Nov. 25, 1952 J. J. BROPHY 2,618,796

STIFFENING UPPERS OF SHOES

Filed May 5, 1949 2 SHEETS—SHEET 1

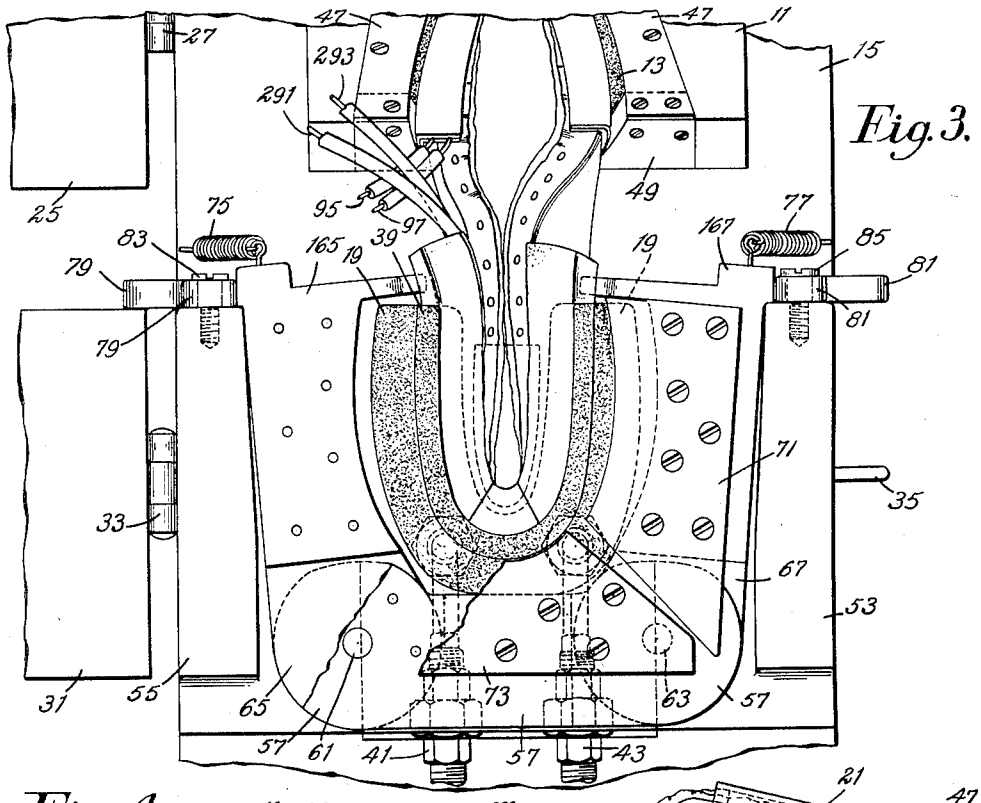


Fig. 3.

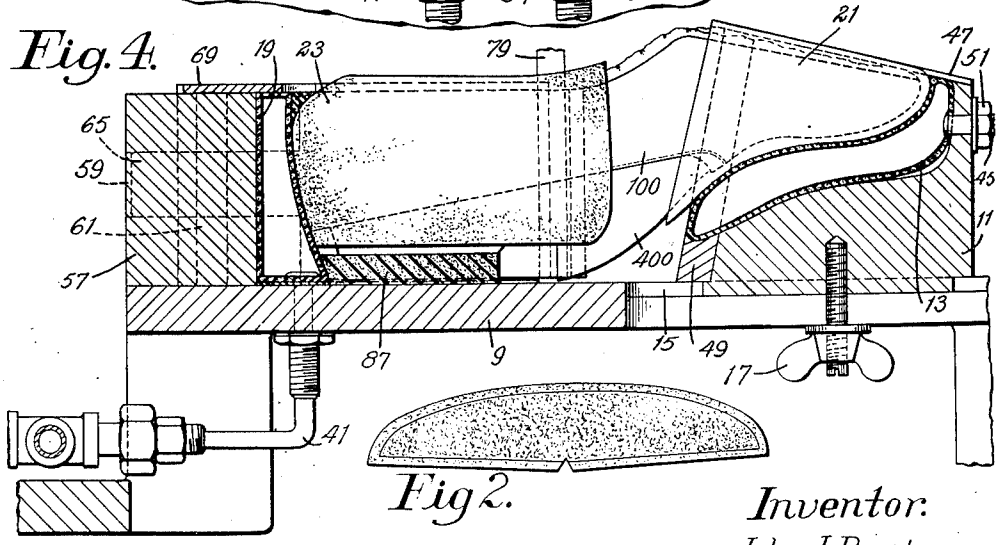


Fig. 4.

