

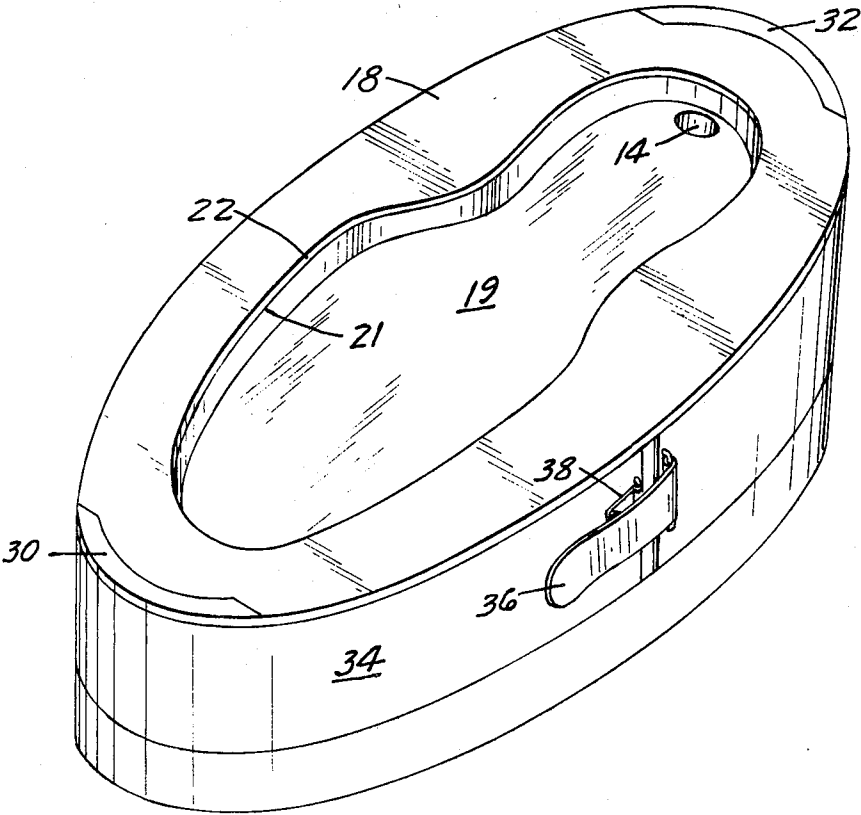
[72] Inventors **Myron W. Hall**
Sunfish Lake;
Harvey A. Chapman, Richfield, both of
Minn.
[21] Appl. No. **67,542**
[22] Filed **Aug. 27, 1970**
[45] Patented **Jan. 4, 1972**
[73] Assignee **Minnesota Mining and Manufacturing**
Company
Saint Paul, Minn.
Continuation of application Ser. No.
716,779, Mar. 28, 1968. This application
Aug. 27, 1970, Ser. No. 67,542

