APPARATUS FOR HEAT TREATING AN ARTICLE OF FOOTWEAR
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7 Claims. (Cl. 12--1)

The present application is a divisional application of U.S. patent application Serial No. 82,462, filed January 13, 1961, and now abandoned.
The present invention relates generally to footwear and more particularly to a novel apparatus for heat treating an article of footwear in manufacture thereof.

In recent years, footwear having a light, flexible, elastomeric sole portion secured to a fabric, leather or composition upper have come into increased usage, particularly for leisure-time wear. The lightness and high degree of flexibility of the latter footwear make this type of footwear very comfortable, and in many instances this footwear has replaced the conventional leather slipper because of the relative ease of manufacture and reduction in cost.

In the manufacture of certain footwear having an elastomeric sole portion secured to an upper portion, it has heretofore been customary to stitch or cement the sole portion to the upper. Thus, certain types of footwear, such as slippers having a flexible elastomeric sole, for example, are generally made by securing an upper to a preformed elastomeric sole portion by a stitching or cementing operation. In making the usual cloth slipper, one or more side wall sections comprising the vamp and quarter or upper is stitched or cemented to an insole portion which, in turn, is stitched or cemented to a preformed sole. Since the glue or cement used to secure the sole portion to the upper is subject to being washed out when contacted with hot cleaning solutions and the stitches commonly used to secure the sole portion to the upper tend to break, the useful life of footwear of the foregoing type has been relatively limited and the multiplicity of intricate manufacturing operations are quite costly.

In other footwear, a rubber sole portion has been vulcanized to an upper by placing a pre-assembled footwear upper and rubber sole in a suitable mold and heating the assembly for an extended period to form and cure the rubber sole composition. The vulcanization process is time-consuming and this materially adds to the cost of the article. Moreover, the vulcanized sole is relatively heavy and often has a disagreeable odor.

In footwear of the foregoing type, it is also often desirable to provide some added cushioning means associated with the insole or the outer sole. Thus, a flat section of sponge rubber or the like having the form of the insole is often securely cemented to the insole or inner surface of the sole by applying a continuous coating of cement to one side of the section of sponge rubber and securing it to the insole or outer sole before joining the upper to the sole. When the sole material is relatively stiff or inflexible and unyielding, a thicker section of sponge rubber or the like material is required. The latter requirement, of course, further increases the cost of the footwear.

It is an object of the present invention to provide a novel apparatus for use in the manufacture of footwear having an elastomeric sole.

Other objects of the present invention will be apparent to those skilled in the art from the following detailed description and claims to follow when read in connection with the accompanying drawings wherein:

FIG. 1 is a side elevational view partially in vertical section of an article of footwear embodying the present invention;
FIG. 2 is a bottom plan view of the article of footwear shown in FIG. 1 with a portion of the structure broken away to show the interior thereof;
FIG. 3 is a transverse vertical sectional view along the line 3--3 of FIG. 1;
FIG. 4 is a side elevational view partially in vertical section of a modified form of the present invention;
FIG. 5 is a fragmentary side elevational view of apparatus used in the manufacture of footwear shown in FIGS. 1 and 4 with wall sections of the apparatus removed to show the interior thereof; and
FIG. 6 is a fragmentary perspective view partially in section showing additional apparatus used in the manufacture of the footwear shown in FIG. 1.

The foregoing objects are accomplished in one embodiment of the present invention by providing the upper of an article of footwear which can be formed of knitted fabric, woven fabric, leather or the like, of any desired construction, with an elastomeric sole portion joined or fused integrally with the upper of the footwear to securely enclose and hold the lateral edge portions thereof of which can comprise the lower lateral surfaces of a knitted sock-type upper or the edge seams of an upper having an insole secured thereto. In one preferred embodiment of the present invention, a sponge type resilient section is secured to the lower surface of an insole section at spaced points thereon within a pocket or recess formed by the lower edge seam of the upper and insole of the footwear structure. Thereafter the exposed outer surfaces of the resilient section and the lower edges or seams of the upper are enclosed in an expanded or cellular elastomeric material which forms the sole portion of the footwear.

More particularly, an improved article of footwear of the present invention is made by applying to an upper of any desired construction, an elastomeric sole, preferably an expanded plastic composition, by dipping the upper while mounted on a form into a solution or dispersion of an elastomeric material so as to just immerse or cover the bottom of the insole and the lower edges of the upper including the seam thereof. Thereafter, the sole is welded or fused to the upper, preferably by passing the dipped upper through a heated oven to solidify rapidly the elastomeric sole material. If required, the upper can be pretreated with a sizing material to increase the adhesion of the elastomeric material thereto, although this is generally not required. The characteristics of the elastomeric sole can be largely determined by controlling the composition and viscosity of the elastomeric material. Since all the insole-upper edge seams and the cemented portions of the insole are completely sealably enclosed and held by the elastomeric sole and portion in the present invention, the strength of the footwear is not dependent on the stitching or cementing operation as in the conventional footwear structure.

