Sept. 1, 1959 E. E. JOINER ET AL 2,901,841

HEEL ATTACHING WITH RESIN MIXTURES

Filed July 16, 1958

Fig. 1

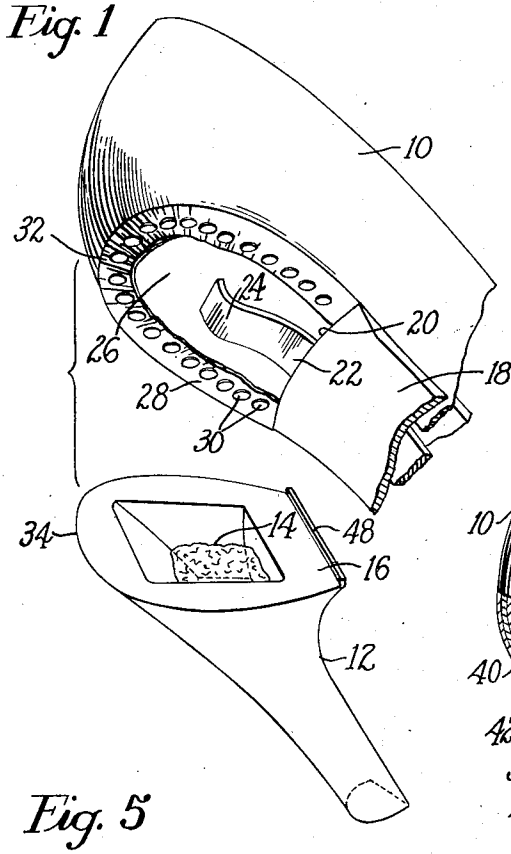


Fig. 2

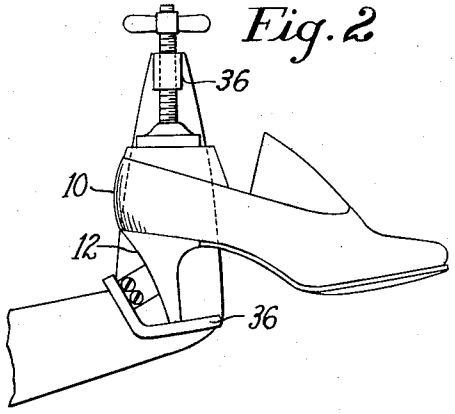


Fig. 3

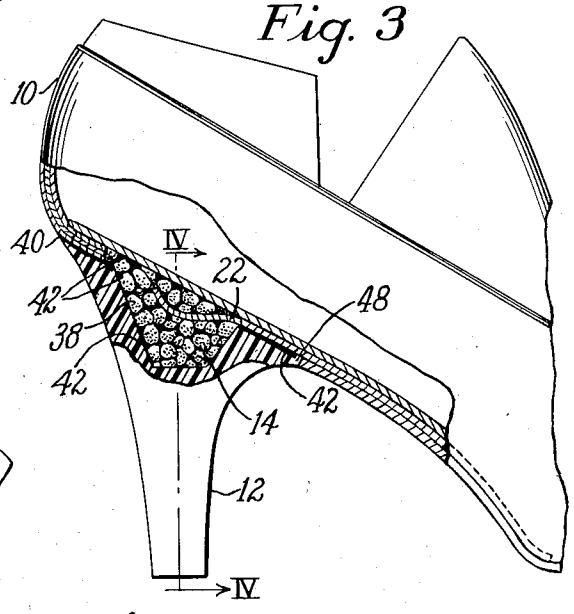


Fig. 5

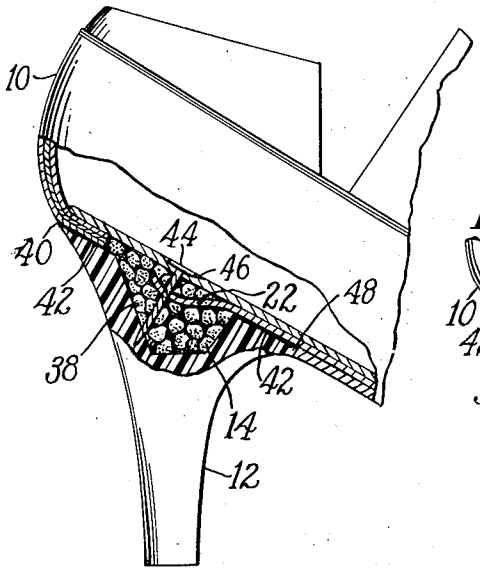
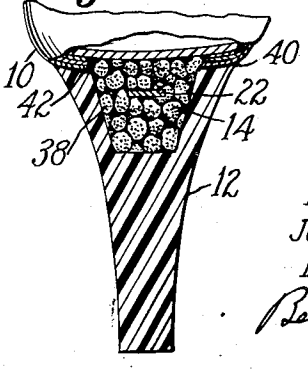


Fig. 4



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HEEL ATTACHING WITH RESIN MIXTURES

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10 Claims. (Cl. 36—24.5)

This invention relates to attachment of heels to shoes, and particularly to a method for attaching heels to shoes which does not require the use of permanent metallic fasteners.

The usual method of attaching a heel to a shoe is by a metallic fastener such as a nail or screw which must be inserted by complicated and expensive machinery. Such customary fastenings present disadvantages in many styles of shoes, particularly women's shoes. A metallic fastening in a shoe creates a rough, uncomfortable surface at the heel seat where the clinched fastening is covered with a thin lining. Such a metallic fastening tends to corrode, causing staining and deterioration of the leather and often tends to work loose, while in use, puncturing the lining and irritating the wearer's heel. If the fastening for a currently fashionable narrow thin heel is large enough to be secure, it may be so large as to split such a slim wooden or plastic heel, resulting in an expensive reject or an unsafely attached heel.

In an attempt to overcome the undesirable features of the mechanical fasteners, various methods to attach a heel to a shoe using a plastic rather than a mechanical bond have been suggested, for example in United States Letters Patent No. 2,299,195, granted October 20, 1942, on an application filed in the name of A. E. Ushakoff, and No. 2,447,512, granted August 24, 1948, on an application filed in the name of J. F. Leahy. But such methods require some additional mechanical adaptation, such as physically shaping the heel or shoe upper to provide an interlocking relationship between the plastic and the heel and