Fig 2.

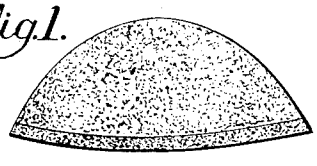


Fig. 1.

Inventor:
John J. Brophy.
By his Attorney.
Thomas J. Ryan.

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Filed May 5, 1949 2 SHEETS—SHEET 2

Fig 5.

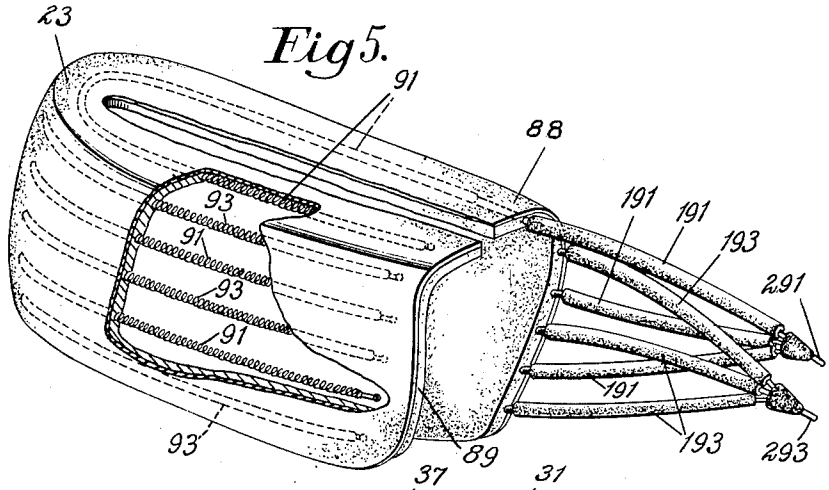


Fig. 6.

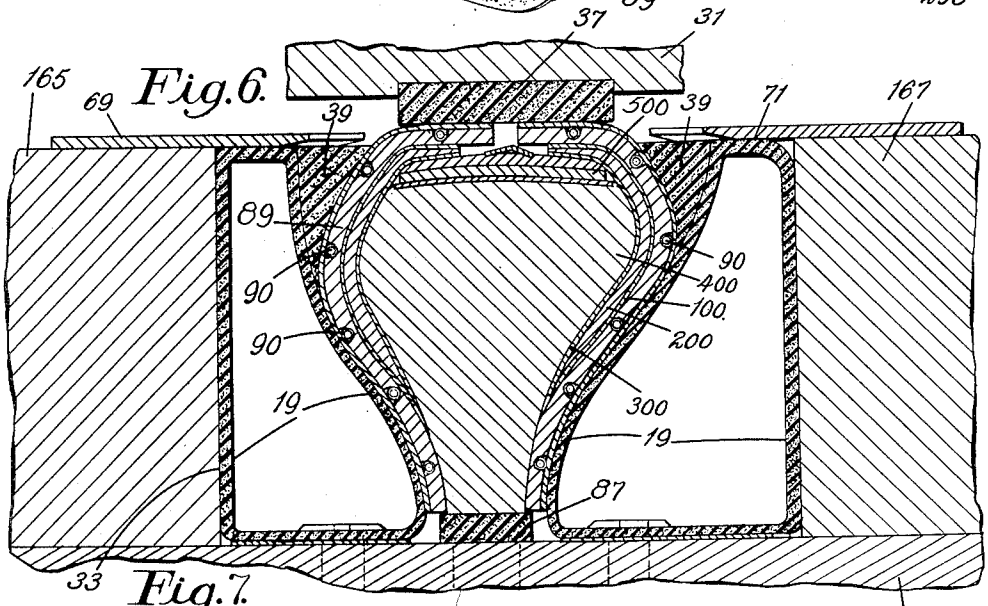
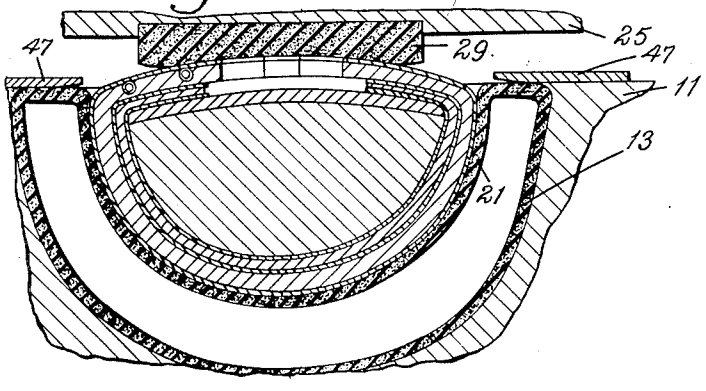