The elastomeric materials which can be used in accordance with the present invention for dipping an upper are those which can be provided as viscous solutions or dispersions at temperatures below the char temperatures of the upper to be treated therewith and which will within a reasonably short period readily solidify to form a flexible sole portion having satisfactory wear characteristics for the particular use intended. Among the elastomeric ma-
terials which can be used to form the improved footwear of the present invention are rubber latex solutions, both natural and synthetic, and solutions or dispersions of poly-
ethylene, polypropylene, the vinyl plastics and similar
plastomeric materials.

It is preferable to utilize the foregoing specified mate-
rials and other elastomeric materials having similar prop-
erties in their expandable form. Thus, in the preferred
form of the footwear, the upper is dipped in a viscous,
elastomeric solution or dispersion, such as expandable
rubber latex solution or a polyethylene, polypropylene or
polyvinyl chloride solution or dispersion containing a con-
ventional blowing agent such as sodium bicarbonate,
which produces an inner cellular structure and a smooth outer
skin which can be impressed or otherwise provided with
any desired design or pattern.

A particularly suitable type of expandable elastomeric
material for use in the manufacture of footwear in ac-
cordance with the present invention comprises the ex-
pandable plastisols which are dispersions of a polyvinyl
chloride resin in a liquid plasticizer along with stabilizers,
a dispersant, any conventional blowing agent, colorants
where desired, and other modifying agents. The plastisol
composition is formulated so that it is a relatively viscous
liquid which can be poured or pumped for ease of han-
dling. For example, the plastisol used can be formed of
from ten parts to four hundred parts of plasticizer for
ever one hundred parts of polyvinyl chloride resin.
Since the plastisols contain little or no solvents or diflu-
ents, there is little shrinkage problem and the plastisol
can be stored for long periods at normal storage tempera-
tures without deteriorating. Where it becomes neces-
sary to lower the viscosity, a small amount of petroleum
naptha or mineral spirits can be added. The plastisol
composition is readily expandable and solidified to a tough,
resilient, cellular solid by heating to a temperature of be-
tween 250-400°F, although heating to a temperature of
about 360-390°F is preferred. The time required for a com-
plete conversion of a plastisol liquid preparation to a
solid at the latter temperatures preferably varies between
7 to 12 minutes. However, the temperature and time
requirements to complete fusion of the plasticizer and
resin is extremely flexible and can vary between much
wider limits than the preferred ranges indicated above.

When the conversion temperature for the particular plas-
tisol is attained, the conversion into a solid is almost in-
stantaneous and the particles of polyvinyl chloride resin
fuse with or dissolve in the plasticizer to form an inte-
gral solid compound.

If desired, the elastomeric solutions or dispersions can
have suspeded therein various solids which will impart
a desirable appearance or improved surface character-
istic to the elastomeric sole. For example, particles of
colored Mylar plastic, or the like, can be added to the
elastomeric solution or dispersion to impart a decorative
appearance. Other particles, such as nylon or Teflon,
can be added both for improved appearance and wear
properties. Also, particles of an abrasive can be sus-
pended in the elastomeric material, if desired.

As previously indicated, the construction of the foot-
wear upper prior to dipping in the elastomeric solution can
be of any desired type including all the various in-
sole-vamp or upper assemblies to which the presently used
preformed sole sections are secured by stitching and ce-
menting or vulcanizing. However, because of the ab-
sence or the need for reliance on the strength of the
stitches or cement for holding the parts of the sole struc-
ture in assembled form, a minimum of work is required
to form an upper which is satisfactory for dipping in the
present invention.

In accordance with one embodiment of the present in-
vention, an upper is formed by joining one or more sec-
tions of fabric, leather, plastic, or a combination thereof
lightly stitched, either in seam or outseam, to an
insole section of cloth or other suitable material to form
a uniform seam or marginal flange completely around the
edge thereof. The edge seam is preferably processed to
prevent irregularities in the edge portions of the dipped
sole due to the presence of frayed seams, and this is con-
vieniently effected by providing a binding strip over this
entire edge seam. The insole-vamp assembly when thus
formed and mounted on a suitable form such as a shoe
last, can then be dipped into a liquid elastomeric material
of a type heretofore described to provide an elastomeric
sole portion which completely encloses and securely holds
when solidified the insole and upper integrally with the
sole portion of the footwear. Where it is desirable to pro-
vide additional cushioning effect in the above structure,
the insole may be of a rubber or other resilient mate-
rial stitched, or otherwise secured to the inner surface of
the insole after the outer sole has been solidified and com-
pleted as hereinafter described.

