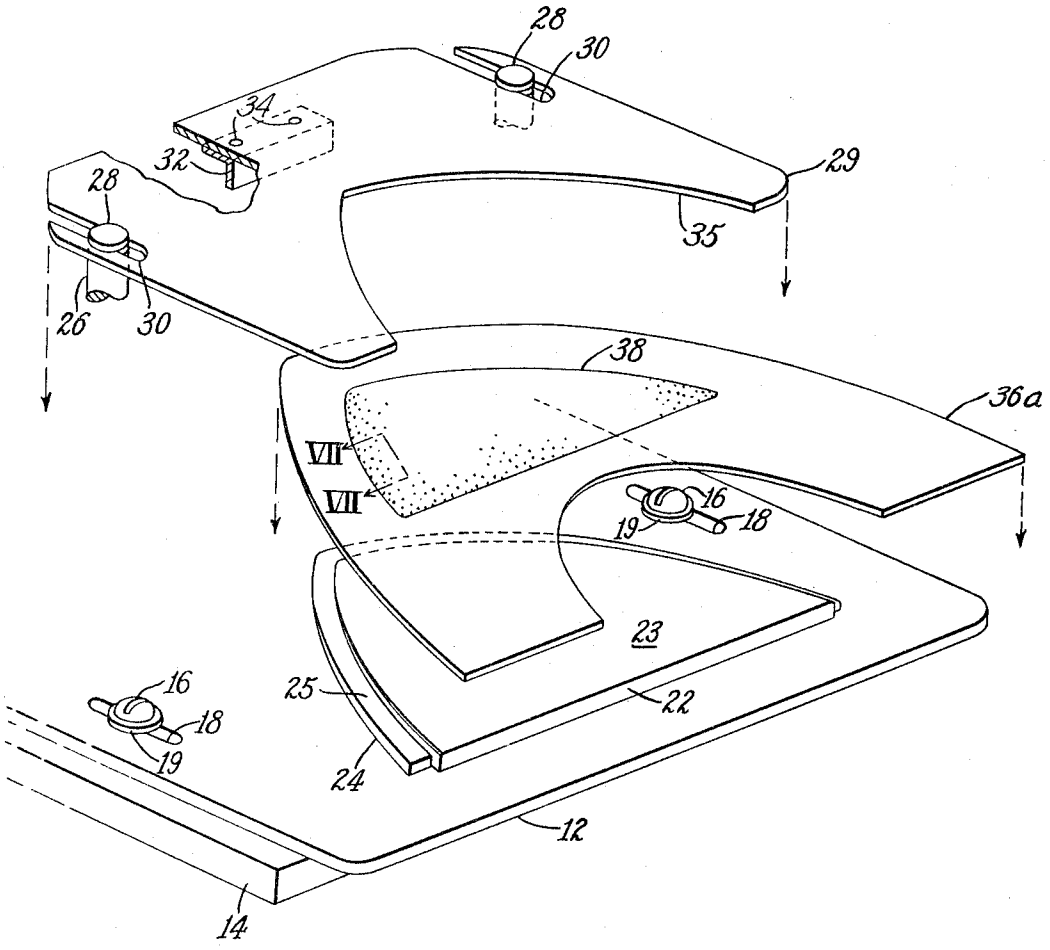
May 2, 1967 A. M. CHAPLICK ET AL 3,316,573