Fig. 7.



Inventor
John J. Brophy.
By his Attorney.
Thomas J. Ryan.

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UNITED STATES PATENT OFFICE

2,618,796

STIFFENING UPPERS OF SHOES

John J. Brophy, Salem, Mass., assignor to United Shoe Machinery Corporation, Flemington, N. J., a corporation of New Jersey

Application May 5, 1949, Serial No. 91,606

2 Claims. (Cl. 12—146)

1

This invention relates to stiffening selected portions of the uppers of shoes and is herein set forth in connection with stiffening the toe portions and the rear portions of uppers.

It is common to provide a toe stiffener blank, usually one having a fabric base impregnated with a stiffening substance, which can be softened and rendered limp by treatment with a solvent or with heat; to incorporate the softened blank in an assembled upper; and then to conform the upper with the softened blank to a last, the blank becoming hard and resilient upon evaporation of the solvent or upon dissipation of the heat.

There are certain disadvantages involved in the use of stiffener blanks of the general type outlined above. They can be most conveniently incorporated in the assembled uppers, and are usually so incorporated, just prior to the pulling-over operation, a special solvent-applying or heat-applying apparatus being provided for rendering them temporarily limp. They become hard and resilient as soon as the solvent has evaporated or the heat dissipated; but it is difficult to maintain them limp, and hence in condition for being conformed to the last, for just the right time, and then to have them become hard soon afterward so that the last may be removed from the upper. These and other disadvantages present very considerable difficulties to the use of such blanks as counter stiffeners so that, although toe stiffeners of the general type under discussion are widely used, no shoe manufacturer, so far as I am aware, uses them as counter stiffeners.

The patent to Schwartz No. 1,215,875 of February 13, 1917, discloses a method intended to avoid the disadvantages involved in the use of stiffener blanks which are given a preliminary treatment to render them soft and limp before they are conformed to the last. This patent discloses a method which comprises the use of a stiffener blank carrying shellac in powdered or broken form, whereby the blank is limp when cold and dry. Such a stiffener blank is incorporated in the assembled upper of a shoe and conformed to the last. After the shoe is lasted, the part of the upper which contains the stiffener blank is subjected to radiant heat to fuse the shellac whereby the particles of shellac are caused to run together so that, when the shellac hardens, a stiffened portion of the upper results. Shellac is not a satisfactory material for use in stiffening portions of the uppers of shoes; and subjecting the selected portion of the upper to radiant heat for approximately an hour at a temperature between 210° and 250° F., as is necessary in the patented

2

process, is extremely injurious to all but a very few kinds of leather. Consequently no one, so far as I am aware, has ever made use of the Schwartz process, said patent never having advanced at all the art of shoemaking.

