Feb. 26, 1957 L. J. MONCRIEFF 2,782,459

COVERING

Filed Sept. 13, 1951

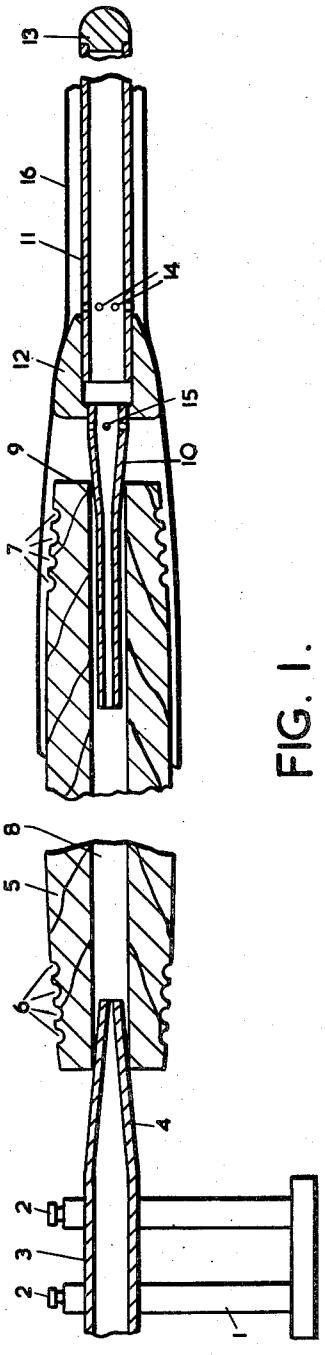


FIG. 1.

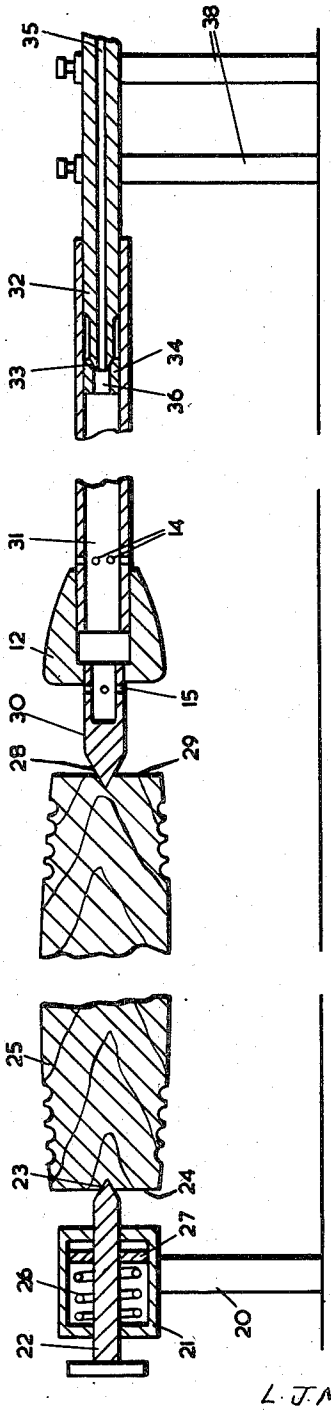


FIG. 2.

L. J. MONCRIEFF
INVENTOR

J. Kelly & A. Stevenson
ATTORNEYS

United States Patent Office 2,782,459 Patented Feb. 26, 1957

2,782,459

COVERING

Leslie John Moncrieff, London, England, assignor to British Celanese Limited, a company incorporated of Great Britain

Application September 13, 1951, Serial No. 246,455

Claims priority, application Great Britain September 26, 1950

10 Claims. (Cl. 18—1)

This invention relates to improvements in covering, and in particular to a method and apparatus for providing rods with a tight-fitting tubular covering of cellulose acetate or other thermoplastic.

The terms "rods" is used in this specification to include tubes (i. e. hollow rods) as well as solid rods. The rods may be of circular or other cross-section, for example elliptical or polygonal. The cross-sectional area and shape of the rods may be constant throughout their length or may vary to some extent. The rods for example may be peripherally ridged and/or grooved and may taper slightly, for example towards each end.

