Oct. 18, 1966 J. M. NARDONE 3,278,959

ADHESIVE PROCESSES FOR THE ATTACHMENT OF SOLES TO SHOE UPPERS

Filed Sept. 22, 1965

Fig. 1

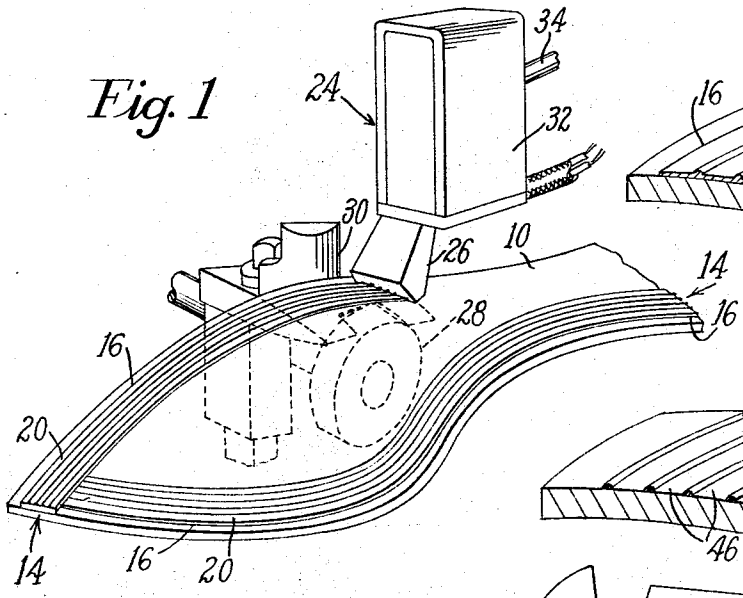


Fig. 2

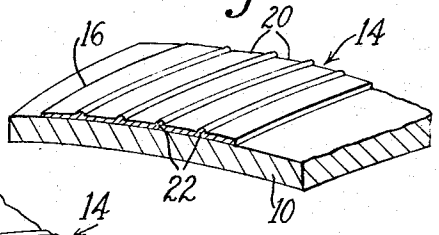


Fig. 3

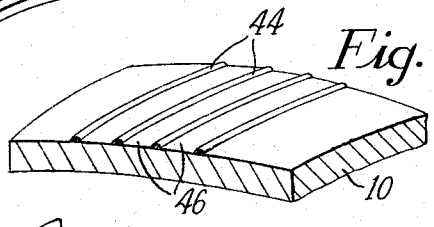


Fig. 4

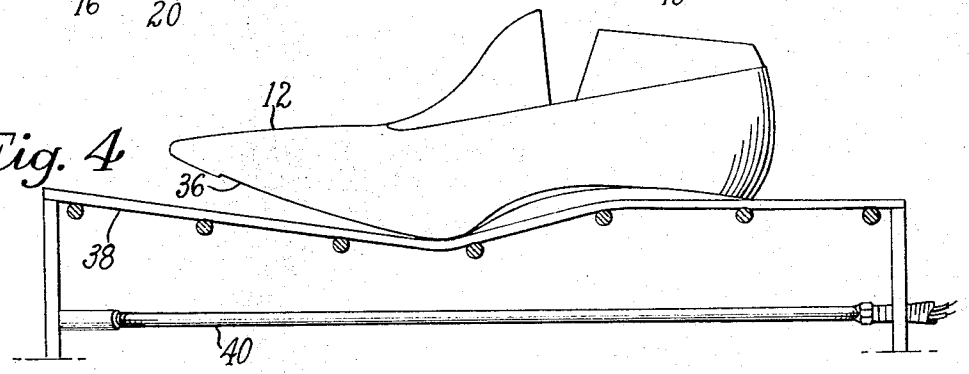


Fig. 5

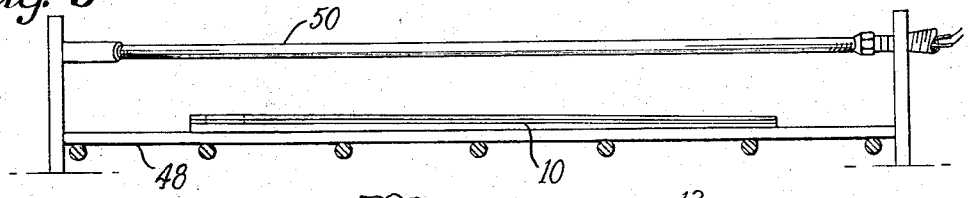


Fig. 6

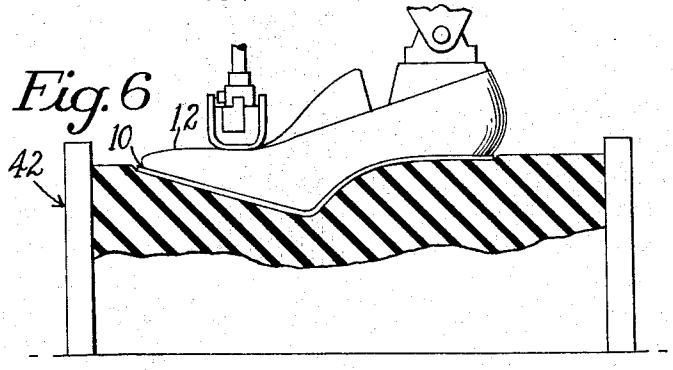
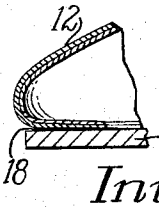


Fig. 7



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ADHESIVE PROCESSES FOR THE ATTACHMENT OF SOLES TO SHOE UPPERS

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7 Claims. (Cl. 12—142)

This application is a continuation-in-part of my copending application Serial No. 268,137, entitled "Adhesive Process for the Attachment of Soles to Shoe Uppers," filed March 26, 1963.

This invention relates to an improved process for attaching soles to shoe uppers.

Hot melt adhesive sole attaching involves applying thermoplastic (in the sense of heat fusible), synthetic polymeric adhesive on the attaching marginal surface of a shoe sole and assembling and pressing the sole with the adhesive in molten condition against the heated bottom of a shoe upper. In this process the adhesive may be supplied in molten condition and the temperature and quantity of adhesive applied may be controlled to supply at least the amount of sensible heat necessary to maintain the adhesive in activated, sole bonding adhesive condition. Alternatively thermoplastic adhesive on the attaching marginal surface of a shoe sole may be brought from solid to molten condition by a heating step prior to assembling of the sole with the shoe upper.

The development of a strong bond by the polymer resin adhesive is dependent in considerable measure on the successful penetration and/or thorough wetting of the surfaces to be bonded. Because the irregularities in the "roughed" surface of the outsole and of the bottom of the upper due, for example, to pleating at the toe and to tacks or other holding devices, it has