to a further aspect of the present invention we provide hose manufactured by the method according to the present invention.

The invention will now be described in more detail, by way of example only, with reference to the accompanying drawing in which the single Figure is a schematic illustration of apparatus for carrying out a method of hose manufacture according to the present invention.

A hose assembly 10 comprising an inner liner 11 of Hytrel coated with a thermoplastic adhesive 12, for example an SBS copolymer, and a tubular woven textile reinforcement jacket 13 is inflated with air to a pressure in the range 20 to 60 p.s.i. and passed through a cross-head extruder 14 where an outer cover 15 of polyurethane is applied to the jacket 13.

The thermoplastic adhesive 12 is activated by the heat imparted to the assembly during extrusion of the outer cover 15 and effects bonding of the liner 11 to the jacket 13.

On leaving the extruder 14 the covered hose assembly is passed through a cooling medium, for example water, to cool the outer cover before entering a caterpillar haul-off 16. The haul-off 16 advances the hose assembly 10 through the apparatus at a predetermined rate sufficient to ensure complete activation of the liner adhesive 12 before the covered assembly passes through the cooling medium.

From the haul-off 16 the covered assembly is passed through sets of nip rollers 17 where the assembly adopts the layflat configuration of the finished hose and then through a haul-off (not shown) from where the hose is collected and stored on a drum (not shown). The final haul-off is required to overcome drag on the hose caused by the internal pressure restricting entry into the nip.

It will be appreciated that the nip rollers 17 close the hose assembly 10 and thereby facilitate maintenance of the internal pressure in the hose assembly during application of the outer cover 15. The haul-off 16 before the nip rollers 17 may be omitted.

In a modification to the above-described method the hose assembly 10 is passed through a preheater zone 18, e.g. an array of heating devices, prior to entering the extruder 14. The degree of pre-heat is selected to ensure that the reinforcement jacket of the hose assembly 10 entering the extruder 14 is completely dry and that complete activation of the adhesive 12 occurs in the extruder 14.

In a further modification the hose assembly 10 is passed through an applicator, e.g. a T-head extruder, for applying to the reinforcement jacket 13 a thermoplastic adhesive, e.g. an SBS copolymer, which is subsequently activated by the heat imparted to the assembly during extrusion of the outer cover. The adhesive applied to the jacket 13 may be provided in addition to the adhesive 12 applied to the liner 11 and effect bonding of the cover 15 to the jacket 13. Alternatively the step of coating the liner 11 with the adhesive 12 may be omitted and the adhesive applied to the jacket 13 selected to have a sufficiently low viscosity at the operating temperature that substantially complete impregnation of the interstices of the reinforcement jacket occurs and subsequent activation of the adhesive causes the reinforcement jacket 13 to bond to both the liner 11 and cover 15. Impregnation of the reinforcement jacket 13 by the adhesive displaces the air contained in the interstices of the jacket thus improving the bonding of the liner and cover to the jacket and reducing or substantially eliminating blistering of the extruded cover by air trapped in the reinforcement jacket.

In the above-described method and modifications thereof the liner 11 is bonded to the reinforcement jacket by an adhesive. However, it will be appreciated that the invention is not restricted to the use of adhesives but includes the possibility of forming the liner from a thermoplastic elastomer which softens sufficiently as a result of the heat imparted to the assembly during the extrusion of the cover to adhere to the reinforcement jacket under the pressure conditions and, on subsequent cooling, sets and bonds to the jacket.

It will be apparent from the foregoing that in the above-described methods and modifications thereof the liner 11 is not attached to the jacket 13 in the inflated assembly until either the adhesive, where provided has been activated or the liner material softened by passage through the extruder 14. The method of hose manufacture according to the present invention therefore combines the steps of applying the outer cover and bonding the liner to the reinforcement structure in a single stage by utilising the heat of the extrusion process to either activate the adhesive or soften the liner material. Consequently the usual step of laying out the covered assembly and inflating with steam under pressure to effect bonding of the liner to the reinforcement structure is avoided.

CLAIMS

1. A method of hose manufacture comprises providing an assembly of a tubular reinforcement structure and an inner liner of elastomeric material with an extruded outer cover of elastomeric material, the heat imparted to the hose assembly during said extrusion being sufficient to effect bonding of the liner to the reinforcement structure.

2. A method according to claim 1 wherein the liner material is a thermoplastic elastomer and the heat imparted to the hose assembly during said extrusion is sufficient to soften the liner material to effect bonding of the liner to the reinforcement structure.

3. A method according to claim 1 wherein an adhesive is applied to the hose assembly and the heat imparted to the hose assembly during said extrusion is sufficient to activate the adhesive and effect bonding of the liner to the reinforcement structure.

4. A method according to claim 3 wherein the adhesive is applied to the liner.

5. A method according to claim 3 wherein the adhesive is applied to the reinforcement structure.

6. A method according to any one of the preceding claims wherein the hose assembly is pre-heated prior to said extrusion.

7. A method according to any one of the preceding claims wherein the hose assembly is internally supported by a mandrel.

8. A method according to claim 7 wherein the mandrel comprises a pressurised fluid medium.

9. A method of hose manufacture substantially as hereinbefore described with reference to the accompanying drawing.

10. A hose manufactured by the method according to any one of claims 1 to 9.

11. A hose according to claim 10 wherein the liner material comprises natural or synthetic rubber.

12. A hose according to claim 11 wherein the liner material is a thermoplastic elastomer.

13. A hose according to any one of claims 10, 11 or 12 wherein the cover material comprises a solidifiable elastomer.

14. A hose according to any one of claims 10 to 13 wherein the reinforcement structure comprises a natural or synthetic textile material.

15. A hose according to any one of claims 10 to

13 wherein the reinforcement comprises a non-textile material.

16. A hose according to any one of claims 10 to 15 wherein the adhesive is a thermoplastic adhesive.

17. A hose according to any one of claims 10 to 15 wherein the adhesive is a chemical adhesive.

18. A hose according to any one of claims 10 to 14 wherein the adhesive is an elastomeric polyester copolymer.

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