According to the present invention there is incorporated in a selected portion of the upper in unheated, dry, limp form, stiffener material comprising a rigid heat-fusible thermoplastic resin, for example a vinyl resin. A vinyl resin as herein referred to is a resin which is a derivative of a compound containing the vinyl radical $CH_2{=}CH$ and in which there are no conjugated double bonds. The selected portion containing the stiffener material is then conformed to the shape in which it is to be stiffened, for example by lasting the upper, and subjected to the heating effect of a high-frequency field to convert it to a tough, strong, resilient condition. The high-frequency field generates heat directly in the stiffener material so that the material is heated rapidly without the necessity of transmitting heat through the layers of the assembled upper. The field need be applied for only a very short interval; there is no danger of injuring the upper of a shoe such as is present when radiant heat is used, and a stiffener material having a comparatively high melting or softening point can be employed.

In accordance with another aspect of the invention, the heating rate of the stiffener material may be increased by incorporating with it a substance having certain electrical properties as hereinafter described.

An apparatus for use in carrying out a step of the method is disclosed in divisional application Serial No. 610,110, filed August 10, 1945, now United States Patent No. 2,406,738 of September 3, 1946. This application is a continuation-in-part of my application Serial No. 564,605 filed November 22, 1944 which has matured into Patent No. 2,492,413, granted December 27, 1949.

Referring to the accompanying drawings,

Fig. 1 is a plan of a toe stiffener blank according to the present invention;

Fig. 2 is a similar view of a counter stiffener blank;

Fig. 3 is a plan of an apparatus for subjecting the front and rear portions of the upper of a lasted shoe to the heating effect of a high-frequency field, a shoe being shown in place, certain parts of the apparatus having been removed or broken away;

Fig. 4 is a vertical longitudinal section of the apparatus and lasted shoe shown in Fig. 3, the plate 69, which has been removed in Fig. 3, being shown;

Fig. 5 is a perspective of the rear electrode holder with the electrode;

Fig. 6 is a vertical cross section through the rear part of the apparatus and the shoe which are shown in Fig. 3; and

Fig. 7 is a vertical cross section through the forward part of the apparatus and shoe.

The stiffener blanks (Figs. 1 and 2) may be made by coating or impregnating a flexible sheet or porous base, such as cotton flannel, felt or paper, with a solution or dispersion of a stiffening material comprising a rigid heat-fusible thermoplastic resin, such, for example, as polyvinyl acetate, in a solvent, such for example, as acetone; treating the impregnated base with a nonsolvent liquid, such, for example, as water, which is miscible with the solvent but is not a solvent for the resin, so as to precipitate the resin in the base; and then drying the sheet.

The procedure outlined above for impregnating a porous sheet by precipitating in its interstices a rigid heat-fusible thermoplastic resin may be carried out in any suitable manner, for example, as disclosed in United States Letters Patent No. 1,256,240, dated February 12, 1918, and No. 1,353,599, dated September 21, 1920, both granted upon applications of Stanley P. Lovell. The dry sheet carrying the stiffener material in precipitated form, if stiffer than desired, may be rendered limp or flexible by any suitable treatment. For example, the sheet may be carried between moving belts which make sharp reverse turns over small rolls so as to bend the sheet sharply first in one direction and then in another; or the sheet may be run through a mangle and thus be rendered limp and flexible by reducing the precipitated stiffener material more or less to discrete particles. After the above treatment the stiffener blanks may be cut out of the sheet.

It may be desired to omit the precipitating step, in which case the solvent (or the water of a latex dispersion) may be caused to evaporate, and the dry sheet containing the stiffener material treated, if necessary, to render said sheet limp. It will be understood that the base, instead of being a separate member, may be some part of the assembled upper of a shoe, for example, the doubler, which has, for example, been cut out of an impregnated sheet. Also, if desired, the porous base may be omitted, and limp, easily conformable stiffener blanks produced by spraying a suitable solution or latex of a rigid heat-fusible thermoplastic resin in a suitable manner upon a smooth surface, peeling off the comparatively thick, porous sheet which results when the solvent has evaporated, and cutting out blanks from such a sheet. In any case, there will be incorporated in the upper of a shoe limp stiffener material comprising a rigid heat-fusible thermoplastic resin in a substantially discontinuous form which material, while unheated and dry, may be conformed with the upper to a last and the resin later caused to fuse and become continuous by subjecting the material to the heating effect of a high-frequency field. Advantageously the softening point of the material will be about 150° C. or lower.