been necessary to use at least a minimum thickness for the ribbon of deposited adhesive and some difficulty has been encountered in the sole attaching pressing operation. That is, the molten adhesive has allowed "skidding" of the outsole relative to the shoe upper by a lubricating action. Also in the course of pressing, some difficulty has been encountered due to "squeeze out" of molten adhesive from between the outsole and shoe upper.

It is an object of the present invention to provide a hot melt adhesive sole attaching process in which a strong over-all sole attaching bond is secured with minimum danger of "squeeze-out."

To these ends and in accordance with a feature of the present invention, thick deposits of thermoplastic adhesive are laid down in spaced areas on the attaching marginal portions of a sole with adjacent areas in the attaching marginal portions having insufficient adhesive for sole attaching, i.e. either a thin coating or no coating, the areas with insufficient adhesive being disposed to receive molten adhesive from the thick deposits in subsequent assembly and pressing steps of sole attaching.

"Squeeze-out" is prevented most effectively if the thick deposits are disposed inwardly of the outer edges of the attaching marginal portions of the sole leaving a strip with insufficient adhesive along the outer edges of the attaching marginal portions of the sole. In a preferred form the thick deposits are provided in the form of spaced lines or ridges of substantial thickness and narrow width. The thickness, location and relative size of the thick deposits of thermoplastic adhesive and of the areas with insufficient adhesive are arranged to provide a quantity of adhesive effective for sole attaching over substantially the entire attaching marginal area. For example, if the desired over-all level of adhesive for sole attaching were 0.010 inch, the volume of adhesive in the shoe for areas above this level would be adjusted to be at least about equal to the free space up to this level in the areas with insufficient adhesive.