SHOE MANUFACTURE

Filed Jan. 20, 1964

3 Sheets-Sheet 1

Fig. 1



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By their Attorney

Cornelius F. Cleary

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SHOE MANUFACTURE

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Fig. 2

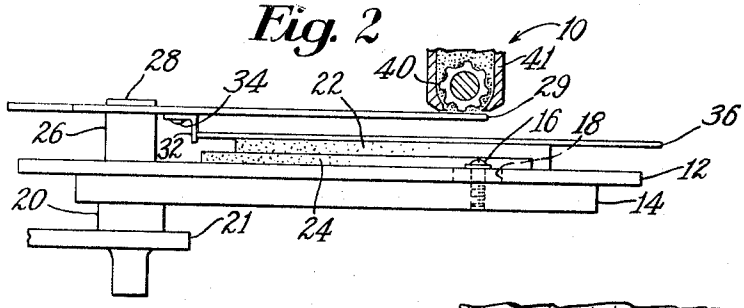


Fig. 3

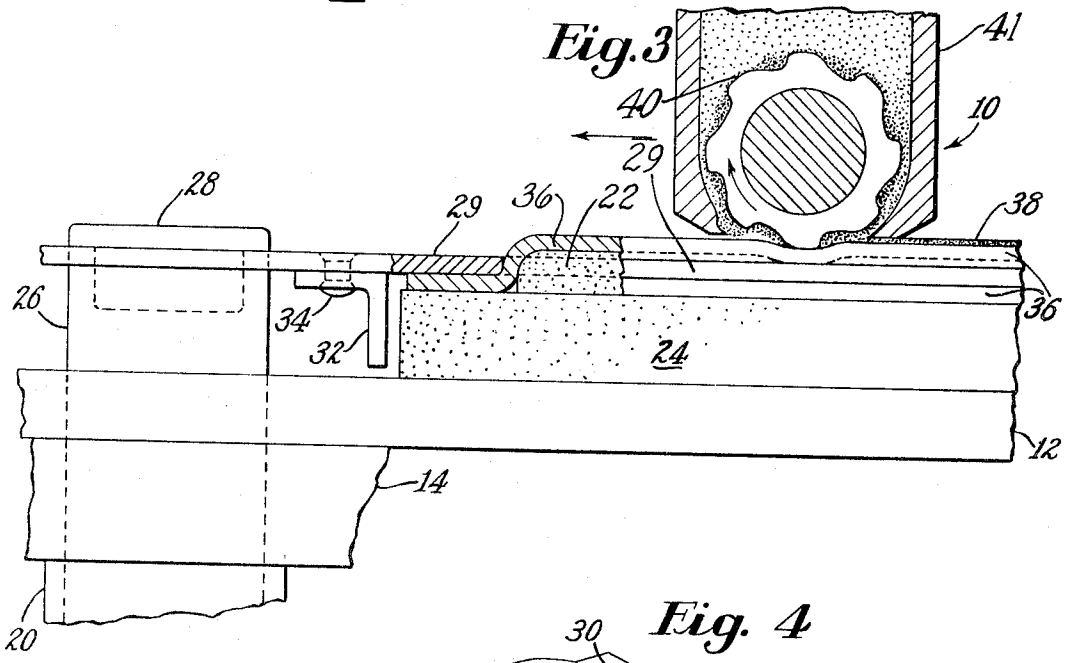
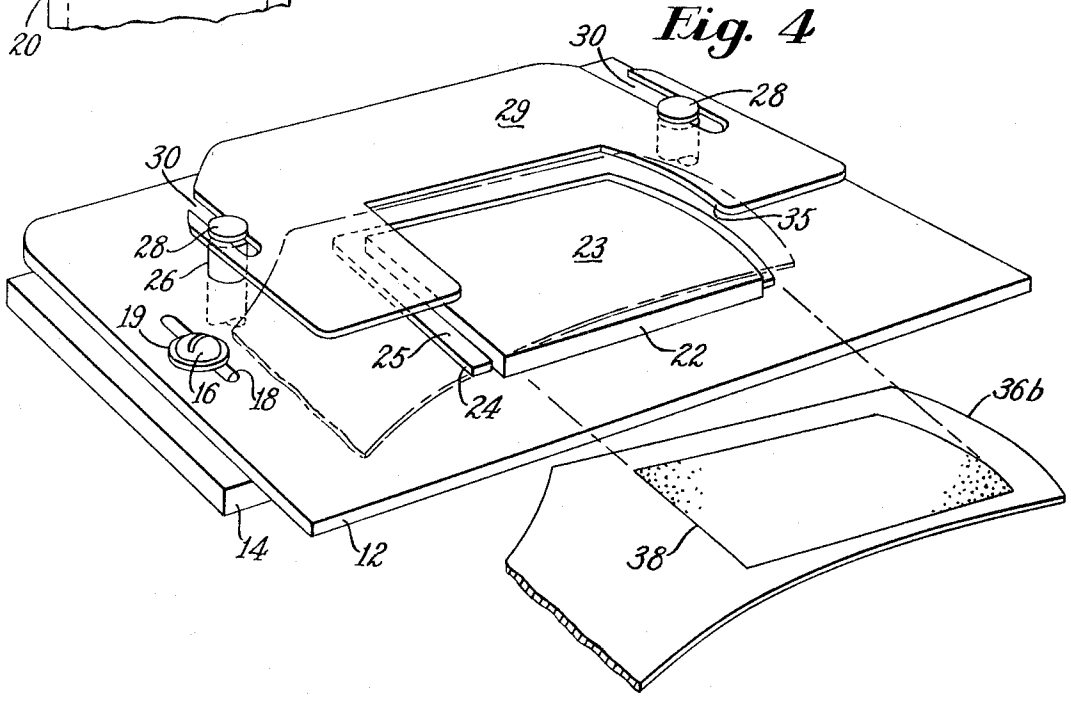