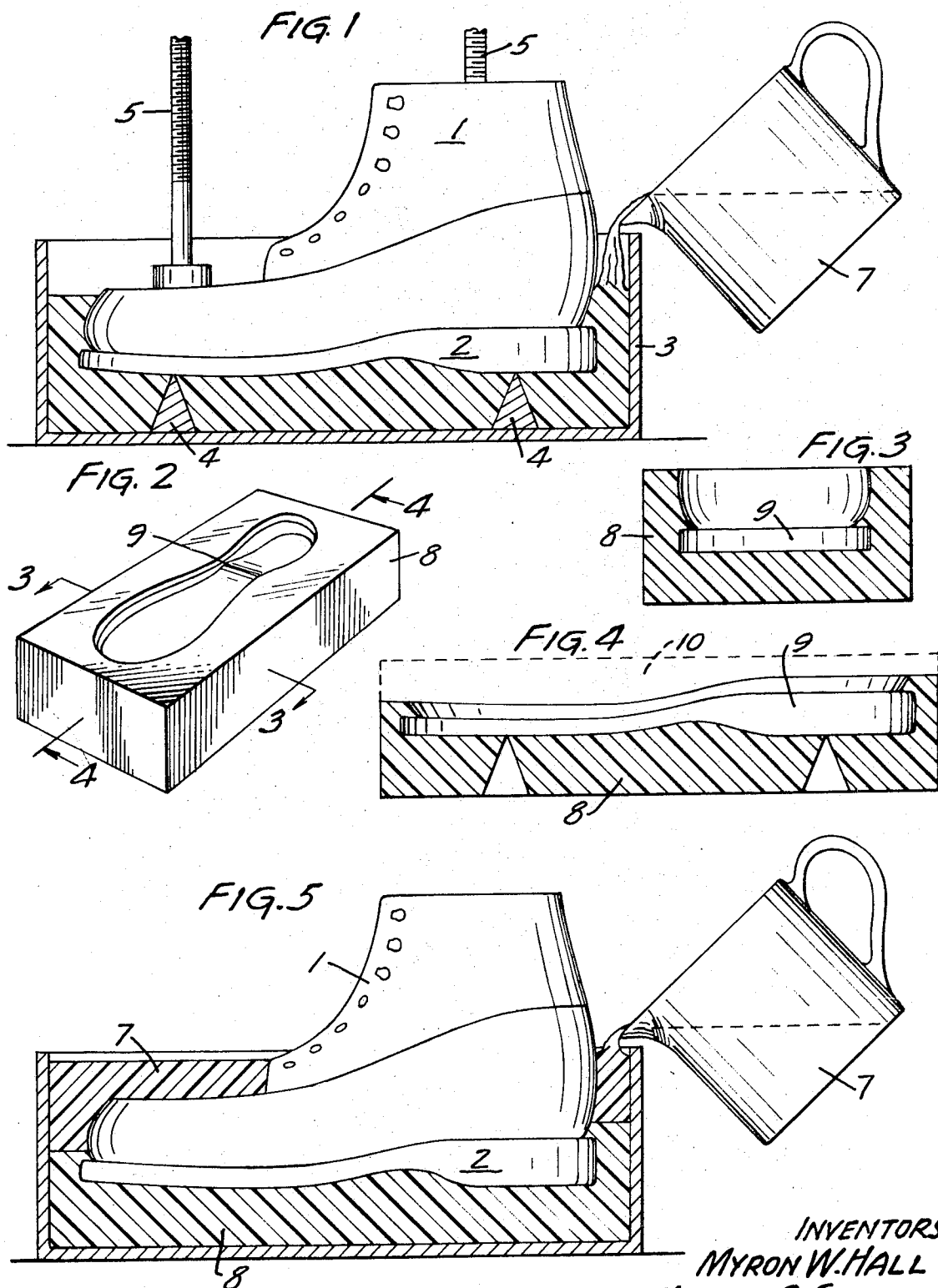
2,687,554	8/1954	Root.....	18/34 S
2,714,226	8/1955	Axelrad	18/DIG. 44
2,894,288	7/1959	Brindis	18/DIG. 44
2,965,946	12/1960	Sweet et al.	18/DIG. 44
3,051,995	9/1962	Ferrell et al.	18/42 A UX
3,104,425	9/1963	Crane et al.	18/2 RP X
3,306,964	2/1967	Miller	18/34 S X
3,314,640	4/1967	Snow	249/83
3,353,220	11/1967	Lenoble	18/DIG. 44

Primary Examiner—J. Howard Flint, Jr.
Attorney—Kinney, Alexander, Sell, Steldt & DeLaHunt