With the adhesive in at least the thick deposits in molten adhesive condition from the sensible heat of deposition in molten condition or in molten condition from a heating step, the sole is pressed against the heated bottom of a shoe upper to force the adhesive into attaching relation with the shoe upper. The attaching pressure spreads out adhesive from the thick deposits so that adhesive connection is secured between substantially all areas of the attaching marginal surface of the sole and the bottom of the shoe upper. The ability of the areas with insufficient adhesive to accept adhesive reduces the danger of squeeze out, while at the same time the thickness of adhesive in the thick deposits enables the adhesive to enter into very effective wetting engagement with the bottom of a shoe upper, but to set up quickly when spread out by pressure.

The invention will be described further in connection with the attached drawings forming part of the disclosure of the present case in which:

FIG. 1 is a diagrammatic angular view with parts broken away of a modified outsole cementer laying down hot molten adhesive on the attaching margin of an outsole;

FIG. 2 is an enlarged angular view of a portion of an outsole partially in section with a band of adhesive having thin outer edge areas and with thicker areas spaced from the edges of the band;

FIG. 3 is an enlarged angular view of a portion of an outsole partially in section with adhesive strands on the attaching margin;

FIG. 4 is a diagrammatic elevational view showing the heating of the bottom of a shoe upper;

FIG. 5 is a diagrammatic elevational view showing the heating of the adhesive and adjacent areas of attaching margin on the surface of an outsole;

FIG. 6 is a diagrammatic elevational view partially in section showing the bonding of an outsole to an upper in a sole attaching press; and

FIG. 7 is an elevational view with parts broken away showing the all over adhesive bonding secured by pressing the outsole against the bottom of a shoe upper.

Successful operation of the present process involves a balance and control of the quantity of molten adhesive deposited and its location and distribution on the attaching margin of the outsole. Adhesive deposits of greater thickness are so disposed as to quantity and proximity to areas with less than sufficient adhesive for sole attaching that adhesive in the thicker areas is able to spread over onto thinner areas under the force of sole attaching pressure to insure the presence of sole attaching adhesive for a good sole attaching connection. This distribution of adhesive offers the advantage that the thicker areas, having less surface area per unit volume, retain heat better so that they remain in active adhesive condition for periods allowing greater latitude in manipulation of the outsole and shoe upper.

Best all over connection between the attaching margin of the outsole **10** and the bottom of a shoe upper **12** is secured with a disposition of adhesive as shown in FIGS. 1 and 2 in which the adhesive deposit **14** covers substantially the entire attaching margin of the outsole extending at its outer edge **16** just short of the juncture **18** (see FIG. 7) where upper and sole comes together in the completed shoe, and with thin areas **20** (see FIG. 2) i.e., areas having less than sufficient adhesive for sole attaching along the outer edge of the attaching margins. Deposition in the thin areas of only enough adhesive to wet the attaching marginal surface of the sole gives better over-all bond-

ing than is obtained where such areas do not have deposited adhesive. At the same time where the thicker bodies **22** of adhesive are spaced from the outer edge **16** of the adhesive band any material squeezed towards the outer edge can be taken up by space between the sole **10** and the bottom of a shoe upper **12**. It is to be noted that the thin areas **20** of the band have effected a wetting of the attaching margin of the sole so that adhesive from thicker areas **22** does not have to supply heat to insure fluidity of adhesive for entering into wetting engagement with the sole.

The deposition of molten adhesive in areas of less thickness and greater thickness may involve a variety of patterns, for example, spaced buttons or mounds, short ridges or a variety of other patterns distributed along the length of the attaching margin of the sole. For purposes of convenience the process will be described in connection with the pattern shown in FIGS. 1 and 2 in which the areas **22** of greater thickness are in the form of spaced ribs continuous with a thin deposit **20** of adhesive covering the rest of the attaching margin of the sole and extending longitudinally parallel to and spaced from each other and from the outer edge **16** of the band.