The invention provides a simple and rapid method of providing rods with a tubular covering of cellulose acetate or other thermoplastic. In the process of the invention a tube of the thermoplastic material of smaller internal cross-section than the cross-section of the rod is drawn in a temporarily softened condition over a mandrel on to the rod, the tube being expanded before reaching the rod by passage over an expanded portion of the mandrel, and pressure being exerted on the interior of the tube by a gaseous medium, preferably air at atmospheric temperature, supplied through outlets in the mandrel in the neighbourhood of said expansion. Preferably the outlet orifices for the gaseous medium are in two regions of the mandrel spaced apart along its length so that the gaseous pressure around one of said regions can be increased when necessary, to prevent the tube sticking to the mandrel in that region, by pressing the tube against the mandrel in the other region so as to reduce the gaseous flow into said other region. It is of particular advantage for one of said regions to be immediately behind and the other in front of the expansion. Preferably a pre-formed tube of the thermoplastic material is used in a softened condition brought about by soaking the tube in a suitable volatile liquid. The tube in the softened condition should be limp rather than sticky, and it must readily undergo hardening, e. g. by evaporation of volatile softening agent, to a rigid condition which is maintained under all atmospheric conditions. This hardening should be accompanied by some shrinkage. Softening could be effected by heat and hot air or steam could be used as the gaseous medium but these are unnecessary complications which are preferably avoided so that the operation can be carried out manually with a minimum of equipment.

An important advantage of the process of the invention is that it can be used not only with the relatively flexible thermoplastics such as polyvinyl chloride and cellulose nitrate, but also with the more rigid plastics such as cellulose acetate, cellulose propionate, cellulose acetate-propionate and cellulose acetate-butyrate. These more rigid thermoplastics give excellent service as rod coverings, for example on perambulator handles, and in service have many advantages over the more rubber-like plastics such as polyvinyl chloride, for example in hardness, high heat-softening point, appearance and resistance to staining when brought in contact with dyed articles. Compared with cellulose nitrate these more rigid cellulose derivatives have, of course, the important advantage of substantial non-inflammability. Their use in the form of tubes for covering rods such as perambulator handles has, however, hitherto involved an operation so slow and difficult that materials inferior in service to these cellulose derivatives have been generally preferred for the purpose. In addition to the advantage of enabling such relatively rigid thermoplastics to be used on substantially equal terms with the more flexible thermoplastics, the process of the invention is of advantage even with these more flexible thermoplastics in giving great speed of operation and improved control.

Apparatus according to the invention comprises a mandrel suitable for use in providing rods with a covering of thermoplastic material, which comprises a hollow stem and a rearwardly tapering expansion thereon whereby a softened tube of said material can be expanded while being drawn over the mandrel, said stem projecting behind said expansion so as to be capable of supporting the tube on its way to the expansion, and projecting forward of said expansion so as to be capable of engaging the rear end of the rod being covered, one end of the stem being closed and the other end being open so that a gaseous medium can be admitted to the inside of the stem, and the stem being provided with outlet means for allowing said medium to escape into the annular space between the stem and the tube behind and in front of the expansion.

In covering rods having an axial passage through them from end to end, e. g. the peripherally grooved wooden dowels of this construction commonly used in making perambulator handles, the rod is preferably held during covering between hollow centres engaging opposite ends of said passage, one of the centres supplying the gaseous medium to said passage, the other centre being on the forward end of the mandrel and conveying the gaseous medium from said passage to a passage in the mandrel communicating with outlet orifices whence it issues into the annular space between the tube and the mandrel.

A mandrel suitable for use in covering hollow rods comprises a hollow stem and a rearwardly tapering expansion thereon for expanding the softened tube drawn over it, the stem extending behind the expansion to form a support for the tube approaching the expansion, and being closed at its rear end, and extending forward of the expansion to form a nozzle adapted to fit into the rear end of the rod so that the mandrel is carried by the rod and the passage through the rod communicates with the inside of the stem, and outlets being provided in the stem near the rear end of the expansion and between the forward end of the expansion and the nozzle, for allowing the gaseous medium entering the stem from the passage through the rod to issue into the annular space between the tube and the stem on both sides of the expansion. This mandrel is employed in combination with a support for the forward end of a tubular rod to be covered, said support comprising a nozzle capable of fitting into said forward end so as to support the rod and enable a gaseous medium supplied to the nozzle to pass therefrom into the passage through the rod.