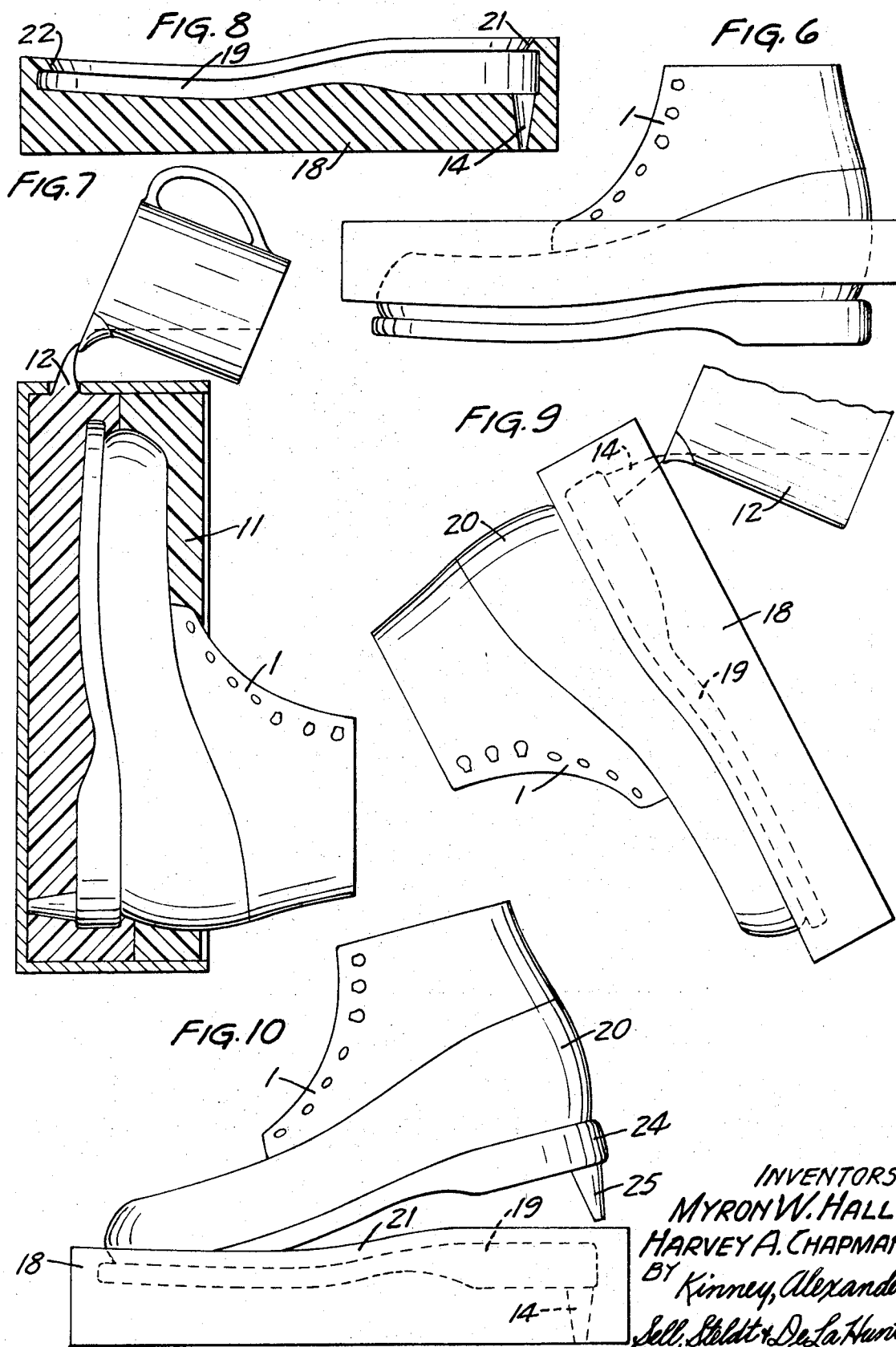
[54] **ELASTOMERIC SHOE SOLE MOLD**
4 Claims, 11 Drawing Figs.
[52] U.S. Cl..... **425/450,**
425/90, 425/175
[51] Int. Cl..... **B29c 1/00**
[50] Field of Search..... **18/43, 34 S**
[56] **References Cited**
UNITED STATES PATENTS
2,196,258 4/1940 Erdle..... 18/DIG. 44

ABSTRACT: Mold for forming shoe soles in situ which is formed from a single cast elastomeric polyurethane piece having an opening on one side with an inwardly projecting lip encircling the opening to support a shoe upper placed over the mold, liquid polyurethane-forming reaction mixture being cast into the cavity, hardened at a low temperature and then stripped from the mold, encircling lip being sufficiently flexible to permit stripping of shoe from mold without tearing away of sole, said mold preferably having a releasable clamping means such as an encircling band for sealing the mold around a shoe upper and being releasable to facilitate removal of the soled shoe from the mold.