An illustrative procedure to aid in understanding the operation of the invention is the process of cement outsole attaching in which a molten, solvent-free thermoplastic adhesive is spread as a band **14** on the attaching margin of an outsole **10** by a modified outsole cementer **24**, as shown in FIG. 1. The outsole cementer **24** comprises a nozzle **26** for applying and spreading the adhesive, a drive wheel **28** for moving the outsole **10** at a desired rate past the nozzle **26**, and a guide **30** for maintaining the margin of the outsole **10** in desired relation to the nozzle **26**. The outer edge **16** of the band **14** of adhesive as applied is just inside, e.g. up to $\frac{1}{16}$ inch inside the line of juncture **18** between sole **10** and upper **12** in the completed shoe. In the device shown, molten cement for the nozzle **26** is supplied from the melting device **32** for handling a rod or strand **34** of thermoplastic adhesive; but it is to be understood that other molten adhesive supplies may be used where the nature of the adhesive permits.

As shown in FIG. 1, the cemeter **24** applies a band **14** extending around at least the forward portion of the outsole **10** and it may extend around the entire margin of the outsole depending on the shoe construction involved. The deposited band **14** of adhesive may have a thickness of the order of about 0.002 to about 0.008 inch, in the thinner area **20**, and from about 0.02 to about 0.05 inch in the thicker areas or ridges **22**. The adhesive is applied at a temperature substantially above its melting point to secure good wetting of the sole and preferably is at a temperature sufficiently high to provide sensible heat for maintaining the adhesive at least in the thicker areas **22** in molten condition for a time adequate for sole attaching operations. For this type of operation, the temperature should be at least 30° C. and may be 100° C. or more above the melting point of the adhesive. With such temperatures and with the cross section of adhesive in the thicker areas **22**, as much as 20 seconds may be available for assembling outsole and upper and pressing them together to form a permanent bond.

The thermoplastic adhesive useful for outsole attaching according to the present method, involves a special combination of physical characteristics for effective operation. In general, the adhesive must be thermoplastic at least to the extent that it does not set up prior to completion of the assembly operations involved in the present process. Resins having molecular weights preferably not over about 50,000 have been preferred in order that they may have necessary fluidity for spreading, wetting and penetration. Mixtures of polymeric materials having molecular weights above this value, with resins of lower molecular weight may be compounded to approximate the physical properties of the preferred resins for use in the present process. It has been found desirable that the adhesive have a melting point (ball and ring) of from about 80° C., to about 200° C. and have a relatively wide temperature range, preferably a range of at least 20° C. in which it is visco-elastic when cooled from molten condition. The term "visco-elastic" refers to a condition in which the adhesive is somewhat rubbery but deformable and flowable under pressure, in order that it may permit limited movement, for example, of the outsole **14** relative to an upper **30** so that accurate positioning of the outsole **14** relative to the upper **30** may be assured even after the outsole has come in contact. The temperature range in which the visco-elastic condition in the preferred adhesives occurs may be from about 10° C. to about 60° C. below the melting point of the adhesive; and the adhesive will harden to a strong, tough condition at temperatures at least as high as 50° C. Other important properties are relatively high strength, toughness and at least limited flexibility at room temperature in order that the adhesive may successively withstand the severe stresses encountered in the use of a shoe.

Synthetic polymer resins which have been found useful include the polyesters from reaction and condensation of one or more dicarboxylic acids, for example, terephthalates, isophthalates, sebacates, azelates, succinates and glycols. Preferred polyesters include condensates of a lower alkylene glycol such as ethylene glycol or butylene glycol with dicarboxylic acids, for example, condensates of 1,4 butane diol with mixed terephthalate and isophthalate components in the molar ratio of from about 1:1 to about 4:1 and condensates of mixed ethylene glycol and 1,4 butane diol and mixtures of these with mixed terephthalate, isophthalate and sebacate or azelate components in percentages of 40% to 60% terephthalate, 20% to 50% isophthalate and 10% to 20% sebacate or azelate. Polyesteramides, for example, adipic polyesteramides in which the hydroxy component is 1,6 hexane diol, 1,4 butane diol or ethylene glycol, stereo-specific catalyzed polymers of vinyl alkyl ethers where the alkyl group has from 1 to 4 carbon atoms, polymers and copolymers of lower alkyl acrylates and methacrylates are also useful.