Fig. 4



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SHOE MANUFACTURE

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Fig. 5

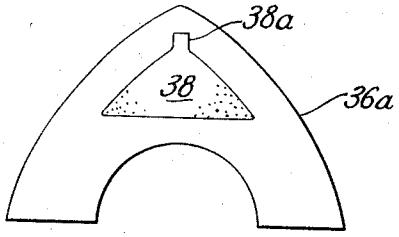


Fig. 6

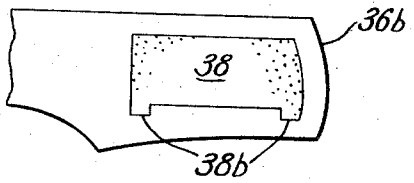


Fig. 7

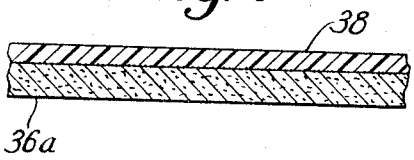
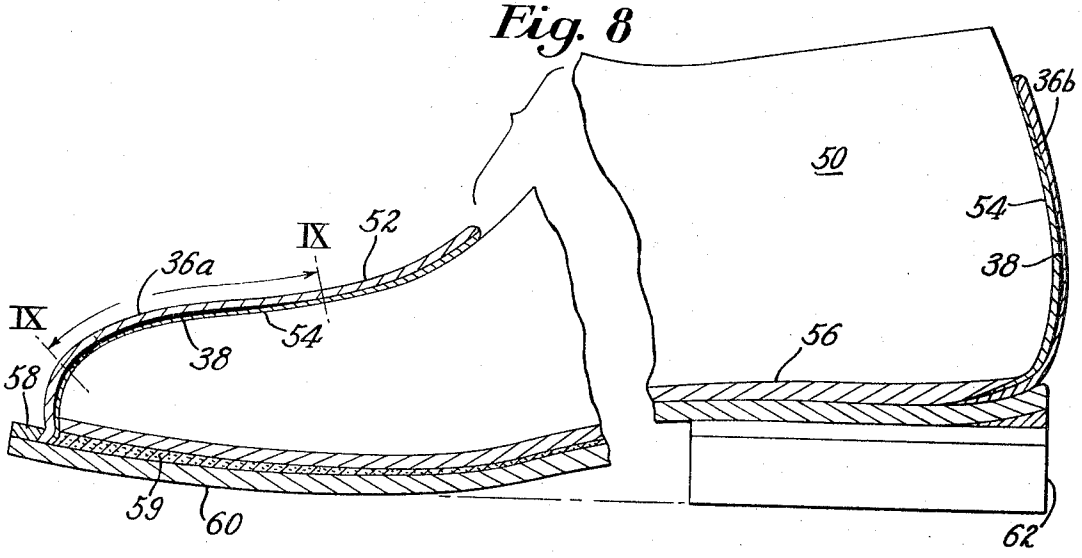


Fig. 8



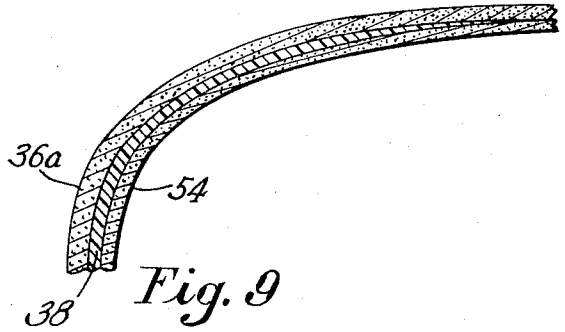


Fig. 9

United States Patent Office 3,316,573 Patented May 2, 1967

3,316,573

SHOE MANUFACTURE

Adolph M. Chaplick, Hudson, N.H., and Conrad Rossitto, Andover, Mass., assignors to United Shoe Machinery Corporation, Flemington, N.J., a corporation of New Jersey

Filed Jan. 20, 1964, Ser. No. 338,705
6 Claims. (Cl. 12—146)

The present invention is directed to providing stiffening in shoe uppers.

In the stiffening of shoe uppers, particularly the toe and heel ends, for the purpose of preserving a desired shape, there have been three general expedients. Preformed stiffener elements and particularly, preformed fiber counters have been provided which are inserted in a shoe upper prior to lasting. Separate moldable sheet materials softenable by heating or by solvent have been inserted in shoe uppers prior to lasting and are shaped in the course of lasting to a desired configuration which they retain by being allowed to harden before removal of the shoe upper from the last. Shoe uppers have also been stiffened by impregnating a shoe component with a solution or dispersion in a volatile liquid vehicle of a hardenable stiffener material prior to lasting of the shoe upper, the shoe upper being stiffened by hardening of the impregnating material after the shoe is lasted.