In certain cases I have found it advantageous to impart to the material which is to be incorporated into the upper, a greater susceptibility to the heating effect of the high-frequency field than it normally possesses. It is well known in dielectric heating that, where a material fills the space between electrodes, the high-frequency electric energy dissipated per unit volume of material per unit of time is represented by the equation:

$$P_v = 2\pi K_o E^2 f e' \tan \delta \qquad (1)$$

where

K_o=the capacitance per unit cube of free space
E=the voltage gradient
f=the frequency
e'=the dielectric constant
δ=the loss angle

Where the material is being treated between electrodes, and where a series dielectric such as an air gap is present, the formula becomes:

$$P_v = \frac{BE^2 f e' \tan \delta}{k^2\left[1+2\left(\frac{e'}{e_i}\right)\left(\frac{1-k}{k}\right)+\left(\frac{e'}{e_i}\right)^2\left(\frac{1-k}{k}\right)^2(1+\tan^2\delta)\right]} \qquad (2)$$

where:

B=a constant
E, f, e', δ as defined above
e_i=the dielectric constant of the series dielectric
k=the ratio of the space occupied by the material to the total space occupied by the material and the series dielectric (spacing factor)

In a practical system comprising an oscillator, electrodes, and the material to be heated by the field between the electrodes, where such material is present in series with another dielectric, Equation 2 can be applied only as a general guide in ascertaining the optimum values of the dielectric characteristics e' and tan δ of the material because of the effect of other variables which affect the strength and configuration of the electric field. Experience, however, has shown that the best conditions for heating a mass of stiffener material incorporated into the upper of a shoe exist where the dielectric constant e' lies in the range of about 1–3 or somewhat higher and the tangent of the loss angle, tan δ, lies in the range of 0.7–2.0. Although these represent optimum values, a stiffener composition having a tan δ of only about .01 can be softened if the leather of the upper is dry. As used in the claims, the term "dielectrically heatable" as applied to the stiffener material implies the possession of dielectric loss characteristics such that the material when incorporated in an upper may be dielectrically heated to fuse the resin without burning the leather.

I have found, however, that the heating rate of the mass of stiffener material can be increased both absolutely and also relatively to the heating of the upper leather by the addition to the stiffener resin of as little as .5% of a substance which has at least one of its electrical characteristics e' and tan δ greater than the corresponding characteristic of the stiffener resin and neither of its electrical characteristics e' and tan δ substantially less than those of the resin. Additionally, the substance should be nonreactive with the stiffener resin lest by chemical association the dielectric loss of the resin be lowered. Conveniently the substance may be an organic compound, for example, ethylene glycol, having a melting point below that of the resin in which case the fusing temperature of the mass is lowered, apparently by the solvent or plasticizing effect of the melted organic compound upon the resin.

The addition of organic compounds to material in large quantities tends to adversely affect the

quality of the finished stiffener and, accordingly, it is preferred to limit the amount of an added organic compound to less than about 15% of the combined resin and compound, that is, less than about 18% by weight of the resin.

Limp stiffener blanks, for example, a toe stiffener blank (Fig. 1) and a counter stiffener blank (Fig. 2), may be incorporated in the upper of a shoe at any suitable stage in the manufacture of the shoe. Conveniently the blanks may be incorporated in and become part of the upper during the assembling of the parts of the upper in the stitching room. The upper may then go through the regular shoe-manufacturing operations, including being mounted upon and conformed to a last; and, at any time after the lasting has been completed, the toe and heel ends of the upper, with the conformed, limp stiffener therein, may be subjected to the heating effect of a high-frequency field.

The stiffening material, as has been stated, is preferably incorporated in selected portions of the upper by incorporating two separate stiffener blanks such as are shown in Figs. 1 and 2. In Fig. 6 a lasted upper is indicated at 100 a stiffener at 200, a lining at 300, and a last at 400. After the stiffeners have been incorporated in the upper and the upper has been lasted, the next step is to subject the selected portions of the upper to the heating effect of a high-frequency field. A convenient method of accomplishing this will now be described in connection with a suitable apparatus.