The outsole **10** is assembled with the band **14** of hot molten adhesive on its attaching margin against the heated sole attaching surface **36** of the shoe upper **12**. The attaching surface **36** of the shoe upper **12** may be heated by disposing the upper on a rack **38** in spaced relation to a radiant heating unit **40** as shown in FIG. 4. With plastic upper materials, for example, plasticized vinyl chloride polymers and copolymers, it is desirable that the attaching surface of the upper be heated to about 110° to about 140° F., and with leather uppers temperatures of 150° to 175° F. are preferred.

The assembled shoe upper **12** and outsole **10** are placed promptly in a sole attaching press **42** (see FIG. 6) and subjected to sole attaching pressure. As pressure is applied to the outsole it is conformed and pressed against the shoe bottom. The molten adhesive in the thicker areas **22** wets the attaching surface **36** of the upper and is spread out onto the thinner areas **20** to improve all over adhesion. The molten adhesive will cool and harden quickly and sole attaching pressure may then be released and the shoe removed from the press **42** within a few seconds after the sole **10** has been pressed into all over engagement with the attaching surface **36** of the shoe upper **12**.

In an alternative procedure the molten adhesive is applied to the attaching marginal portion of an outsole **10** in the form of spaced lines **44** separated by spaces **46** containing no adhesive (see FIG. 3) but the spaces **46** may also have adhesive to a thickness less than desired for sole attaching. The deposited lines **44** of adhesive where the spaces **46** are substantially free from adhesive may be of the order of about 0.025" to about 0.06", preferably 0.03" to 0.05" in thickness and from 0.025" to 0.10" in width. It is desirable that the width of the

spaces **46** be at least equal to the thickness of the lines **44** and preferably from 2 to 4 times the thickness.

In this alternative procedure, the molten adhesive applied to the ousole **10** is allowed to cool to form lightly adhering lines or adhesive band which may be strippable as self-supporting lines or band. The outsoles **10** may be stacked substantially directly after application of the adhesive because of the rapid solidification of the adhesive.

Completion of this form of the sole attaching process involves heating of the sole attaching surface **36** of an upper **12** by any suitable means, usually by disposing the upper **12** on a rack **38** spaced from a radiant heating unit **40** as shown in FIG. 4. The outsole **10** is positioned on a rack **48** relative to a radiant heating unit **50** so that the radiant heat falls on the adhesive lines **44** and the surfaces of the outsole **10** adjacent the lines **44**. The lines **44** of adhesive are softened by the radiant heat with the upper portions of the lines which receive heat most directly being made more fluid than portions of the lines closer to the outsole surface. Heat is also absorbed by the outsole material adjacent the adhesive lines to prepare the outsole surface for permanent adhesive engagement by molten adhesive. It has been found that the adherence of the lines to the outsole surface is important since it holds the adhesive lines in extended condition and does not allow the beading up as would be caused by surface tension of adhesive merely laid on a surface.

After heating of the sole attaching surface **36** of the shoe upper **12** and radiant heating of the lines of adhesive **44** and portions of the outsole **10** adjacent the lines, the outsole **10** is positioned on the bottom **36** of the shoe upper **12**. The adhesive in the lines **44** although somewhat rubbery in heated condition, has a visco-elastic nature which allows some sliding of the outsole **10** relative to the shoe upper **12**; but the sliding is limited in extent.

After positioning of the outsole on the bottom of the shoe upper, the assembled shoe upper **12** and outsole **10** are placed in a sole attaching press **42** (see FIG. 6) and subjected to sole attaching pressure. Surprisingly, notwithstanding the amount of time which is available for assembling of the outsole and upper, pressure in the sole attaching press **42** may be released in a matter of only a few seconds. The ability of the adhesive to hold the outsole **10** firmly on the shoe upper **12** after so short a time is due in some measure to the fact that the deeply heated outsole portions permit excellent penetration of the molten adhesive, i.e., do not chill penetrating portions of the adhesive to constitute a block against further penetration. This excellent penetration and/or wetting of the outsole and shoe upper by the adhesive reduce the thickness of the adhesive between outsole and upper and when sole attaching pressure is applied create a geometry between the outsole and shoe upper in which the adhesive may function most effectively.