heel seat. This involves an expensive departure from conventional shoe and heel manufacturing methods. Heel attaching by injection of the plastic material requires a hollow heel with its accompanying structural weakness. The handling of the plastic material itself has proven to be a problem. Even with the shoe bottom and the heel clamped together, it is found that the fluid plastic may stiffen to a degree which prevents complete filling of spaces and bonding of surfaces or on the other hand may exude from between the shoe parts before sufficient pressure can be exerted to force it into the crevices and recesses to bond the shoe parts into a unitary structure.

It is the general object of the present invention to provide a method of attaching a heel to the heel seat of a shoe in a unitary strong, light, rigid structure. It is a further object of the invention to provide a method of joining a heel, especially a solid plastic heel, to a shoe with a plastic material by a relatively simple and inexpensive method which does not require complicated or expensive machinery and which is adaptable to mechanical assembly line technique. It is a further object of this invention to provide a shoe with an interior heel seat of permanently smooth surface construction presenting a more comfortable wearing article of footwear.

We have found that a heel and heel seat of a shoe may be strongly and firmly united in a continuous unitary structure by inserting into a recess provided in the top face of the heel, a special plastic material self-expandable to form a heavy-walled cellular structure having exceptional resistance to crushing under localized pressure. The heel is assembled against the heel seat and the plastic material is expanded by internal pressure to fill the void between the heel and heel seat of the shoe and to wet and bond the entire surface areas in the recesses contained between the peripheral rim of the heel and overlasted upper, thus filling the entire width of the heel-seat area. The expanded plastic material is then cured to a hard rigid body permanently and strongly bonding the parts into a unitary structure.