In the preferred form of the present invention, the in-
sole-vamp assembly, after being sewed outseam and
mounted on a suitable form but before damping in the
elastomeric material, is provided on the outer surface of
the insole with a cushioning means, which can be a flat
resilient section of foam rubber, expanded plastic, felt
or the like material having the hereinafter described
properties and which preferably has the same shape as
the insole. The expanded plastisol composition in a
liquid state is secured at spaced points to the lower surface
of the insole-vamp assembly, with care being taken not
to form a completely vapor impervious layer over the
entire surface of the insole. Thus, when the resilient
section is cemented to the insole, the cement is applied only
at spaced points thereon and not as a continuous film.
After the resilient section is secured to the insole-vamp
assembly and while remaining on the form, an elastomeric
material is applied to select portions of the assembly pref-
erably by dipping a portion of the assembly in an ex-
panded liquid elastomeric material which tends to flow
and diffuse into the fibers, pores and passages in the sur-
faces coated therewith. Immediately thereafter the dipped
assembly is passed through a heated zone, the tempera-
ture of which is regulated and the rate of passage there-
through adjusted, so that the particular elastomeric com-
position is properly expanded and set to form an elastom-
eric solid while at the same time integrally joining the
elastomer sole portion to the insole-vamp assembly.

Immediately after dipping and during the initial por-
tion of the passage of the dipped insole-vamp assembly through the heated zone or oven, it is important to continuously rotate or the dipped insole-vamp assembly through its lat-
titudinal axis to prevent the elastomeric material flowing
unevenly to one portion of the sole and forming an un-
even sole portion. The length of time during which the
assembly must be rotated and the speed of rotation there-
of will, of course, depend on the viscosity and composi-
tion of the elastomeric dip material and also on the tem-
perature of the oven. In general, it is necessary to rotate
the dipped footwear for only about the first two or three
minutes of the 7 to 12 minutes of passage through the
heated oven before the elastomeric material becomes form
retaining.

While the dipped insole-vamp or upper assembly passes
through a heated oven to effect setting or solidification
of the elastomeric material, the various solvents, dispersants
and the like are of necessity driven from the elastomeric
material and must escape without forming blisters theren
due to entrapment of vapors or otherwise disrupting the
out skin or surface of the elastomeric sole. When a re-
silient section is joined with the insole to provide greater
comfort, the air contained therein is an additional source
of gas which might be entrapped. In order to avoid the
later difficulties, it is essential that the resilient section
which is used with the insole be pervious to the passage
of vapors which are driven from the elastomeric material
during the heat treatment and also permit passage there-
through of any gases driven from the resilient section.
The latter requirements also make it essential that there be a discontinuous seal between the insole and the resilient section secured thereto so that there will be a plurality of readily available passage over the entire area thereof through which the gases and vapors can easily escape without encountering significant resistance to flow.

In FIGS. 1–3 of the accompanying drawing is shown a preferred embodiment of the present invention comprising a slipper 10 formed of an upper 11 stitched as at 13 (see FIG. 3) to an insole 12 around the entire periphery thereof spaced a short distance inwardly from the edge 14. The edges of the upper 11, insole 12, and the stitching 13 are preferably enclosed by a binding strip 15 to eliminate frayed edges and form a marginal flange 16. The flange 16 preferably extends perpendicularly to the plane of the insole 12 forming a pocket 17 in which a resilient section 18 is held in contact with the insole 12 by means of spaced segments 19 of a suitable adhesive. The resilient section 18 preferably has fabric covers 20, 20' extending over the longitudinal surfaces thereof with cover 20 preferably being cemented or otherwise secured to the outer edge of the flange 16 to prevent the flange 16 being accidentally deforming prior to or during being in the expanded or cellular elastomeric material which forms the cellular elastomeric sole 21. The outer surface of the cellular elastomeric sole 21 is preferably provided with a pattern or design 22 as by embossing, to improve the appearance and provide increased friction on contact with a smooth surface.