The process described is applicable both to leather outsoles and to natural or synthetic rubber outsole materials. With natural of synthetic rubber outsole materials in many cases it is desirable to provide a primer coat on the attaching surface of the outsole to improve the union between the thermoplastic adhesive and the outsole. Suitable primer compositions include a solution of chlorinated rubber in a volatile organic solvent or a solution of a relatively stable polyisocyanate, for example, a polyarylene polyisocyanate commercialy available as "PAPI."

The following examples are given to aid in understanding the invention. It is to be understood that the invention is not restricted to the particular materials, proportions or procedural conditions employed in the examples.

Example I

A polyester was prepared by the reaction of 1,4 butane diol with dimethyl terephthalate, isophthalic acid and azelaic acid, these three materials being used in molar ratios of 4.4:4.4:1.3. The condensation was carried out to form a resinous adhesive material having a melting point of about 120° C. (ball and ring). This material was formed into a rod of about 3/16" thickness and supplied to a melting and applying device which deposited it at a temperature of 245° C. as a molten adhesive band on the marginal attaching surface of an outsole. The band was about ½" wide, about 0.003" to about 0.004" in thickness in its thinner areas and with spaced parallel ribs 0.030" to 0.035" in thickness spaced about ⅛" apart and with the outer ribs about 1/10" from the edge of the band.

The bottom of a fabric-backed polyvinyl chloride plastic shoe upper was exposed to radiant heat for about four seconds to raise the temperature of the attaching surface of the shoe upper to about 120° to 130° F. and the outsole was spotted against this upper directly after deposition of adhesive on the outsole and the assembly placed in a sole attaching press equipped with a concave surfaced press pad. Pressure was applied to the extent of about 200 lbs. per sq. inch on the assembly and after 8 seconds the pressure was removed. On examination it was found that the sole was strongly attached to the shoe upper and that there had been no squeeze out of adhesive.

Example II

The procedure of Example I was repeated but 15 seconds were allowed to elapse between the application of adhesive to the outside and the spotting of the outsole on the upper and the application of attaching pressure. In this also the sole was strongly attached to the shoe upper and there was no squeeze out of adhesive.

Example III

The procedure of Example I was repeated using a six iron leather outsole. In this case also there was no squeeze out of adhesive and the sole was strongly and uniformly bonded to the shoe upper.

Example IV

The procedure of Example I was repeated but using a leather shoe upper. In this case the radiant heating of the attaching surface of the shoe was continued to raise the temperature of the attaching surface to about 160° F. Excellent sole attaching was obtained in which there was no squeeze out of the adhesive and the sole attaching bond was strong and uniform.

Example V

A polyester was prepared by the reaction and condensation of 1,4 butane diol and equimolar proportions of dimethyl terephthalate and isophthalic acid. Condensation was carried out to form a resinous material having a melting point of about 142° C. (ball and ring). This resin was formed into a flexible rod about ¼ inch in thickness and the rod was fed to a melting device disposed to provide molten adhesive to an outsole cementer. The nozzle of the cementer was provided with four orifices for extrusion of the molten resin adhesive, each orifice being 0.030 inch in diameter. The orifices were spaced about 0.10 inch apart. The melting device and cementer were adjusted to deliver molten resinous material through the nozzle to the surface of a leather outsole at a temperature of 350° F. The lines of resin deposited on the outsole solidified promptly after deposition and were found to have a thickness of about .025 and a width of about .040 inch.

The leather outsole was disposed with the surface carrying the lines of resin adhesive toward a radiant heat source for 15 seconds. The radiant heat raised the surface temperature of the leather to about 150° to 175° F.; and raised the temperature of the lines of adhesive to an extent that the resin became fluid and wet the surface of the leather.

At the same time the bottom of a shoe upper was exposed to radiant heat to raise the temperature of the attaching surface of the shoe upper to about 120° to about 140° F. The outsole was then "spotted" on the

upper and the assembly placed in a sole attaching press. Pressure was applied to the extent of 200 to 225 lbs. gauge pressure on the assembly, and after ten seconds the pressure was removed. On examination it was found that the sole was strongly attached to the shoe upper, that the edges of the sole were very "tight" to the upper and that there had been no squeeze-out of adhesive.