The features of this invention are further illustrated by a description of the accompanying drawings.

In the accompanying drawings,

Fig. 1 is an angular view of a heel and shoe before heel-attaching;

Fig. 2 is an elevational view on a reduced scale of the heel and shoe held in assembled relationship by clamping mechanism;

Fig. 3 is an elevational view partly in section of the heel section of a lasted shoe with the heel secured by expanded resin according to the present invention;

Fig. 4 is a transverse vertical cross-sectional view taken on line IV—IV of Fig. 3; and

Fig. 5 is an elevational view partly in section of the heel section of a lasted shoe with the heel temporarily secured by a removable fastening agent during the permanent attaching process.

A heel **12** useful in the process of the present invention, as shown in Fig. 1, is formed with a recess **14**, in the heel-seat engaging surface **16**, which surface flares outwardly toward the peripheral rim **34** of the heel **12**. A ridge **48** is provided along the heel breast edge of rim **34** to provide a substantially fluid tight seal when pressed against the shoe bottom. The recess **14** is of a size to provide a volume large enough for effective expansion of the filling and bonding resin mixture. The outward flare of the top surface **16** offers a generous surface area for the bonding of upper **10** and heel **12** by the resin.

The shoe upper **10** is of conventional design with the sole **18** terminating at **20** in the vicinity of the heel breast. A special steel shank **22** provided with an offset portion **24** extends beyond the sole **18** into the heel-seat portion **26** of the shoe upper **10** so that it will project into the heel recess **14** when the heel and shoe upper are assembled (see Fig. 3) and be embedded in the expanding resin. It will be understood that conventional shanks may be used and be bonded by the expanding resin to provide a firm union between resin and shank. The overlasted margin **28** of the shoe upper is secured by lasting tacks **30** which are driven around the rim of the heel seat in the conventional manner. This marginal area provides an advantage to the bonding action of the resin mixture by offering many small recesses **32** around the tacks **30** and the crevices formed in lasting the shoe, to receive and hold the resin. When the shoe upper **10** and the heel **12** are joined in opposing relationship, the recess **14** and the heel seat portion of the shoe upper **26** define a closed chamber to contain the resin mixture.

The special resin mixture which is the unifying mechanism of the present invention is a combination of expandable thermoplastic particles or beads preferably polystyrene beads and a liquid thermosetting resin, with a curing agent for the thermosetting resin. The method which is explained in most detail later involves thoroughly and intimately mixing the expandable beads, at room temperature, with the warmed thermosetting resin, adding the curing agent, also at room temperature, and stirring the entire mixture to uniform consistency.

The expandable polystyrene beads preferably employed are known per se and comprise a base of styrene polymer

with a volatile organic liquid which is a non-solvent for the polymer absorbed therein, and homogeneously dispersed throughout the beads. Upon heating to the boiling point of the organic liquid, but below the softening point of the polymer, the liquid volatilizes and, in a closed mold, expands the styrene polymer into a cellular substance. Such expandable polystyrene beads are disclosed in United States Letters Patent No. 2,744,291, granted May 8, 1956, in the name of Fritz Stastny, and No. 2,816,827, granted December 17, 1957, in the name of Murray H. Roth. The beads range in diameter from 1 to 3 mm., with those of the smaller dimension averaging about 1.4 mm. and those of the larger about 2.8 mm.

The preferred thermosetting resin is a polyepoxide which binds together the polystyrene beads and bonds the heel to the shoe upper to secure the mass together in a unitary combination. The polyepoxide is a resinous glycidyl polyether of a member of the group consisting of polyhydric phenols, polyhydric alcohols, and mixtures of these. The polyepoxides are complex resinous materials and may be produced by the reaction of polyhydric phenols with a polyfunctional chlorohydrin such as epichlorohydrin and glycerol dichlorohydrin. The preparation of epoxide resins is shown in United States Patents Nos. 2,506,486 to Bender et al., granted May 2, 1950, and 2,589,245 to Greenlee, granted March 18, 1952.