In covering solid rods, e. g. peripherally grooved wooden dowels unprovided with an axial passage the rod is preferably held between centres during covering, one of said centres being at the end of the mandrel, and the mandrel has an internal passage connecting the supply of gaseous medium with orifices through which said medium issues into the annular space between the tube and the mandrel.

A mandrel suitable for use in covering solid rods comprises a sleeve slidably mounted on a tubular member

adapted to carry the sleeve and to admit a gaseous medium supplied to said member into the inside of the sleeve, said sleeve carrying the expansion for expanding the thermoplastic tube and being provided with outlet means for the gaseous medium behind and in front of said expansion, and being capable of disengagement from the tubular member for the insertion of a fresh thermoplastic tube behind the expansion and of being held in a position on said tubular member in which it engages the rear end of the rod. This mandrel is used in combination with retractable means for engaging and supporting the forward end of a rod to be covered while the rear end of said rod is engaged and supported by the forward end of the mandrel.

Apparatus according to the invention is shown by way of example in the accompanying drawings wherein:

Figure 1 shows in part-sectional elevation an apparatus for providing a hollow rod with a tubular covering of cellulose acetate, and

Figure 2 shows, also in part-sectional elevation, an apparatus for achieving the same purpose when the rod to be coated is solid. The covered rods are suitable for use as perambulator handles.

Referring now to Fig. 1 of the drawings, in a support **1** is held by set-screws **2** an air pipe **3** having a nozzle **4** which forms a support for the wooden rod **5** to be covered. The air pipe is connected with a reservoir of compressed air (not shown) and is provided with a foot-operated throttle valve (not shown) for the control of the air supply. The rod which has two series of peripheral grooves **6** and **7** is circular in cross-section; the radius increases gradually towards the mid point. The rod has a bore **8** extending throughout its length. Into the rearward end **9** of this bore fits the tapered forward end **10** of a hollow mandrel **11** having a rearwardly tapering expansion **12** the maximum diameter of which is substantially equal to the maximum diameter of the rod **5**. The rearwardly projecting part of the mandrel is closed by a rounded wooden plug **13**. Air outlet holes extending through the mandrel from the bore **8** are provided at **14** and **15**. The arrangement is such that with a hollow rod in position, on opening the air throttle air passes from the air-supply pipe through the bore of the rod and then through the bore of the mandrel and escapes through the holes **14** and **15**. In addition a reservoir of air is formed in the rearward extension of the bore **8** and exerts a useful buffer effect. The drawing shows a cellulose acetate tube **16** in course of being drawn from the mandrel **11** on to the rod **5**. The tube is of internal diameter smaller than the maximum diameter of the expansion **12** on the mandrel but larger than the external diameter of the rearwardly projecting part of the mandrel.

In operation the tube is softened, for instance by immersion in a bath comprising acetone, alcohol and water, until it is quite limp. The operator then applies a little lubricant to the expansion **12** of the mandrel, turns on the air supply by means of the foot-control and draws the softened tube along the mandrel, over the expansion, along the rod to the end thereof. (Lubricant could be introduced into the air stream or sprayed into the tube but it has been found better for the operator to apply what lubricant is necessary to the mandrel from time to time.) Once the tube has made contact all round with the tapered portion of the expansion **12** any tendency to stick can be overcome by pressing the tube into close contact with the mandrel at a point in advance of where the sticking is occurring so that slight inflation of the tube occurs at the point of sticking and overcomes the sticking. An operator soon becomes so expert at this operation that it is done almost unconsciously, and the whole process of drawing the tube over the mandrel on to the rod is performed with great rapidity and without undue inflation of the tube such as might cause defects in the covering.

Referring now to Fig. 2 the support **20** carries in a housing **21** a centre **22** adapted to engage a countersink **23** centrally disposed in the forward face **24** of the wooden rod **25** which is identical with the rod **5** of Fig. 1 except for being solid. A spring **26** in the housing **21** bears against a flange **27** on the centre **22** urging it in a rearward direction. A countersink **28** in the rearward face **29** of the rod **25** accommodates the conical forward end of the mandrel **30**. The mandrel has a rearwardly tapering expansion **12** and air holes at **14** and **15** as in the mandrel of Fig. 1. The bore **31** of the mandrel **30** is a sliding fit round the air pipe **32** having a nozzle **33** adapted to seat against the rearward face of a plug **34** in the bore **31** of the mandrel so that the bore **35** of the air pipe connects through the passage **36** in the plug with the bore **31** of the mandrel. The air pipe **32** is carried by a support **38**. The air pipe **32** is connected to a source of compressed air and provided with a foot-operated throttle valve (neither shown). On opening the throttle air passes through the bore of the mandrel and out through the air-holes **14** and **15**.