These known stiffeners suffer from a number of disadvantages. A large stock of preformed stiffener shapes is required to be kept on hand since each size and style of shoe may require a different preformed stiffener. The problem of inserting and properly locating the stiffener element is common to both the preformed stiffener and to the stiffener which is brough to soft, moldable condition by heat or solvent before assembly in a shoe upper. The latter type also introduces the disadvantages of fire hazards with the use of solvent activators, the problem of timing to insert the softened stiffener in a shoe and shape it while it is still soft, and the problem of leaving the shoe upper on the last until solvent has evaporated to allow the stiffener to recover its shape retaining ability. Stiffening by impregnation of a shoe part involves many special problems in control. The character of the impregnant must be maintained at a value insuring effective association of the stiffener material with the shoe upper part into which it is impregnated. The penetration must be controlled as to quantity applied, condition of the impregnant and impregnation procedure so that the desired association of the shoe material and the impregnant is secured. In particular, considerable difficulty is involved in controlling impregnation to prevent "strike through," i.e. penetration of the stiffener material so that it shows either on the inside of the shoe when the lining has been impregnated or the outside of the shoe when the outer has been impregnated. Impregnation also involves the problem of evaporating the vehicle in which the stiffening agent is dissolved or suspended.

It is an object of the present invention to provide an improved stiffening for shoes which avoids the difficulty of inserting and maintaining in place separate stiffener components, and likewise avoids the problems of effecting uniform impregnation and of avoiding "strike through" involved in heretofore known shoe stiffening.

It is a further object of the invention to provide shoe components and shoes of which selected areas may be permanently stiffened into predetermined three-dimensional configuration. By "permanently stiffened" is meant

that the stiffening will be retained when a shoe provided with the same is subjected to ordinary wearing conditions.

It is a still further object of the invention to provide shoe stiffening in which consolidation of the shoe upper components in the stiffened area may be obtained simultaneously and expeditiously without the occurrence of strike through.

These and other objects of the invention are obtained by providing a shoe upper component associated in a selected area with a resiliently flexible stiffener element formed in situ, heating the stiffener element to a temperature below its melting point at which it is moldable but not freely flowable, and application of conforming pressure to that area while it is in heated condition to bring the component to a desired three-dimensional configuration which it will retain on cooling.

The following drawings are included for the purpose of illustrating the present invention in which:

FIG. 1 is a perspective partial view, with parts separated and with some parts broken away and in section, of a work holding means for use with the head of a hot melt stiffening material applicator shown in related position with a vamp toe section having a coating of stiffening material in a defined area or pattern;

FIG. 2 is a partial side elevation with some parts broken away and in section of the work holding means and the head of the hot melt stiffening material applicator taken with a vamp toe section inserted, but, prior to application of stiffening material;

FIG. 3 is a partial side elevation at an enlarged scale with some parts broken away and partly in section of the work holding means and head of the hot melt stiffening applicator taken during application of the stiffening material;

FIG. 4 is a perspective, partial view with some parts broken away and in section, which is intended to show substitution of parts by which the work holding means of FIG. 1 is adapted for application of hot melt stiffening material to the quarter section of a shoe upper;

FIG. 5 is a top plan view of a vamp section of a shoe upper having a coating of stiffening material in a preselected area and in direct adhesive attachment therewith;

FIG. 6 is a top plan view, partly broken away of a quarter section of a shoe upper having a coating of stiffening material in a preselected area and in direct adhesive attachment therewith;

FIG. 7 is a side section taken in magnification along the lines VII—VII of FIG. 1 showing a part of the vamp toe section having a coating of stiffening material in a preselected area and in direct adhesive attachment therewith;

FIG. 8 is a side section, with parts broken away of a formed and lasted shoe carried on a last; and

FIG. 9 is a side section taken in magnification along the lines IX—IX of FIG. 8 showing the coated vamp toe section, including a lining, after conformation and consolidation of shoe parts has been effected.

The drawings generally show an apparatus by means of which the improved expedients of this invention may be practiced and for convenience the invention will be described as practiced with that apparatus. However, it will be understood that the invention may be practiced using other devices or by hand. As shown variously in FIGS. 1–3 and in part in FIG. 4, the apparatus includes an applicator head **10** for applying stiffening material

and a work holding means including a table 12 which is movable and is adjustably positioned on support 14. Bolts 16 directed through slots 18 and lock washers 19 serve to secure the attachment between these parts. Table 12 and support 14 are stationed on posts 20 supported by yoke 21, see particularly FIG. 2.

A pair of shaped back-up pads 22 and 24, made of resilient material such as a foamed plastic, for instance polyurethane or the like, are attachably positioned on table 12. As shown, see for example FIG. 1, pad 24 is lower or less thick than pad 22. The result is that the top surface 23 of pad 22 projects above top surface 25 of pad 24. The desired effect to be obtained from this arrangement may also be obtained by making pad 24 from more compressible material than that used in pad 22. Pad 24 is positioned to the outside and in such a manner that it circumscribes the forward contour of pad 22 to an effective extent.