The epoxide resins used in the present invention are liquid at room temperature, with aviscosity at 25° C. of from about 3600 to 15000 cps. The range of epoxy equivalents is from about 170 to 210 and the molecular weight is between 340 and 400. Such epoxy resins are commercially available as Epon 828 or 820, made by the Chemical Division, Shell Union Oil Co., and Araldite 6005, made by the Ciba Company, Inc.

The epoxide resin is curable to a hard, strong state by the action of a catalyst, such as the aliphatic primary or secondary amines having a molecular weight of at least 100. Included in such amines are ethylene diamine, triethylene tetramine, and dimethyl amino propyl amine.

A modifying agent which may be a high boiling alcohol may be used to secure uniformity of reaction.

The proportion of thermosetting resin relative to the beads is preferably high enough to ensure development of sufficient exothermic heat of reaction to cause effective expansion of the beads to force the resin into firm contact with the surfaces of the heel and heel seat. It is also important that there be enough thermosetting resin to flow into the narrow crevices and recesses of the assembly to secure all-over bonding of the heel to the heel seat. Suitably there will be used from about 1 to about 2 parts by weight of expandable beads to one part by weight of the liquid thermosetting resin.

The mixing procedure employed where polyepoxide resin is used involves heating the epoxide resin to 150° to 190° F., preferably from 180° to 190° F., adding the polystyrene beads at room temperature, and quickly stirring the mixture to insure uniformly wetting the exterior surfaces of the beads with the warm epoxide resin. The curing agent, also at room temperature, is stirred vigorously into the combination, and finally the modifier is added and the entire mixture stirred to uniform condition.

The warm resin mixture is deposited in the recess **14** of the heel **12**. The epoxide resin curing reaction generates sufficient heat to increase the temperature of the mixture to cause expansion of the polystyrene beads. This requires a compact body of a substantial quantity of the resin mixture so that the heat generated will not escape too rapidly. If there is too rapid a transfer of the heat from the reaction, the mixture will not attain a temperature high enough to cause the uniform expansion of the polystyrene beads by the volatilization of the organic liquid occluded in the beads.

With a mass of this resin contained in the heel recess **14**, the heel **12** is assembled against the shoe upper **10** of a lasted shoe, as in Fig. 2, thus defining a closed chamber, and is held in position by a clamp **36**, for a period of sufficient duration to allow the polystyrene beads to expand from internal pressure and the resin to cure. The polystyrene beads expand into a body having fine cellular structure, with each cellular body surrounded by a film of the epoxide resin thus forming a thicker walled cellular structure which serves as binder and reinforcement. The expanding beads drive the epoxide resin outward to coat and adhere to the surfaces it contacts. The entire process from placing the resin mixture in the heel recess **14** to removing the assembled shoe from the clamp may require a matter of from 2 to 20 minutes. The time and the degree of bead expansion may be controlled to some extent by the preheat temperature of the epoxide resin.

Figs. 3 and 4 show the polystyrene beads **38** expanded by the heat developed by the catalytic polymerization of the epoxide resin. The expanding beads increase the volume of the resin mixture until it fills the entire cavity and surrounds the shank **22**, wetting and strongly adhering to all the surfaces it contacts. The expanded polystyrene beads **38** are themselves too large to penetrate the slim crevices between the heel **12** and the shoe upper **10**, but the increase in volume forces the fluid epoxide resin itself free from the beads into the recesses **32** and into these crevices out to the feather edge **40**, depositing a thin layer of solid resin **42**, forming an extremely strong joint at these edge portions. As it is cured, the resin is bonded in an interlocking relationship to the surface of the recesses **32** provided in the shoe parts.