In the operation of the apparatus shown in Fig. 2, assuming that the covering of one rod has just been completed, the covered rod and mandrel are disengaged by retracting the centre **22** against the action of the spring **26**, a fresh thermoplastic tube is inserted on the mandrel **30** so that the forward end of the tube is in contact with the expansion **12**, the mandrel is then pushed back into position on the air pipe **32**, and a fresh rod **25** is then centred between the end **28** of the mandrel and the spring-loaded centre **22**. The air is turned on and the tube is drawn over the expansion **12** of the mandrel on to the rod **25** using the same technique as in operating the apparatus of Fig. 1.

In the apparatus of the invention it is not essential that the air holes **14** and **15** should be exactly in the positions shown nor is it even essential that two separate series **14** and **15** of air holes should be provided. It is very desirable to have air holes in the neighbourhood of the forward edge of the expansion **12** so as to provide for inflation of the tube in the region beyond the expansion **12** but these holes may, instead of being in the forwardly projecting stem portion of the mandrel, be in the forward face of the expansion; or some of the holes may be in said face and the others in said forwardly projecting stem. The holes **14** at or near the rear end of the expansion have been found useful (but not essential) in dealing with any tendency to stick to the rearwardly projecting part of the mandrel. Additional holes may be provided further back from the expansion. An advantage of having air holes in the rearwardly projecting stem portion of the mandrel is that better control of the air pressure at various points along the path of the tube can be so obtained. Thus, for instance, by nipping the tube against the rod with one hand and against the tapered part of the expansion with the other, the air pressure acting to inflate the tube can be reduced below that exerted when the tube is nipped not only on the rod but also against the mandrel at a point behind the air holes **14**. Thus with sets of holes on each side of the expansion as shown in the drawings control of local inflation can be obtained by manual operation of the tube during the covering operation without the necessity of varying the throttle opening. If desired separate air control for the two or more series of holes can be provided, for instance by providing a sleeve valve in the mandrel, but this is a refinement which is generally unnecessary.

A suitable material for the mandrel is brass. The surface may be plated and/or highly polished but this is not generally necessary and a finely roughened surface such as can be obtained by etching or sand blasting may even be of advantage in reducing any tendency to bind on the mandrel. The mandrel surface may be made of self-lubricating material such, for example, as the porous metallic materials charged with lubricant that are used in self-lubricating bearings. Or a material such as poly-

tetrafluorethylene having a low coefficient of fixation towards cellulose derivative materials may be used.

A very suitable material for the pre-formed tube is cellulose acetate plasticised with diethyl phthalate, di-(methoxyethyl)-phthalate or a mixture of dimethyl phthalate and triphenyl phosphate in the weight ratio of 4:1. Other plasticisers can be used, for instance methyl phthalyl ethyl glycollate, ethyl phthalyl ethyl glycollate and tri-(mono-chlorethyl)-phosphate. The pre-formed tube may be made by solventless hot extrusion, e. g. as described, in U. S. application S. No. 243,488, filed August 24, 1951, and in general if a tube is of such composition as to be capable of being made by solventless extrusion it will also be suitable in composition for use in the present invention. The thickness of the tube depends largely on the thickness required in the covering. The most useful results have been obtained with pre-formed tubes of thickness at least 0.01 inch, e. g. 0.02 to 0.1 inch and especially 0.02 to 0.05 inch. The internal diameter of the tube should be less than the maximum diameter of the rod to be coated. Thus, for instance, in coating a rod of maximum diameter 1.125 inches a tube of thickness 0.02 inch and internal diameter 0.720 inch has been found very suitable.