In the modified form of the present invention shown in FIG. 4 of the drawing, a knitted type of footwear illustrated by the slipper sock 30 is shown having integrally fused thereto an expanded or cellular type elastomeric sole 32 with the elastomeric material substantially completely impregnating the knitted sole 34 of the slipper sock 30 to form an inseparable bond therewith. If desired, an inner sole 35 may be inserted into the slipper sock prior to dipping in the outer sole surface of the sock in the liquid elastomeric material. On dipping the assembly, the elastomeric liquid passes through the knitted sole 34 and penetrates into the fibers of the insole 35 prior to being solidified. Where the elastomeric liquid solidifies, an integral sole structure is formed comprising an insole 35, a knitted intermediate sole 34, and the outer elastomeric sole 32, with each being welded or fusibly joined to the other by the solidified elastomeric material.

While the process of providing the flexible or expanded elastomeric soles 21 or 32 described heretofore can be carried out entirely by hand, it has been found preferable to form the process mechanically applying roll 90 disposed adjacent the outer end of the heater 80. As shown in FIG. 6, the decorative design 22 can be formed on the outer surface of the sole 21 by pressing the sole while the footwear remains on the rigid form 61 and while the footwear remains on the rigid form 61 and while the surface thereof is still in a heated condition against the surface of the embossing roller 91 having on the outer surface thereof a hard rubber cover layer 92 which has the desired design 22 sculptured or molded in the surface thereof. Other means for applying the design 22 can be used, such as using a heated embossing roll or the like. Additional indicia, such as the size of the footwear and a trademark designation can also be impressed in the elastomeric sole portion of the footwear in the foregoing manner.

In order to further illustrate the present invention and without, however, limiting the invention to the specific materials or conditions employed, the following specific example is set forth.

**EXAMPLE 1**

A slipper upper and insole assembly having the form shown in FIGS. 1–3 of the accompanying drawing is mounted on a wooden or metal shoe last or form 61 and a resilient section 18 is secured thereto as described above. Thereafter, the insole portion and edge seams thereof are coated by dipping at room temperature in an expandable, viscous liquid plastisol preparation having the following composition:

<table>
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<tr>
<th>Parts</th>
<th>60</th>
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<tr>
<td>High-molecular weight polyvinyl chloride resin</td>
<td>100</td>
</tr>
<tr>
<td>Di-2-ethylhexyl phthalate plasticizer</td>
<td>110</td>
</tr>
<tr>
<td>Diethylene glycol dibenzoate</td>
<td>20</td>
</tr>
<tr>
<td>Dibasic lead phthalate</td>
<td>3</td>
</tr>
<tr>
<td>p.p.-Oxybis-(benzene sulfonyl) nitrile</td>
<td>3</td>
</tr>
</tbody>
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The plastisol composition is prepared in the conventional manner by blending the several ingredients which are preferably premixed prior to the final blending operation. The plastisol composition has a viscosity of about 12,400 centipoises at room temperature.

As soon as the dipped slipper assembly is removed from the liquid plastisol composition, the form 61 supporting the dipped assembly is mounted on the bracket 59 which is continually rotated at a rate of between 3 and 6 revolutions per minute for about the first 2 to 3 minutes during the passage thereof through the oven 70 or until the plastisol outer portion has solidified. After the pinion 53 engages the rack 54, the slipper assembly is no longer rotated but is moved longitudinally through the oven 70 with the flat surface of the sole 21 facing upwardly toward the infrared heater elements 72 in the upper part of the oven 70 while said oven is maintained at a temperature of about 360° F. The conveyor 50 moves through the oven 70 at a rate of about 1.3 ft. per minute.
With an oven having a heating section of about 12 ft. long, a period of about 9 minutes is required for the passage of the walled, U-shaped support arm 52 through the same. A heating section of about 360° F. is maintained therein. When the temperature within the oven 70 is at about 390° F., a heating period of only about 6 minutes is required and the conveyor is adjusted accordingly.

As the slipper assembly approaches the discharge or outlet 73 of the oven, the rotatable support arm 52 is engaged by the guide rail 75 as heretofore described to rotate the arm and slipper assembly so that the flat portion of the sole 21 is turned downwardly to face the auxiliary infrared heater 80. During the passage over the latter belt portions of the slipper 2 are retained and is therefore brought into contact with the embossing roll 90 to impress a decorative design therein. The slipper is then removed from the form 61 and is ready for packaging, if desired.

While the footwear specifically shown in FIGS. 1-4 of the drawing are slippers, it should be understood that the present invention is applicable to the manufacture of other types of footwear, both for indoor and outdoor use. Thus, for example, a tennis and other sports or athletic shoe, can be made in the above described manner. Also, with the present invention, it is possible to provide a sole section having an integral elastomeric sole without damaging the leather, since the leather need not be exposed to a high temperature for a prolonged period.