The special steel shank **22** with the offset portion **24** is firmly embedded in and held by the expanded resin mixture. The thick cell walls of thermoset resin surrounding the expanded thermoplastic resin particles are strongly resistant to crushing and hold the shank rigidly to the heel and shoe. The epoxide resin between the heel seat and the heel cures to form an extremely tough bond engaging the area of the overlasted upper **28**, and filling all the recesses **32** contained therein out to the feather edge **40**. All the voids between heel and shoe are thus filled to present a continuous, solid attachment of heel to shoe and an all-over support for the wearer's heel while contributing to comfort.

As shown in Fig. 5, an alternative device for holding heel **12** and shoe **10** together is a temporary heel attaching member such as a nail or screw **44** extending through the insole **46** at the heel seat and extending into the heel. This device has the practical advantage of eliminating the need for special clamps. Also, the shoe may be handled for breast flap work while the resin is curing. The use of a temporary nail or screw permits the rapid assembly of shoe and heel parts which may be removed when convenient or left in place if further mechanical strengthening of the bond is desired and it is not detrimental to the appearance of the finished shoe. The invention is not limited to using clamps, nails or screws but may use any other device to hold shoe upper and heel in immovable relationship until the resin mixture has cured into a tight rigid bond.

The following example is given to aid in understanding the present invention, but it is to be understood that the invention is not restricted to the specific composition and procedure described below:

Example I

	Parts by weight
Polystyrene beads containing volatile liquid for expansion	120
Epoxide resin	100
Curing agent (diethylene triamine)	20
High-boiling alcohol	10

The epoxide resin was a glycidyl polyether liquid at room temperature with a viscosity at 70° F. of 8,000 cps. and at 170° F. of 80 cps., and a specific gravity at 25° C. of 1.2. It had a reactivity range of epoxy equivalents of 173–179. The expandable polystyrene beads had a range in diameter of from 1 to 1.5 mm., with an average of about 1.4 mm.

The epoxide resin was heated to about 170° F. and the polystyrene beads, at room temperature, were added and stirred in rapidly so as to insure uniform wetting of the exterior surfaces of the beads with the liquid resin, thereby allowing the beads in expanding to be reinforced by films of the thermosetting hard epoxide resin which forms a thicker walled cellular structure. The curing agent, at room temperature, was then stirred vigorously into the combination, and finally the alcohol was added, and the entire mixture stirred to uniform condition.

5.5 ml. of the liquid mixture while still hot was deposited in the recess of a size 7 heel for a shoe, as described above, and the heel was then clamped to its corresponding overlasted upper which was provided with a shank stiffener, as previously described. The clamp was removed after ten minutes, at which time the mixture had expanded and solidified. When examined the following day, the heel, shank stiffener and shoe upper were found to be firmly and strongly united together by the expanded and hardened resin and the interior heel seat presented a smooth surface. When the shoe was cut open, it was found that the original volume had expanded from 5.5 ml. to a volume of roughly 15 ml.

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 of permanently attaching a heel to a shoe, which comprises providing an overlasted upper of a shoe and a heel having a recess in the heel-seat engaging surface, depositing in said recess a quantity of a fluid resin mixture comprising a liquid thermosetting resin and particles of a thermoplastic resin containing therein a blowing agent, assembling the heel in opposing relationship to the heel seat of the overlasted shoe upper thereby defining a closed chamber, holding said heel and heel seat together, supplying heat to cause gases to evolve from said blowing agent contained in said particles of thermoplastici resin to expand said particles to increase the volume of the resin mixture to fill said chamber and force portions of the liquid thermosetting resin by internal pressure into crevices between the heel and heel seat of the overlasted shoe upper, and maintaining the heel and overlasted upper in opposing relationship until the liquid thermosetting resin mixture has cured into a hard rigid body uniting the heel and shoe into a unitary structure.