Posts 20 are provided with upwardly projecting, slidable connected studs 26, with the result that they are contractable with respect to one another. Posts 20 are also spring loaded, in a manner not shown, to facilitate return to a normal length or height at the rest position. Studs 26 are adapted to receive set bolts 28 for the purpose of stationing shaped clamping plate 29 onto studs 26. Open ended slots 30 are provided at the forward end of clamping plate 29 to aid in effecting this purpose. Clamping plate 29 has a stop 32 attached to its under side by means of bolts 34. The extent to which studs 26 and bolts 34 can be contracted or foreshortened with respect to posts 20, and, coincidentally plate 29 can approach pads 22 and 24, is limited by the bottom edge of stop 32 striking table 12.

The cut out portion 35 of clamping plate 29 may take various shapes. This will depend upon which is to be the predetermined or selected area of a shoe upper component 36 to which coating 38 of the thermoplastic synthetic polymeric material is to be applied. In this regard the shoe upper component 36 may be leather, various natural materials such as cotton fabrics, also fabrics and sheets based on synthetic materials such as polyvinyl chloride and mixtures of these, etc. Cut out 35 is shown in FIG. 1 having a shape which is somewhat semielliptical in nature, in effect similar to the preselected area of coating 38 as applied to the vamp toe section 36*a* of an upper. By contrast, FIG. 4 shows a plate 29 designed for use when coating 38 is to be applied to a quarter or heel end section 36*b* of an upper. As may be further noted from these figures the outlines of pads 22 and 24 correspond with those of the particular cut out 35 in the particular plate 29 to be used. The embodiments shown in FIGS. 5 and 6 are designed to facilitate lasting. These will be discussed in greater detail later in this paper.

The rotating applicator wheel 40 of the applicator head 10 is disposed in the otherwise open lower end of heated chamber 41 containing molten stiffening material and serves to apply coating 38 in fluid state from the chamber onto the selected area of upper components 36. Wheel 40 is also adapted to travel in a horizontal plane to the extend that it applies coating 38 to the portion of the shoe upper exposed through cut out 35 in plate 29. The lower edge of chamber 41 serves as a metering blade in a manner that allows for its coordination with applicator wheel 40. Coordinated positioning between wheel 40 and plate 29 is provided through means not shown.

In providing a coating 38 of a thermoplastic synthetic polymeric material onto a selected area of a shoe upper component 36, the shoe upper component 36 is first positioned on pads 22 and 24.

Plate 29 is then caused to drop down onto upper 36. To do this, set bolts 28 are registered against stops, not shown, and posts 20 are in effect elevated by yoke 21 causing studs 26 and posts 20 to become contracted. At this point, the portion of upper 36 located on pad 22 projects upward through the cut out portion 35 of plate 29 above the level of the upper surface of the plate. This is facilitated by having cut out 35 slightly larger in outline than pad 22. Smooth draping and a taut surface are obtained in upper 36 by the action of plate 29 in pressing marginal portions of the upper around the edge of pad 22 and pressing it against the top surface 25 of pad 24 which is lower than top surface 23 of pad 22. That area of plate 29 which defines cut out 35 is in essential registration with pad 24. When registration is spoken of here, it of course, takes into account that upper 36 is interposed between plate 29 and pads 22 and 24. Applicator wheel 40, which carries the thermoplastic synthetic polymeric material in heat softened fluid form is caused to travel across and in wiping and spreading contact with the portion of the upper projecting through the cut out portion 35 of plate 29. The coating material carried on wheel 40 transfers as coating 38 to the projecting portion of upper 36. The thickness to which the polymeric material is applied as coating 38 is determined by the positioning of the lower edge of the chamber 41 which serves as a metering blade relative to the upper component 36.

After application of coating 38 to component 36, the contracting forces held through posts 20 and studs 21 are released allowing plate 29 to lift off the now coated upper component 36. Coated upper 36 may then be removed from pad 22.

The coating 38 of the thermoplastic synthetic polymeric material to be used in practicing the present invention dries quickly to a stiff yet resilient and flexible state by exposure to ambient temperature conditions. A period of 2 seconds may be sufficient to allow the coated uppers 36 to be stacked together or otherwise conveniently handled. Coating 38 is a unitary and distinct element, and is lightly and directly attached, i.e. adhesively, to upper component 36 as indicated in FIG. 5. It can be stripped off as a complete entity from upper component 36 if for some reason it is not found acceptable. Prescribed thickness for coating 38 is 0.010" to 0.100", at least at the more central area portions. Actually, it may be desirable to have the peripheral areas of coating 38 be rather thin to give a feather edge effect. One way this can be accomplished is by sculpturing the edges of pad 22.