It will also be understood that the elastomeric sole of the footwear of the present invention can be provided with a raised heel portion, if desired. Thus, for example, a felt heel section is well suited by being secured to the outer heel portion of the resilient section, which may also be made of felt, before dipping the assembly in the elastomeric liquid, since the felt has sufficient body and resistance to compression to provide the desired heel lift.

In the specification and the claims to follow the terms "welded," "fused" and "fusibly joining," as applied to the bond between the elastomeric material and an insole or upper, designates the integral connection formed with the insole or upper when a flowable elastomeric material, such as a polyvinyl chloride plastisol in intimate or impregnating contact with an insole or upper, is transformed from the fluid state into the solid state on attaining a predetermined temperature without requiring the application of pressure or the use of chemical agents which require a prolonged reaction period in order to form an elastomeric solid.

1. A slipper comprising: a chamber having openings at opposite ends thereof, heating means mounted in said chamber for heating the interior thereof, a conveyor means for conveying an article of footwear into one end of said chamber and out the opposite end thereof, said conveyor means including a footwear form support arm rotatably mounted thereon for conveying an article of footwear into one end of said chamber and out the opposite end thereof, said footwear form support arm having adjacent the outer end thereof mounting means for detachably engaging a footwear form, and said support arm having engaging means formed integrally therewith and spaced inwardly from said mounting means adapted to effect rotation of said arm about the longitudinal axis of said arm during travel of said conveyor means, mechanical means mounted in said chamber for engagement with said engaging means to effect said rotation, and said mechanical means being disposed adjacent said one end and extending into said chamber to effect rotation of said article of footwear supported by said arm during the initial portion of the period said article of footwear is passing through said chamber.

2. An apparatus for manufacturing an article of footwear comprising: a chamber having openings at opposite ends thereof, heating means mounted in said chamber for heating the interior thereof, a continuous conveyor means associated therewith for rotatably supporting and conveying an article of footwear into one end of said heated chamber, said conveyor means including mechanical means adjacent said one end and extending into said chamber which is adapted to effect rotation of said article of footwear supported by said conveyor means during at least the initial portion of the period said footwear is passing through said heated chamber, guide means adjacent said opposite end of said chamber adapted to maintain said article of footwear in a predetermined position, and auxiliary heating means disposed opposite said guide means adapted to apply heat to a predetermined portion of said article of footwear to facilitate forming indelica at said predetermined portion of said article of footwear.

3. An apparatus for manufacturing an article of footwear comprising: a chamber having openings at opposite ends thereof, heating means mounted in said chamber for heating the interior thereof, a conveyor means for conveying an article of footwear into one end of said chamber and out the opposite end thereof, said footwear form support arm having adjacent the outer end thereof mounting means for detachably engaging a footwear form and having intermediate the ends thereof a guide section, and guide means disposed opposite side of said chamber for engagement with said guide section to maintain said article of footwear on said footwear form in a predetermined position as said footwear form leaves said chamber.

4. In apparatus for manufacturing an article of footwear including a continuous conveyor means and an article of footwear support carried by said conveyor means for supporting and conveying a footwear form having an article of footwear, a chamber through which said article of footwear is conveyed from the inlet end to the outlet end thereof on said conveyor means, and heating means mounted in said chamber for heating the interior thereof, the improvement comprising: guide means fixedly attached to said chamber and extending axially upwardly from said outlet end and engageable with said conveyor means supporting said article of footwear and maintaining said article of footwear in a predetermined position from a point within the interior of said chamber to a point spaced axially outwardly from said outlet end, and auxiliary heating means disposed opposite said guide means and extending axially outwardly from said outlet end for heating a predetermined portion of said article of footwear while supported by said conveyor means in said predetermined position.

5. An apparatus for manufacturing an article of footwear as in claim 1, wherein said footwear form support arm has positioning means intermediate the ends thereof which normally maintains the said mounting means in a predetermined position while said engaging means is out of engagement with said mechanical means; said mounting of said footwear form on said mounting means is facilitated.

6. An apparatus as in claim 5, wherein said position comprises a section of said arm which extends outwardly from the longitudinal axis about which said arm rotates and which is disposed in a downwardly depending position while said engaging means is out of engagement with said mechanical means.

7. An apparatus for manufacturing an article of footwear as in claim 3, wherein said guide section comprises a generally U-shaped portion of said chamber and guide means comprises a cam rail extending from a point spaced inwardly from the outlet end of said chamber to a point spaced outwardly beyond said outlet end and which is adapted to engage said U-shaped portion of said support arm and maintain said article of footwear in said predeter-
mined position as said article of footwear leaves the interior of said chamber.

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