2. A method of permanently attaching a heel to a shoe, which comprises providing an overlasted upper of a shoe including a shank stiffener with an end extending into the heel-seat portion, providing a heel having a recess in the heel-seat engaging surface, depositing in said recess a quantity of a fluid resin mixture comprising a liquid thermosetting resin and particles of a thermoplastic resin containing therein a blowing agent, assembling the heel in opposing relationship to the heel seat of the overlasted shoe upper thereby defining a closed chamber with the end of said shank stiffener in said chamber, holding said heel and heel seat together and supplying heat to cause gases to evolve from said blowing agent contained in said particles of thermoplastic resin to expand said particles to increase the volume of the resin mixture to fill said chamber and surround said end of said shank stiffener and force portions of said liquid thermosetting resin by internal pressure into crevices between the heel and heel seat of the overlasted shoe upper, and maintaining the heel and overlasted upper including the shank stiffener in opposing relationship until the liquid thermosetting resin mixture has cured into a hard rigid body uniting the heel, shank stiffener and shoe into a unitary structure.

3. A method of permanently attaching a heel to a shoe, which comprises providing an overlasted upper of a shoe and a heel having a recess in the heel-seat engaging surface, depositing in said recess a quantity of a fluid resin mixture comprising a liquid resinous glycidyl polyether, a curing agent for said resinous glycidyl polyether, and expandable polystyrene beads containing therein a homogeneously dispersed volatile organic liquid whose boiling point is lower than the softening point of the polystyrene, assembling the heel in opposing relationship to the heel seat of the overlasted shoe upper thereby defining a closed chamber, holding said heel and heel seat together, supplying heat to volatilize said organic liquid dispersed in said polystyrene beads to expand said beads to increase the volume of the resin mixture to fill said chamber and to force portions of said liquid resinous glycidyl polyester by internal pressure into crevices between the heel and heel seat of the overlasted shoe upper, and maintaining the heel and overlasted upper in opposing relationship until the resin mixture has cured into a heavy-walled crush-resistant cellular structure constituting a hard rigid body uniting the heel and shoe into a unitary structure.

4. A method of permanently attaching a heel to a shoe, which comprises providing an overlasted upper of a shoe, providing a heel having a recess in the heel-seat engaging surface, depositing in said recess a quantity of a fluid resin mixture comprising a liquid resinous glycidyl polyether, a curing agent for said resinous glycidyl polyether, and expandable polystyrene beads containing therein a homogeneously dispersed volatile organic liquid whose boiling point is lower than the softening point of the polystyrene, the deposited resin mixture constituting a body of sufficient cross section that exothermic heat evolved in curing the glycidyl polyether causes expansion of said polystyrene beads, assembling the heel in opposing relationship to the heel seat of the overlasted shoe upper thereby defining a closed chamber, holding said heel and heel seat together, and by the exothermic heat of the curing reaction volatilizing said organic liquid dispersed in said polystyrene beads to expand said beads to increase the volume of the resin mixture to fill said chamber and to force portions of said liquid resinous glycidyl polyether by internal pressure into crevices between the heel and heel seat of the overlasted shoe upper, and maintaining the heel and overlasted upper in opposing relationship until the liquid resin mixture has cured into a heavy-walled crush-resistant cellular structure constituting a hard rigid body uniting the heel and shoe into a unitary structure.

5. A method of permanently attaching a heel to a shoe, which comprises providing an overlasted upper of a shoe including a shank stiffener with an end extending into the heel-seat portion, providing a heel having a recess in the heel-seat engaging surface, depositing in said recess a quantity of an expandable fluid resin mixture comprising a liquid resinous glycidyl polyether, a curing agent for said resinous glycidyl polyether, and expandable polystyrene beads containing therein a homogeneously dispersed volatile organic liquid whose boiling point is lower than the softening point of the polystyrene, the deposited resin mixture constituting a body of sufficient cross section that exothermic heat evolved in curing the glycidyl polyether causes expansion of said polystyrene beads, assembling the heel in opposing relationship to the heel seat of the overlasted shoe upper thereby defining a closed chamber, holding said heel and heel seat together, and by the exothermic heat of the curing reaction volatilizing said organic liquid dispersed in said polystyrene beads to expand said polystyrene beads into cellular bodies, said cellular bodies being surrounded by and embedded in a continuous phase of said resinous