Upper components 36, to which coatings 38 are in direct adhesive attachment in selected areas, may then be included in an upper assembly for placement on a last or form 50 as shown in FIG. 8. Coatings 38 are activated to moldable but not freely flowable condition by subjecting them to a temperature below the melting point of the polymeric material, suitably in the range of about 160° F. to about 210° F. Steaming is a convenient manner for obtaining activation and is of special advantage in rendering upper materials such as leather, more readily lastable. While in activated condition simultaneous forming of the shoe upper 52 and conforming of coating 38 with component 36 may be carried out on last 50. As shown in FIG. 8 shoe upper 52 includes a lining 54 but it is to be understood that unlined shoes may also be made. Also shown included are insole 56, welt 58, bottom filling 59, outsole 60 and multiple part heel 62. Note in that figure that in obtaining stiffening in upper 52 a minimum of bulk is contributed to the upper 52.

As indicated earlier the embodiments of the coated component 36, specifically 36*a* and 36*b* shown in FIGS. 5 and 6 respectively are designed to facilitate attachment between their parts and an insole. The tab portions 38*a* and 38*b* shown projecting outward from coating 38 serve to provide adhesive attachment between either the vamp or quarter, 36*a* and 36*b* respectively and the underside of an insole. These tab portions can also take different shapes as desired.

As indicated in FIG. 9, the result of forming is that coating 38 together with upper component 36 and lining 54 are provided in a permanently stiffened three-dimen-

sional configuration. This is obtained for the reason that consolidation of these parts through coating **38** is accomplished simultaneously with conforming of coating **38** carried out on last **50**. The moldable but not freely flowable condition of the coating **38** resulting from the nature of the polymeric material and its heating to a temperature below its melting point makes this consolidation without objectionable thinning out or displacement of the coating material and with no strike-through of upper **36** or lining **54** by the ocating material. Rather coatings **38** retain their identities as distinct, unitary stiffening entities or coatings. This is surprising in view of the considerable stress, on the order of 800–1000 lbs. total pulling load, applied to these three components, while coatings **38** are in a heated conformable condition, by the pulling over or forming operation.

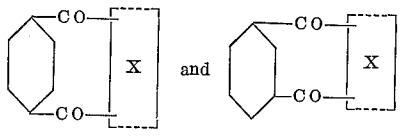
Formation of the coating or layer of thermoplastic polymeric material in the important new adherent but non-penetrating relation on the shoe component and in the desired thickness is obtained by providing certain properties in the polymeric material and by control of the conditions of application. The material in the layer provides shape retaining ability through its own strength rather than through penetration into a fibrous mass so that it must be stiff, strong and tough, i.e., resistant to cracking when subjected to flexing and other stress in a shoe. Stiffness of the polymeric materials for the present use should be in the range as determined by the Olsen Stiffness Tester, of from 0.25 to 4.0 units, preferably from 0.5 to 1.5 units. This test involves flexing a 0.015" film at 50° using a weight attached to the pendulum of the tester. Softening points, determined by conventional Ring and Ball procedures should be in the range of 200° F. to 400° F.

The desired wetting and spreading properties are secured by using an application temperature for a given polymeric material such that its falling ball viscosity at the application temperature is not less than 35 seconds as determined with a 5/16" steel ball falling through the middle four inches of a column of molten material in a 25 mm. diameter tube, 150 mm. in length. At this viscosity the polymeric materials enter into wetting engagement with the surface of the shoe component when applied as by applicator head **10** but do not penetrate significantly and do not run from the surface to which applied so that an adequate thickness of the layer may be formed.

Various thermoplastic synthetic polymeric materials may be prepared by controlled polymerization or blending of products of polymerization to give the desired physical properties. Materials useful in the present relation include various polyesters and copolyesters, polyamides, polyesteramides, polyvinyl compounds such as polystyrenes, polyvinyl acetate and so on. The preferred polymeric materials are the copolyesters which are condensates of (I) a glycol represented by the formula:

$$HO—(CH_2)_n—OH$$

wherein n is an integer of 2–4 with (II) a combination or mixture of dicarboxylic organic acid compounds, that is acids or acid derivative compounds. The preferred mixture of acid compounds is made up of (IIa) aromatic dicarboxylic acid compounds represented by the formulae:



(para) (meta)

wherein X represents oxygen, and $(OR)_2$ radicals and wherein in the latter R represents hydrogen and methyl radicals and (IIb) linear aliphatic dicarboxylic acid compounds represented by the formula:

$$(R_1)—OOC—(CH_2)_n—COO—(R_1)$$

wherein n is an integer of 6–12 and R_1 is a hydrogen or an alkyl radical containing 1 to 4 carbon atoms.

The glycol (I) can be used singly or as a mixture of the defined glycols, as for instance a mixture of propyl and butyl glycols. The preferred glycol is 1,4 butane diol which is in further preference used singly to satisfy the glycol requirement.