Referring first to Figs. 3 and 4, the apparatus comprises a base 9 upon which are mounted a front section and a rear section. The front section comprises a block 11 which is hollowed out to receive a flexible rubber bag 13 shaped to receive the toe portion of a lasted shoe, said block being adjustable toward and from the rear section in a guideway 15 formed in the base 9 and held in adjusted position by a clamping screw 17, the purpose of this adjustment being to provide for shoes of different lengths. The rear section also has a flexible bag 19 which is shaped to extend around the rear and sides of the shoe, and the wings or sides of which can be moved from open to closed position. Two electrode holders 21, 23, the details of construction of which will be described later, are placed respectively upon the toe portion and the rear portion of the upper on the lasted shoe, and then the lasted shoe, with the electrode holders in place upon it, is placed as shown in Figs. 3 and 4 with the electrode holder 21 resting against the bag 13 and the electrode holder 23 resting against the bag 19, the block 11 having been adjusted horizontally and locked in position by the clamping screw 17. A cover 25, which is hinged to the front section at 27, is swung over and down into horizontal position and fastened in this position by a hasp (not shown) on the cover, the slot in the hasp receiving a staple (not shown) driven into the block 11, a pin (not shown) being passed through the staple to hold the hasp in place. The cover 25 (Fig. 7) has set into it near its middle a block of resilient material 29 which presses down the electrode holder on the toe portion of the shoe. A similar cover 31 (Fig. 3), hinged to a stationary part of the rear section at 33, is swung over and its hasp (not shown) held by a staple 35 which is driven into a stationary part of the rear section. This cover 31 (Fig. 6) has set into it near its middle a block of resilient material 37 which presses the electrode holder 23 and the rear portion of the lasted shoe against the flexible bag 19. Next, the sides or wings of the rear bag 19 are forced inwardly in a manner presently to be described so as to press the sides or wings of the rear electrode against the upper and the upper against the sides of the rear portion of the last.

In the manufacture of shoes it is usual to tack an insole to a last, the heel end of the insole being somewhat narrower than the widest part of the rear end of the last so that there is a reentrant angle which extends around the heel end of the last and insole, said angle (Fig. 6) being bounded on one side by the edge of the insole 500 and on the other by the somewhat curved surface at the bottom of the heel end of the last. It is desirable that the finished stiffener should bridge this angle; and in order that the stiffener, while soft, shall not be forced into this angle, the inner wall of the bag at this locality is given sufficient rigidity. In the illustrated construction there is vulcanized or otherwise attached to the adjacent portion of the inner wall of the bag 19 a strip of resilient material 39, wedge-shaped in cross section, so that no objectionable crease or depression appears in the outer of the finished shoe.

With the shoe and the electrodes thus firmly held, a fluid under pressure, for example, compressed air, is forced through two pipes 41 and 43 into the rear bag 19 and through the pipe 45 into the front bag 13 to distend the bags. Thereafter the electrodes are energized from the terminals of an oscillator whereby the stiffening material which, when prepared by precipitation or by flexing of a sheet, comprises a layer of discrete particles, is caused to fuse and fill the voids therein whereby finally, it becomes substantially continuous, hard, and resilient. The purpose of the pressure is twofold. First, it presses the electrodes, which are flexible, firmly into contact with the shoe, thereby rendering them much more effective. Second, it presses the outer, the stiffening material, and the lining of the shoe into firm contact with each other so that the three members are firmly bonded together in the finished shoe.

Although the pressure applied by the bags serves to press together the outer, the stiffening material and the lining, to facilitate bonding, it has been found that adequate bonding is ordinarily obtained without external pressure by the pressure exerted between the lasted over upper and the last.

The general construction and mode of operation having been given above, a detailed description of the parts of the apparatus will be found in United States Letters Patent No. 2,406,738 referred to above.