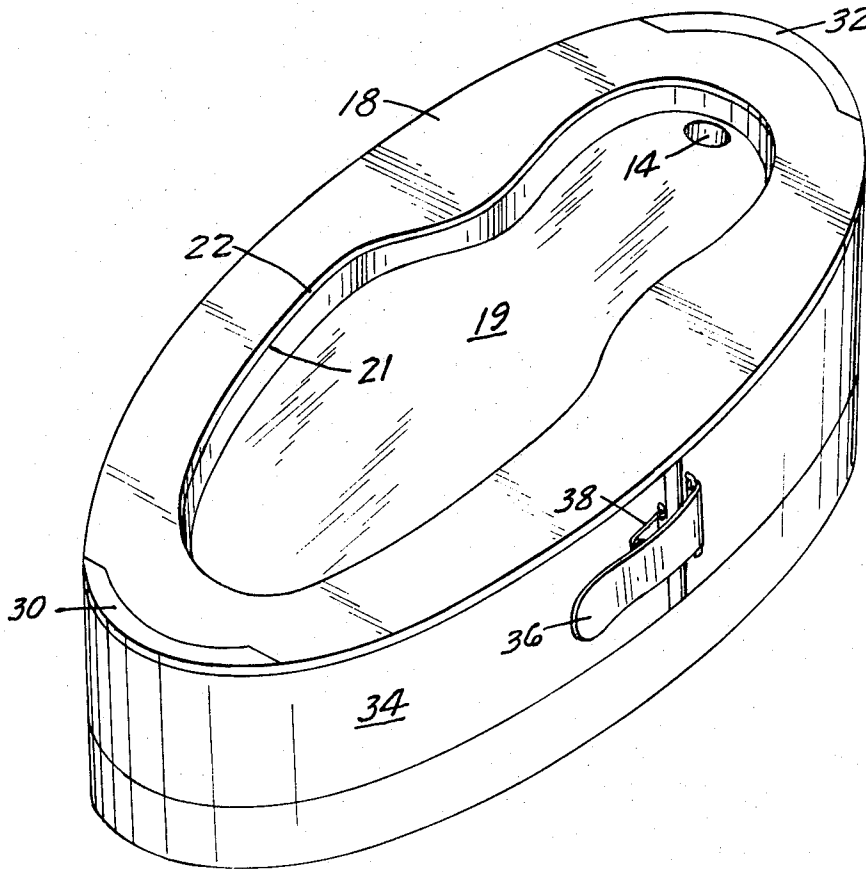


INVENTORS
 MYRON W. HALL
 HARVEY A. CHAPMAN
 BY *Kinney, Alexander,
 Sell, Steldt & DeLaHunt*
 ATTORNEYS



INVENTORS
 MYRON W. HALL
 HARVEY A. CHAPMAN
 BY Kinney, Alexander,
 Sell, Seldt & De La Hunt
 ATTORNEYS

FIG. 11



INVENTORS
MYRON W. HALL
HARVEY A. CHAPMAN
BY Kinney, Alexander,
Sell, Stellett & DeLo Hunt
ATTORNEYS

ELASTOMERIC SHOE SOLE MOLD

This application is a continuation of Ser. No. 716,799, filed Mar. 28, 1968.

This invention relates to molds for in situ soling of shoes.

The traditional method of shoe manufacture involves formation of a lasted shoe upper having a welt thereon to which the sole is affixed by stitching. As this method involves costly and time-consuming hand labor, many alternative procedures have been developed.

One alternative procedure involves eliminating the welt and instead adhesively attaching a preformed sole to the upper. Adhesion problems are inherent in this method and many steps are still required in the combined processes of separately forming the uppers and soles followed by bonding the same together.

Another alternative method is the direct or in situ molding of soles onto uppers. At least two variants of in situ molding have been employed commercially. One involves vulcanizing a rubbery composition directly onto the shoe upper and the other involves injection molding a plastic composition onto the shoe upper. Both of these procedures require high temperatures and pressures in their practice. Both procedures necessitate removal of the shoe uppers from the wooden lasts around which they are formed and remounting of the upper on special metal lasts which are capable of withstanding the temperatures and pressures required by the molding procedures. In addition to the special lasts, multisectioned rigid sole-forming molds must be used. Conventionally these molds have three major parts; a bottom portion and two side portions. These parts are held together in assembled relation by expensive complex machinery while the soles are molded. Representative molds of this type are shown in U.S. Pat. No. 2,956,313, issued to Choice, Oct. 18, 1960, U.S. Pat. No. 2,976,624 issued to Rollman, Mar. 28, 1961, and U.S. Pat. No. 3,189,943 issued to Choice et al., June 22, 1965. These molds are formed by various procedures known to the metal working arts. The dies are expensive, prohibitively so, in the case of low-volume shoe lines.