The aromatic dicarboxylic acid compound (IIa) can be isophthalic acid, terephthalic acid, anhydrides of isophthalic acid and terephthalic acid, the methyl esters of isophthalic acid and terephthalic acid, etc. Preferably a mixture of isophthalic acid and terephthalic acid is used.

The linear aliphatic dicarboxylic acid compound (IIb) can be any of suberic acid, azelaic acid, sebacic acid, hendecanedioic acid, dodecanedioic acid, brassylic acid, various methyl, ethyl, propyl and butyl esters of the preceding acids, etc. Linear aliphatic dicarboxylic acid compounds based on sebacic acid and azelaic acid are preferred. This preferance includes the acids themselves as well as their esters represented by dibutyl sebacate and the like.

The amounts of the various reactants to be used in producing the preferred thermoplastic copolyesters are also subject to definition. The amount of glycol (I) to dicarboxylic organic acid compound (II) ranges about 1.1–10.0:1.0 mols respectively, with preference directed to about 1.3–2.0:1.0 mols respectively. The dicarboxylic organic acid is in turn made up of about 40 to 95 mols percent aromatic dicarboxylic acid compound (IIa) and the remainder aliphatic dicarboxylic acid compound (IIb). Preference in this respect is about 70 to 90 mols percent aromatic dicarboxylic acid compound (IIa) and the remainder aliphatic dicarboxylic acid compound (IIb).

The presence of aliphatic dibasic acid compound in the thermoplastic copolyesters is important to the obtainment of a stiffener material which has not only sufficient stiffness but also sufficient flexibility and resilience in a final solidified form. In a sense this polymeric material then is one which enjoys internal plasticization. Intrinsic viscosities, which can also be used as prerequisites for the material, range .3 to .75 with preference ranging .4 to .5. Useful copolyesters will have softening points, determined by ring and ball procedures, ranging 200° F. to 400° F., preferably 250° F. to 350° F. Further determination within their ranges may be necessary in view of the nature of the shoe component to be coated, i.e. leather, fabric, etc.

The following examples are given by way of illustration to aid in understanding the invention but it is to be understood that the invention is not to be restricted to the particular materials or procedures of the examples.

Example I

A terpolyester was formed by condensation under conventional conditions of 1,4 butane diol with terephthalic, isophthalic and sebacic acid components in the molar ratio of 1.9:1.8:1.4. This terpolyester had an intrinsic viscosity of 0.4, an Olsen Stiffness of about 2 units, and a Ball and Ring softening point of 329 to 335° F.

The terpolyester was heated to 400° F. to 425° F., at which temperature it had a falling steel ball viscosity of about 27 seconds and was supplied to the applicator roll which was set to transfer an 0.020 inch thick coating onto the heel portion and onto the toe portions of women's leather shoe upper parts. After application, the applied material hardened quickly so that the shoe upper parts could be stacked with others within one to three seconds. The thermoplastic material applied showed substantially no penetration into the upper material and was lightly adherent so that it could be stripped off the leather upper without difficulty.

The stacked parts were then assembled with other parts including linings of cotton duck at the heel and toe areas. The heel portion of the upper was subjected

to steam for roughly 30 seconds to bring its temperature to from 170° F. to 190° F. and the upper placed on a last and heel seat lasted. Thereafter the toe portion of the upper was subjected to similar steaming and the shoe was toe lasted. After completion of lasting, soling, heeling and other operations were carried out and the shoes removed from the last. The toe and heel portions of the shoe were found to have good resilient stiffness. In addition lamination consolidation between the shoe upper and the lining, and the overall appearance of the shoe were excellent. The shoes were subjected to wear testing with outstanding results. Appearance was maintained and the flexible stiffness and consolidation of the parts were retained.

Example II

A terpolyester was made by condensation and a polymerization of ethylene glycol with the following acid residue components:

	Mol percentages
Terephthalic acid	59
Isophthalic acid	24
Sebacic acid	17

Softening point Ball and Ring 307° F. to 310° F.

This material had an intrinsic viscosity of about 0.4. The material was used in shoemaking following the procedure set forth in Example I to form a stiffened shoe of excellent appearance and shape retaining characteristics.

Example III

1,4 butane diol was condensed with each of the following acid mixtures the relative proportions of the acid residue components being expressed in mol percent.

	A	B	C	D
Terephthalic	51	59	47	60
Isophthalic	41	24	44	
Azelaic		17	8	
Sebacic	8			40
Softening Point, ° F	277-287	298-304	275-285	300-303

The polyester materials had intrinsic viscosities of 0.4 to 0.5 and Olsen Stiffness values in the range of 1.5 to 2.5 units.