Example VI

A polyester was prepared by the reaction and condensation of ethylene glycol with a mixture comprising in terms of mol percentages 60% of dimethyl terephthalate, 20% isophthalic acid and 20% sebacic acid. Condensation was carried out to the extent of providing a melting point of 170° C. (ring and ball). This resin was formed into a rod and used for attaching leather soles to shoe uppers, using the procedure and conditions set forth in Example V but delivering the molten resinous material at a temperature of about 375° F. The sole was found to be strongly and tightly attached to the shoe upper.

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

1. The process of permanently attaching a shoe sole and a bottom of a shoe upper which comprises depositing hot molten substantially solvent-free thermoplastic synthetic polymeric resin adhesive over the attaching marginal surface of said sole, areas of said attaching margin disposed nearest the outer edge of said sole having less than sufficient adhesive for sole attaching and being adapted and arranged to accept adhesive forced from other areas of said attaching margin to resist squeeze out, the adhesive in said other areas being substantially thicker than in the first mentioned areas to provide a total quantity of adhesive in said attaching margin sufficient for adhesive connection between substantially the entire attaching marginal surface of said sole and adjacent areas of a shoe bottom, heating the bottom of the shoe upper, assembling said sole with its adhesive against said heated bottom with the adhesive in at least said areas of greater thickness in molten adhesive condition, exerting pressure to force the adhesive into permanent attaching relation with the heated surface of the shoe bottom and cooling the adhesive to establish rapidly a strong union of the sole and the shoe.

2. The process of permanently attaching a shoe sole and a bottom of a shoe upper as defined in claim **1** in which said other areas having greater thickness of adhesive are spaced bodies of adhesive continuous with adhesive on the first-mentioned areas of the attaching margin, said bodies being of such size and so located along said marginal attaching surface as to supply adhesive to areas with less than sufficient adhesive for sole attaching.

3. The process of permanently attaching a shoe sole and a bottom of a shoe upper as defined in claim **2** in which said spaced bodies are parallel ridges of adhesive extending the length of said marginal attaching surfaces and being of such size as to supply adhesive to areas with less than sufficient adhesive for sole attaching.

4. The process of permanently attaching a shoe sole and a bottom of a shoe upper which comprises depositing a band of hot molten substantially solvent-free thermoplastic synthetic polymeric resin adhesive over substantially the entire attaching marginal surface of said sole, a strip of said band extending the length of said band and disposed adjacent the edge of said band nearest the outer edge of said sole having less than sufficient adhesive for sole attaching and being adapted and arranged to accept adhesive forced from other areas of said band to resist squeeze out, the adhesive in said other areas being substantially thicker than in said strip to provide a total quantity of adhesive in said band sufficient for sole attaching adhesive connection between substantially the entire attaching marginal surface of said sole and adjacent areas of a shoe bottom, heating the bottom of the shoe upper, asembling said sole with its band of adhesive against said heated bottom with the adhesive in at least said areas of greater thickness in molten adhesive condition, exerting pressure to force the adhesive into permanent attaching relation with the heated surface of the shoe bottom and cooling the adhesive to establish rapidly a strong union of the sole and the shoe.

5. The process of permanently attaching a shoe sole and a bottom of a shoe upper as defined in claim **4** in which said other areas having greater thickness of adhesive are spaced parallel ridges of adhesive continuous with adhesive on said strip, extending the length of said marginal attaching surface and being of such size as to supply adhesive to areas with less than sufficient adhesive for sole attaching.

6. The process of permanently attaching a shoe sole and a bottom of a shoe upper as defined in claim **5** in which the adhesive in at least said areas of greater thickness is retained in molten adhesive condition for sole attaching by the sensible heat derived from the quantity and temperature of the adhesive applied.

7. The process of permanently attaching a shoe sole and a bottom of a shoe upper as defined in claim **5** in which the adhesive and the attaching surface of the sole are subjected to radiant heat to bring the adhesive to molten condition.

References Cited by the Examiner

UNITED STATES PATENTS

2,385,523	9/1945	Marasco	12—142
2,648,078	8/1953	Eppler	12—55
3,021,543	2/1962	Crowley	12—142
3,056,984	10/1962	Snitzer	12—142
3,168,754	2/1965	Rossitto	12—142

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