The temperatures used in vulcanizing rubber and/or melting a resin such as polyvinyl chloride in injection molding, often must be in the range of 300° to 450 °F. These high temperatures inherently limit the kinds of materials which can be used for shoe uppers upon which soles could heretofore be molded in situ. Some leather substitutes are severely damaged under these conditions and adverse effects have been observed in natural leather.

The present invention provides a commercially feasible in situ shoe sole casting system, including an extremely low-cost, one-piece flexible mold that can be readily made by a simple casting procedure.

In comparison with known molds for in situ shoe sole molding, the cost of which is measured in thousands of dollars, the molds of the present invention can be made at a cost of only a few dollars. The invention in addition eliminates many of the costly procedures previously required in the manufacture of shoes having molded in place rubbery soles. In the practice of this invention, the shoe uppers need not be removed from the wooden lasts over which they are formed and the soles may be cast in place thereon by means of a simple one-step casting procedure using a liquid sole-forming material which cures at low temperatures in a short time to form a tenaciously adhering tough elastomeric sole on the shoe uppers. After a period of only minutes the soled shoe easily can be stripped from the mold without disassembling the mold, and the mold is ready for reuse. Because of the low molding temperatures and pressures used in practicing the invention, the shoe uppers can be formed from any suitable material including heat-sensitive leather substitutes which could not previously be used in in situ sole-molding processes.

The one-piece molds of the present invention are provided with elastomeric lips which perform the dual function of supporting the shoe uppers in place over the mold cavity during molding and also form a molding surface which shapes the exposed upper surfaces of the shoe soles. The molds are further

provided with means to urge the sides thereof into sealing engagement with a shoe upper, the means being releasable to permit easy removal of the soled shoe upper from the mold.

The shoe soles are formed from an elastomer cured in the mold in contact with a shoe upper from liquid reaction components at low temperatures. Since these liquid components can partly penetrate the shoe upper materials prior to formation of the final rubbery polymer, it is believed that hitherto unobtained bond strengths are formed between the upper and the sole. The shoe soles have exceptional abrasion and cut-growth resistance.

The invention will be further described with reference to the accompanying drawings wherein,

FIG. 1 is a cross-sectional view showing the first step in the process of making a mold of this invention;

FIG. 2 is a perspective view of an elastomeric matrix having a shoe bottom imprint therein;

FIG. 3 is a cross-sectional view taken along line 3—3 of FIG. 2;

FIG. 4 is a cross-sectional view taken along line 4—4 of FIG. 2 after a trimming operation has been performed on the matrix;

FIG. 5 is a cross-sectional view illustrating a further step in the preferred mold-making sequence;

FIG. 6 is a side view of a model used for forming the mold;

FIG. 7 is a cross-sectional view showing the step of making a mold using the model of FIG. 6;

FIG. 8 is a cross-sectional view taken along the longitudinal axis of the mold formed in FIG. 7;

FIG. 9 is a side view showing the formation in situ of a sole on a shoe upper in accordance with the invention;

FIG. 10 is a side view showing the stripping of a shoe from a mold; and

FIG. 11 is a perspective view of a mold of this invention showing a preferred configuration and clamping device.

Referring now more particularly to the drawings, there is seen in FIG. 1, a shoe 1 of a size and style for which it is desired to produce a mold for casting of soles in situ. Shoe 1 has a sole portion 2 thereon of the desired design. Shoe 1 is shown in position in a form or chase 3 spaced above the bottom of the chase by supports 4. Positioning means 5 supported by suitable supporting means (not shown) are used for positioning shoe 1 accurately in chase 3. The bottom of shoe 1 is coated with a parting agent such as oil, wax, or preferably a silicone or siloxane resin. A liquid reaction mixture 7 is poured into chase 3 to a depth extending somewhat above the top of sole 2. The liquid reaction mixture hardens within a short time to form an elastomeric matrix 8 which is shown in FIGS. 2 and 3 stripped away from shoe 1. An imprint or "surface negative" 9 of the lower portion of the shoe is formed in matrix 8. As shown in FIG. 4 matrix 8 is trimmed by cutting away the upper portion 10 thereof along a plane parallel to and slightly above the top of the portion of imprint or cavity 9 which corresponds to the top of sole 2.