Example I

	Parts by weight
Polyvinyl acetate R. H. #410	45
Acetamide	15
Acetone	90

Polyvinyl acetate R. H. #410 is a polymerized vinyl acetate put out by the E. I. du Pont de Nemours & Co., Inc., of Wilmington, Delaware, and has a softening range of 65–75° C. Its electrical characteristics ϵ' and $\tan \delta$ are respectively about 3 and .02 while those of acetamide are about 3.75 and .1045 respectively, the acetamide assisting the heating and fusion of the polymer. Cotton duck was dipped in the solution, and the resin was precipitated in a water solution. The

duck was dried, a stiffener blank cut therefrom and incorporated into a toe portion of the upper of a shoe. The portion was subjected to a high-frequency electric field and a tough, resilient toe was obtained.

The following are examples of solutions which may be used to prepare a stiffener material for stiffening a portion of a shoe as described above.

Example II

	Parts by weight
Normal propyl methacrylate	35
Acetamide	12
Acetone	80

Example III

	Parts by weight
Normal butyl methacrylate	35
Acetamide	12
Acetone	80

Example IV

	Parts by weight
Vinylite VYLF	85
O-nitrodiphenyl	15
Methyl ethyl ketone	170

Vinylite VYLF, put out by Carbide and Carbon Chemicals Corporation, of New York, New York, is a vinyl chloride-vinyl acetate copolymer, having a softening range of 85–95° C. while its e' and tan δ are about 3 and .02 respectively. O-nitrodiphenyl has a melting point of 37° C. and is used to assist the heating and fusing of the polymer.

Example V

	Parts by weight
Pliolite latex 190	80
Diethyl amine	10

Pliolite latex, put out by Goodyear Tire and Rubber Co., of Akron, Ohio, is a dispersion of a styrene-butadiene copolymer (30% solids in water), and has a softening range of 70–80° C., an e' of about 2.5 and tan δ of about .0005.

Diethyl amine is a liquid at 20° C. and boils at 55–56° C., and is used to assist the heating and fusing of the polymer.

Example VI

	Parts by weight
Lustron latex X600	85
Ethylene glycol	12

Lustron latex X600, put out by Monsanto Chemical Co., of St. Louis, Missouri, is a polystyrene water dispersion latex, having a softening range of 120–130° C. The e' and tan δ of polystyrene are about 2.5 and .0001 respectively.

Ethylene glycol is a liquid boiling at 197° C. and is used to assist the heating and fusing of the polymer.

Example VII

	Parts by weight
Geon 204	82
O-nitrodiphenyl	11
Methyl ethyl ketone	175

Geon 204, put out by B. F. Goodrich Co., of Cleveland, Ohio, is a polyvinyl chloride-polyvinylidene copolymer softening at about 150° C.

Example VIII

	Parts by weight
Vinylite XYHL	20
Orthodichlorobenzene	2
Ethyl alcohol	80

Vinylite XYHL, put out by Carbide and Carbon Chemicals Corporation, of New York, New York, is a vinyl acetal (butyral) polymer having a softening range of 95–105° C. This polymer has an e' of 3.5 and a tan δ of .006.

Orthodichlorobenzene is a liquid having a boiling point of 179° and is used to assist the heating and fusion of the polymer.

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

1. In a method of producing a stiffening portion in a shoe, the steps comprising incorporating in a selected portion of the upper in unheated, dry, limp form dielectrically-heatable stiffener material comprising a heat-fusible, thermoplastic resin capable of hardening said material in rigid form following heat treatment thereof and an organic compound nonreactive with said resin, said compound having at least one of its electrical characteristics e' and tan δ greater than the corresponding characteristic of the resin and having neither of its said electrical characteristics substantially less than those of the resin, conforming the selected portion containing the resin to the shape in which it is to be stiffened, and subjecting it to the heating effect of a high-frequency electric field to fuse the resinous material.

2. In a method of producing a stiffened portion in a shoe, the steps comprising incorporating in a selected portion of the upper prior to pulling over and lasting an unheated dry, limp dielectrically-heatable blank comprising a thermoplastic resin material capable of hardening said blank in rigid form following heat treatment thereof, said blank additionally comprising not more than 15% by weight of an organic compound having characteristics e' and tan δ not substantially less than the plastic material and at least one of said characteristics greater than said material, said compound being substantially nonreactive therewith, associating the upper with a sole member, conforming the selected portion to its desired final shape, and heating the blank by subjecting it to a high-frequency electric field to harden said blank.

JOHN J. BROPHY.

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