These materials also were used in making shoes according to the procedure set forth in Example I. All shoes retained fine appearance after wear and the stiffened portions maintained the shape of the shoe and continued to provide flexible resilient stiffening and to maintain the consolidation of parts.

Example IV

A polyamide resin from condensation of dimerized soy bean oil fatty acid with ethylene diamine and having a Ball and Ring softening point of 100° C.–116° C. was supplied to the applicator which was adjusted to an application temperature of 300° F. and spread as a coating 0.01 inch in thickness onto toe portions of a shoe upper part. The shoe upper was completed, steamed, lasted, soled and heeled as in Example I using a steaming period for activation of the polyamide material of about 25 seconds. The completed shoes exhibited a good appearance which was retained when worn.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

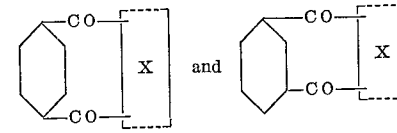
1. A method for providing a shoe component in permanently stiffened three dimensional configuration which comprises the steps of applying a coating of viscous molten thermoplastic synthetic polymeric material to the surface of the area of said shoe component to be stiffened, said thermoplastic synthetic polymeric material having a softening point of from 200° F. to 400° F. and a stiffness when cooled and solidified to provide through its strength and stiffness as a layer of the below defined thickness the added stiffening needed to hold said shoe component in said three dimensional configuration, and being applied at a temperature at which said molten thermoplastic synthetic polymeric material has a viscosity low enough to wet and adhere to said surface but sufficiently high that it will substantially not penetrate the shoe component to be stiffened, cooling the said material to form a stiffly resilient, distinct, at least lightly adherent layer of the order of from about 0.010 to about 0.10 inch in thickness above the surface of said shoe component giving the stiffness required for holding said shoe component in the desired three dimensional configuration, and applying conforming pressure to shape said shoe to the desired three dimensional configuration.

2. A method for providing a shoe component in permanently stiffened three dimensional configuration as defined in claim 1 in which said molten thermoplastic synthetic polymeric material has a falling ball viscosity of not less than 35 seconds at the temperature of application.

3. A method for providing a shoe component in permanently stiffened three-dimensional configuration which comprises applying viscous molten thermoplastic synthetic polymeric material as a coating forming a distinct layer of a thickness above the surface of the shie component providing through its strength and stiffness when solidified as a layer on said shoe component the added stiffness needed to hold said shoe component in said three dimensional configuration and being applied at a temperature at which said viscous molten thermoplastic synthetic polymeric material has a viscosity low enough to wet and adhere to said surface but sufficiently high that it will substantially not penetrate the shoe component to be stiffened, said polymeric material being the reaction product of (I) a glycol represented by the formula:

$$HO—(CH_2)_n—OH$$

wherein n is an integer of 2–4 with (II) a combination of dicarboxylic organic acid compounds, the said combination being (II*a*) aromatic dicarboxylic acid compounds represented by the formula:



wherein X represents oxygen and $(OR)_2$ radicals with R being selected from the class consisting of hydrogen and methyl radical, and (IIb) linear aliphatic dicarboxylic acid compounds represented by the formula:

$$(R_1)—OOC—(CH_2)_n—COO—(R_1)$$

where R_1 is selected from the class consisting of hydrogen and alkyl radicals containing 1–4 carbon atoms and n is an integer of 6–12, the amount of (I) glycol to (II) organic dicarboxylic acid compound ranging about 1.1–10.0:1.0 mols, and (II) organic dicarboxylic acid compound being about 40 to 95 mols percent of (IIa) aromatic dicarboxylic acid compound and the remainder (IIb) linear aliphatic dicarboxylic acid compound, said polymeric material having a softening point of from 200° F. to 400° F. and a stiffness as a solidified layer to provide the added stiffness needed to hold said shoe component in said three dimensional configuration cooling the said material to form a stiffly resilient, distinct, at least lightly adherent layer on said shoe component, and forming said shoe component to a desired three-dimensional configuration.

4. A method according to claim 3 wherein the glycol is 1,4 butane diol and the (IIa) aromatic dicarboxylic acid compound is a mixture of isophthalic and terephthalic acid.

5. A method according to claim 3 wherein the glycol is 1,4 butane diol and the (IIb) linear aliphatic dicarboxylic acid compound is a member of the group consisting of sebacic acid, dibutyl sebacate and azelaic acid.

6. A method according to claim 3 wherein the amount of (I) glycol to (II) dicarboxylic organic acid compound ranges from 1.3–2.0:1.0 mols respectively and the (II) dicarboxylic organic acid compound is about 70 to 90 mol percent (IIa) aromatic dicarboxylic acid compound and the remainder (IIb) linear aliphatic dicarboxylic acid compound.

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