For softening the tube liquids consisting essentially of a volatile solvent for the material of the tube diluted with a volatile non-solvent have been found most suitable. (The term volatile in this specification means having a normal boiling point not greater than about 110° C.) For cellulose acetate, volatile solvents include acetone, methylene ethylene ether, and dioxane, and volatile non-solvents include water, methanol, ethanol, isopropanol, benzene and toluene. Acetone is the preferred volatile solvent and among volatile non-solvents water, especially in admixture with an alcohol, is preferred. A particularly useful softening liquid for cellulose acetate has the composition (by volume)

23 parts of acetone
43 parts of industrial alcohol
34 parts of water.

In this solution softening of a tube of thickness 0.20 inch and initial diameter 0.720 inch to the desired degree of limpness occurs at ordinary temperature in the space of about one hour. Thinner tubes, of course, soften more rapidly. The speed of softening can be increased by raising the temperature of the bath or by increasing the proportion of acetone, but too high a proportion of acetone or other active solvent is apt to result in the formation of a hard skin on the tube. Minor proportions of a medium boiling solvent, e. g. ethyl lactate or diacetone alcohol, can be included in the softening bath. The softening bath may also contain a small proportion of a wetting agent such as the sodium salt of secondary octadecyl acid sulphate.

The invention has been described with particular reference to covering the rods with tubes having a basis of cellulose acetate. The process and apparatus of the invention can, however, be employed with advantage in covering rods with tubes having a basis of other thermoplastics, for example other thermoplastic cellulose derivatives such as cellulose propionate, cellulose acetate-propionate, cellulose acetate-butyrate, ethyl cellulose and benzyl cellulose; solid polymers and co-polymers of ethylene; thermoplastic polyvinyl compounds, for example polyvinyl chloride, polystyrene, and co-polymers of vinyl chloride with a minor proportion of vinyl acetate, of vinylidene chloride with a minor proportion of vinyl chloride, and of vinyl chloride or vinylidene chloride with acrylonitrile or methacrylonitrile; thermoplastic polymers of acrylic acid derivatives, for example polyethyl acrylate and polymethyl methacrylate; and thermoplastic linear condensation polymers such as the nylons, polyethylene terephthalate and poly-4-amino-1.2.4-triazole.

The hollow or solid rods to be covered may be of various rigid materials including wood, metals, ceramics and heat-hardened plastics. Naturally the material of the rod must not be such that it becomes soft or sticky by contact with the softened tube. For covering rods of non-circular cross-section, the cross-sectional shape of the expansion on the mandrel may be modified correspondingly and pre-formed tubes may be used of cross-sectional shape approximating to the average cross-sectional shape of the rod, though this is not usually necessary.

Having described my invention, what I desire to secure by Letters Patent is:

1. Process for providing rods with a covering of thermoplastic material, wherein a tube of said material of smaller internal cross-sectional area than the maximum cross-sectional area of the rod in a temporarily softened condition is drawn as a single operation over a mandrel, which gradually expands the tube to said maximum area, and on to the rod, pressure being exerted against the inside of the tube meanwhile by a gaseous medium introduced through apertures in the mandrel.

2. Process for providing rods with a covering of normally rigid thermoplastic material, wherein a tube of said material of smaller internal cross-sectional area than the maximum cross-sectional area of the rod is converted into a temporarily limp condition by swelling with a homogeneous mixture of a solvent and a non-solvent, and while in said condition is expanded gradually to an internal cross-sectional area at least as great as said maximum cross-sectional area, by being drawn over a three dimensional shaping surface, and is drawn from said surface on to the rod, pressure being exerted on the internal surface of the tube by air supplied to the interior of the tube in regions behind and in front of said shaping surface, and the tube subsequently being hardened in position by evaporation.

3. Process for providing rods with a covering of normally rigid thermoplastic material, wherein a tube of a plasticised cellulose ester of a carboxylic acid containing 2 to 4 carbon atoms of smaller internal cross-sectional area than the maximum cross-sectional area of the rod is converted into a temporarily limped condition by swelling with a homogeneous mixture of a solvent and a non-solvent, and while in said condition is expanded gradually to an internal cross-sectional area, at least as great as said maximum cross-sectional area, by being drawn over a three dimensional shaping surface, and is drawn from said surface on to the rod, pressure being exerted on the internal surface of the tube by air supplied to the interior of the tube in regions behind and in front of said shaping surface, and the tube subsequently being hardened in position by evaporation.