After the trimming operation, matrix 8 is placed back on shoe 1. A parting agent is coated on the top surface of matrix 8 and the shoe 1 and matrix 8 are again positioned in chase 3. Additional liquid reaction mixture 7 is poured into chase 3 above matrix 8 to imbue a part of the shoe upper therein. After the additional reaction mixture has hardened, shoe 1 and the matrix portions are again removed from chase 3 and matrix 8 is again stripped away from the bottom of the shoe to leave the shoe embedded in an elastomeric slab 11 as shown in FIG. 6. The shoe thus embedded in slab 11 forms an accurate model from which any number of molds can be formed for use in practicing the invention.

As shown in FIG. 7 shoe 1 and elastomeric slab 11 are again positioned in a chase 3 as shown to form a cover portion therefor. Prior to placing the same in the chase the bottom portions of shoe 1 and slab 11 are coated with a release or parting agent. The chase is positioned in an upright position as shown and a liquid reaction mixture 12 of a different composition as hereinafter specified is cast through an opening in the

end thereof. The upright orientation of the chase minimizes the inclusion of bubbles in mold 18 formed from the cast reaction mixture. A mold insert 13 is positioned in the chase to form a sprue opening 14 in mold 18.

The reaction mixture hardens or cures to form a tough elastomeric mold 18 free of bubbles and other imperfections and having a cavity 19 therein which is in accurate detail a surface negative of sole 2. The preferred soling resins harden within a matter of minutes. In addition the top of mold 18 has a contour similar and parallel to the bottom of a lasted shoe upper 20 which is similar to the upper portion of shoe 1. A lip 21 is formed which encircles the perimeter of the mold cavity; preferably the lip edge is beveled as at 22 to provide an upper beveled surface terminating in a sharp edge. The undersurface of the lip 21 conforms to the upper surface of sole 2. The beveled upper surface 22 of lip 21 matches the contour of that portion of the bottom of shoe 1 which rests thereagainst so that a lasted shoe upper 20 conforming to shoe 1 will nest snugly in the beveled mold cavity opening.

In using a mold 18 to form shoe soles as shown in FIG. 9, the cavity 19 is coated with a suitable, e.g. silicone, release agent. A lasted shoe upper 20 is positioned on lip 21 to close mold cavity 19. The sides of the mold are then urged inwardly by suitable clamping means to tightly seal the lip of the mold opening around the shoe upper. The upper can also be held in place by any suitable clamping means such as C-clamps or the like which urge the upper toward the cavity so that the assembled mold and shoe upper can be placed in a nearly upright position such as shown in FIG. 9 for casting of the sole in situ on the upper. A castable liquid reaction mixture 12 which may, if desired, be of the same composition as mold 18 is then poured through opening 14 in the end of the mold. The liquid reaction mixture sets in a short time to form a tough rubbery elastomer. Curing can be accelerated by heating the assembled mold, the shoe upper and reaction mixture in an oven at moderate temperatures, typically at 150°F.

After sufficient curing to form a shape stable sole 24, the shoe is stripped from the mold simply by grasping the heel portion by hand and pulling. The elastomeric lip, and the elastomeric sole flex sufficiently to permit easy removal of the soled shoe from the mold. A sprue piece 25, removed along with the shoe, is subsequently cut off. The sprue opening 14 in the mold is preferably large enough to allow the escape of air therethrough during filling of the mold. Five-eighths inch diameter has been found suitable. Removal of the sprue piece is facilitated by tapering the sprue opening in the mold so that it widens inwardly. After cutting away the sprue portion 25 the shoe is in a finished condition suitable for wearing.

A preferred form of clamping device for sealing the sides or periphery of the mold opening against the sides of the shoe upper, is shown in FIG. 11. As seen, mold 18 is preferably oval in shape and having ends 30 and 32 cut away and replaced by rigid incompressible elements 30 and 32, which preferably have the same size and shape as the removed end portions. Inserts 30 and 32 may be metal, wood, rigid plastic, or any other suitable material. The preferred clamping means is a metal band 34 which encircles the mold and is provided with a toggle clamp 36 for contracting and expanding the same. Clamp 36 may be of a conventional design such as one having a pivoted arm 38 which permits shortening and lengthening of the encircling band. The combination of the oval shape of the mold and the encircling band permits the compressive forces produced on tightened clamping band 34 to radially inwardly compress the mold around the shoe upper.