glycidyl polyether, the expansion of said beads increasing the volume of said resin mixture to fill said chamber to force portions of said liquid resinous glycidyl polyether by internal pressure into crevices between the heel and heel seat of the overlasted shoe upper, and maintaining the heel and overlasted upper in opposing relationship until the liquid resin mixture has cured into a heavy-walled crush-resistant cellular structure constituting a hard rigid body uniting the heel and shoe into a unitary structure.

6. A method of permanently attaching a heel to a shoe, which comprises providing an overlasted upper of a shoe and a heel having a recess in the heel-seat engaging surface, depositing in said recess a quantity of a fluid resin mixture comprising a liquid resinous glycidyl polyether, a curing agent for said resinous glycidyl polyether, and expandable polystyrene beads containing therein a homogeneously dispersed volatile organic liquid whose boiling point is lower than the softening point of the polystyrene, assembling the heel in opposing relationship to the heel seat of the overlasted shoe upper thereby defining a closed chamber, inserting a removable mechanical fastening means through said heel seat and into said heel to hold said heel and heel seat together, and by the exothermic heat of the curing reaction volatilizing said organic liquid dispersed in said polystyrene beads to expand said beads to increase the volume of the resin mixture to fill said chamber and to force portions of said liquid resinous glycidyl polyether by internal pressure into crevices between the heel and heel seat of the overlasted shoe upper, and maintaining the heel and overlasted upper in said opposing relationship until the liquid resin mixture has cured into a heavy-walled crush-resistant cellular structure constituting a hard rigid body uniting the heel and shoe into a unitary structure.

7. In combination, a shoe upper including a shank stiffener with an end extending into the heel-seat portion, a heel attached to said upper having a recess in the heel-seat engaging surface, and a body of thick-walled cellular resin filling said recess and surrounding said end of said shank stiffener and adhering to said shank stiffener and to the walls of said recess and to the heel seat of said shoe upper, and portions of said resin extending out into the crevices between the heel and heel-seat to hold said heel, shank stiffener and shoe upper firmly together.

8. In combination, a shoe upper, a heel attached to said upper, said heel having a recess in the heel seat engaging surface, and a body comprising particles of a fine cellular thermoplastic resin surrounded by and embedded in a cured thermosetting resin, filling said recess and adhering to the walls of said recess and to the heel seat of said shoe upper and portions of said cured thermosetting resin substantially free from particles of said fine cellular thermoplastic resin extending out into the crevices between the heel and heel-seat to hold said heel and shoe upper firmly together.

9. In combination, a shoe upper, a heel attached to said upper, said heel having a recess in the heel-seat engaging surface, and a body comprising particles of a fine cellular polystyrene resin surrounded by and embedded in a cured resinous glycidyl polyether filling said recess and adhering to the walls of said recess and to the heel seat of said shoe upper and portions of said resinous glycidyl polyether substantially free from particles of said fine cellular polystyrene resin extending out into the crevices between the heel and heel seat to hold said heel and shoe upper firmly together.

10. In combination, a shoe upper including a shank stiffener with an end extending into the heel-seat portion, a heel attached to said upper having a recess in the heel-seat engaging surface, and a body comprising particles of a fine cellular polystyrene resin surrounded by and embedded in a cured resinous glycidyl polyether filling said recess and surrounding said end of said shank stiffener and adhering to said shank stiffener and to the walls of said recess and to the heel seat of said shoe upper and portions of said resinous glycidyl polyether extending out into crevices between the heel and heel-seat to hold said heel, shank stiffener and shoe upper firmly together.

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