4. Process for providing rods with a covering of normally rigid thermoplastic material, wherein a tube of plasticised cellulose acetate of smaller internal cross-sectional area than the maximum cross-sectional area of the rod is converted into a temporarily limp condition by swelling with a homogeneous mixture of a solvent and a non-solvent, and while in said condition is expanded gradually to an internal cross-sectional area at least as great as said maximum cross-sectional area, by being drawn over a three dimensional shaping surface, and is drawn from said surface on to the rod, pressure being exerted on the internal surface of the tube by air supplied to the interior of the tube in regions behind and in front of said shaping surface, and the tube subsequently being hardened in position by evaporation.

5. Process for providing rods with a covering of normally rigid thermoplastic material, wherein a tube of plasticised cellulose acetate of smaller internal cross-sectional area than the maximum cross-sectional area of the rod is converted into a temporarily limp condition by swelling with a homogeneous mixture of acetone, ethyl alcohol and water, and while in said condition is expanded gradually to an internal cross-sectional area at least as great as said maximum cross-sectional area,

by being drawn over a three dimensional shaping surface, and is drawn from said surface on to the rod, pressure being exerted on the internal surface of the tube by air supplied to the interior of the tube in regions behind and in front of said shaping surface, and the tube subsequently being hardened in position by evaporation.

6. A mandrel suitable for use in providing rods with a covering of thermoplastic material, which comprises a hollow stem and a rearwardly tapering expansion thereon whereby a softened tube of said material can be expanded while being drawn over the mandrel, said stem projecting behind said expansion so as to be capable of supporting the tube on its way to the expansion, and projecting forward of said expansion so as to be capable of engaging the rear end of the rod being covered, one end of the stem being closed and the other end being open so that a gaseous medium can be admitted to the inside of the stem, and the stem being provided with outlet means for allowing said medium to escape into the annular space between the stem and the tube behind and in front of the expansion.

7. A mandrel according to claim 6 suitable for use in covering hollow rods, wherein the forward projection of the stem terminates in a nozzle that can be fitted into the rear end of the passage in a rod to be covered so that the mandrel is supported by the rod and a gaseous medium can be admitted from said passage to the inside of the hollow stem, and the rear end of the stem is closed.

8. A mandrel according to claim 6 suitable for use in covering solid rods, which comprises a sleeve slidably mounted on a tubular member adapted to carry the sleeve and to admit a gaseous medium supplied to said member into the inside of the sleeve, said sleeve carrying the expansion for expanding the thermoplastic tube and being provided with outlet means for the gaseous medium behind and in front of said expansion, and being capable of disengagement from the tubular member for the insertion of a fresh thermoplastic tube behind the expansion and of being held in a position on said tubular member in which it engages the rear end of the rod.

9. The combination of a mandrel according to claim 6 wherein the forward projection of the stem terminates in a nozzle that can be fitted into the rear end of a passage through the rod to be covered so that the mandrel is supported by the rod and a gaseous medium can be admitted from said passage to the inside of the hollow stem, the rear end of the stem being closed, and a support for the forward end of the rod to be covered, said support comprising a nozzle capable of fitting into said forward end so as to support the rod and enable a gaseous medium supplied to the nozzle to pass therefrom into the passage through the rod.

10. The combination of a mandrel according to claim 6, which comprises a sleeve slidably mounted on a tubular member adapted to carry the sleeve and to admit a gaseous medium supplied to said member into the inside of the sleeve, said sleeve carrying the expansion for expanding the thermoplastic tube and being provided with outlet means for the gaseous medium behind and in front of said expansion and being capable of disengagement from the tubular member for the insertion of a fresh thermoplastic tube behind the expansion and of being held in a position on said tubular member in which it engages the rear end of the rod, together with retractable means for engaging and supporting the forward end of the rod to be covered while the rear end of said rod is engaged and supported by the forward end of the mandrel.

References Cited in the file of this patent

UNITED STATES PATENTS

901,093	Gregory	Oct. 13, 1908
1,461,130	Loughead	July 10, 1923
1,479,936	Stevens	Jan. 8, 1924
1,537,860	Miller	May 12, 1925
2,027,962	Currie	Jan. 14, 1936
2,183,691	Owens	Dec. 19, 1939
2,272,704	Harding	Feb. 10, 1942
2,565,316	Lucas	Aug. 21, 1951