While the preferred form of clamping means is an encircling band, other means can be substituted therefor. For example, the encircling means can be an inflatable elastomeric tube in which compression is achieved by inflating the tube. Alternately, hinged clamping elements could be provided on either side of the mold. Such elements could be pivoted inwardly toward the mold from each side and held in place by suitable fastening means during the shoe-soling operation, and later released and pivoted away for removal of the soled shoe and application of another shoe upper over the mold.

The preferred low temperature curing elastomeric compositions for use in making the molds of the present invention and for forming shoe soles in situ are tough, tear and abrasion resistant, dimensionally stable, cross-linked polyurethane elastomers. Such compositions are the reaction products of certain liquid reaction mixtures of organic isocyanates, polyalkylene ether polyols and aromatic diamines. These reaction mixtures form polyurethane rubber elastomers in a single-stage continuous curing cycle with little or no added heat when reacted with one another in the presence of any one, or combination of more than one, of polyol-soluble organic compounds of certain polyvalent metals, e.g. tin, lead and mercury. As a practical consideration, organo-mercuric compounds alone, or combined with organic lead salts are much preferred as these appear to catalyze the reaction even in the presence of moisture without undue side reactions. Thus it is possible to operate under normally occurring ambient humidity conditions and with upper materials containing slight amounts of moisture.

In order to form by single-stage reaction a completely reacted elastomer, the isocyanates and active hydrogen containing constituents should be present in approximately stoichiometric amounts, i.e., the ratio of NCO groups to active hydrogens should be between about 0.95:1 to 1.15:1. By "active hydrogen" is meant hydrogen which displays activity according to the Zerewitinoff test described in J.A.C.S. 49,3181 (1927). Preferably, the NCO and hydrogen reactants are prepared as separate parts of a two-part mixture. It will be understood that a portion of the active hydrogen containing constituents, e.g. a polyalkylene ether glycol, may be added to the isocyanate part of the two-part system in order to improve and to increase the molecular weight of the NCO terminated material thereby reducing the toxicity and moisture sensitivity of the same prior to mixing with the other reactants. The other part of the two-part system preferably contains the remainder of the active hydrogen-containing material which is preferably a mixture of polyalkylene ether glycol, polyalkylene ether triol, and an aromatic diamine such as 4,4' methylene bis 2-chloroaniline. The resulting rubber is a tough, durable, cut-growth-resistant material which provides an ideal rubber shoe sole and tough, durable, reusable molds.

The composition used in the preliminary steps of forming the mold, particularly the liquid reaction mixture identified by numeral 7 in the accompanying drawings, can be a composition other than that used for the soles. For example, a useful elastomer can be made without the diamine and by loading with a cheap clay filler to provide bulk without undue cost. Such a composition forms an easily abrasible elastomer, more suitable for use in the mold-forming procedure.

It will be understood that the matrix shown in FIG. 4 could be used as a mold in place of that shown in FIG. 8 if sufficient care were used in its formation; however, for accuracy of shape and detail, the procedure outlined hereinbefore is followed in mold formation. It will, of course, be necessary to use a reaction mixture providing the toughness required to produce a mold which can be used repeatedly.

The invention will be further explained with reference to the following example. All parts are by weight unless otherwise noted:

EXAMPLE

A shoe-forming mold was formed following the steps set forth in the drawings. Reaction mixture 7 consisted of the following parts "A" and "B" which were mixed together in the proportion of 100 parts part "A" and 14 parts part "B" shortly before casting in the chase 3 to form cast 8.

PART A

	Parts
Polypropylene glycol 2000 m.w.	42.6
Glycerine based polypropylene ether triol 1,500 m.w.	36.0
PbO	0.6
Iron Oxides (Pigment—"Mapico Brown")	1.5

5

Kaolin (Filler—Huber "HI-White")	67.5
Lead 2-ethyl hexoate	0.3
Calcium 2-ethyl hexoate	0.6
2,6 di-tert-butyl-4-methylphenol (antioxidant)	0.6
Phenyl mercuric acetate	0.3

PART B

	Parts
Tolylene diisocyanate	129.5
Dipropylene glycol	29.0

The mixture hardened to an elastomeric body at room temperature and was removed from the chase about one-half hour after casting. The matrix was then stripped from the shoe, trimmed as shown in FIG. 4 and ground smooth. The part of the shoe immersed in the casting had previously been treated with a silicone release agent (Dow Corning Silicone DC-7) to enable release from the matrix. The shoe used as a pattern was then inserted in the elastomeric casting 8, placed in the chase 3, and elastomeric slab 11, of the same composition as the casting 8, poured thereover. After hardening of slab 11 with the upper of the pattern shoe embedded therein, the slab and shoe were removed from the chase. The resulting mold form consisting of the pattern shoe embedded in slab 11 was then used to form a shoe sole forming mold 18 by the procedure illustrated in FIG. 7 from a two-part reaction mixture which consisted of the following parts "A" and "B." These parts were mixed in a ratio of 3.4 parts "A" for each part "B."

PART A

	Weight Parts
Polypropylene ether glycol (2000 m.w.)	356
PbO	1.2
Silica (Cab-O-Sil)	16
4,4' methylene bis 2-chloroaniline	21.6
Calcium 2-ethyl hexoate	1.2
Phenyl mercuric acetate	2.4
2,6-di-tert-butyl-4-methylphenol	1.6

PART B

Tolylene diisocyanate	62.3
Polypropylene ether glycol (400 m.w.)	31.4
Polypropylene ether triol (400 m.w.)	6.3

The mixture was converted to a solid, completely reacted, elastomer in 30 minutes at 150 °F., after which it was removed from the chase. The resulting mold was mounted on a mold frame as illustrated in FIG. 9 and used to cast shoe soles directly onto a wooden lasted upper by use of a reaction mixture identical to that which was used to form the mold. An

6

iron oxide pigment was added to impart a dark brown color. The reaction mixture was again cured for 30 minutes at 150 ° F. The shoe soles thus formed were tough, elastomeric, abrasion and cut-growth resistant and had a Shore A hardness of 62.

What is claimed is:

1. A mold for casting shoe soles in situ on lasted shoe uppers comprising, in combination: elastomeric polyurethane matrix having a cavity open on one side for receiving said shoe upper, said cavity conforming to the shape of a shoe sole corresponding to said shoe upper, said matrix having an inwardly projecting lip encircling the perimeter of said cavity adapted to support said shoe upper on said matrix and to form a top surface of said sole, the matrix surrounding said cavity being of a single unitary piece, said lip being deformable to permit stripping of successive soled shoes from the matrix, means for holding a shoe upper in position over said mold cavity, said matrix having an opening for charging sole forming material into said cavity, and releasable clamping means engaging the sides of said matrix, capable of compressing said matrix into sealing engagement with the sides of said shoe upper, said clamping means being releasable to permit easy withdrawal of a shoe after a sole is formed thereon in said mold.

2. A mold according to claim 1 wherein said matrix is in the shape of an oval which has its ends removed, said ends being replaced by rigid incompressible elements having a shape corresponding to the removed ends, said clamping means completely encircling said mold, said clamping means being contractable to radially inwardly compress the sides of said mold into sealing relationship around said shoe upper and expandable for removal of a soled shoe and positioning of another shoe upper over said opening.

3. A mold according to claim 2 wherein said clamping means is a metal band having a toggle clamp therein for shortening and lengthening thereof.

4. A mold for casting shoe soles in situ on lasted shoe uppers comprising, in combination: an elastomeric polyurethane matrix having a cavity open on one side for receiving said shoe upper, said cavity conforming to the shape of a shoe sole corresponding to said shoe upper, said matrix having an inwardly projecting lip encircling the perimeter of said cavity adapted to support said shoe upper on said matrix and to form a top surface of said sole, said lip being deformable to permit stripping of successive soled shoes from the matrix, said matrix further having an arcuate, smooth-surfaced outer perimeter such that it may be encircled and radially compressed around said shoe upper by a clamping means, said matrix having an opening for charging sole forming material into said cavity, and an expandable, contractable clamping means encircling said outer perimeter, said clamping means being expandable for positioning said shoe upper into said cavity and contractable after insertion of said shoe upper into said opening, whereby said matrix is radially compressed into a sealing relationship around said shoe upper.

* * * * *

60

65

70

75