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PROCESS FOR PRODUCING SEAMLESS COSMETIC GLOVES

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6 Claims. (Cl. 18—47.5)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without payment to us of any royalty thereon.

The present invention provides improvements in the production of molded seamless hollow articles obtained by molding vinyl resins in open, hollow, seamless metal molds, and more specifically, the invention provides improvements in the production of hollow seamless objects obtained by molding polymerized vinyl resin plastisols in open, seamless nickel molds.

Although the process of the present invention is applicable to the molding of seamless hollow articles generally, it is particularly applicable for the production of so-called "cosmetic gloves" employed as coverings for prosthetic hands provided for amputee casualties as replacements for lost natural hands, or as coverings for hand injuries which have resulted in greater or less disfigurement of a natural hand.

As applied to the production of so-called "cosmetic gloves," it may be noted that such articles as customarily available prior to the present development, are open to the objection of unnaturalness in appearance, showing immediately to an observer that the wearer has an artificial hand. The availability of a cosmetic glove which closely approximates the appearance of a natural hand so as to defy detection even on close inspection has been a long-wanted factor for assisting in maintaining the morale of amputees having to rely on artificial hands. Such an accessory, however, has not been available, nor known, prior to the present invention.

While the procedure in the practicing of the invention is especially adapted for the production of such detection-defying cosmetic gloves, in broader aspects certain phases of the procedure of this invention are applicable to the production of flexible seamless hollow resinous articles generally, and in its more general concept the invention provides a process for molding such objects in seamless open nickel molds by slush-molding vinyl chloride polymer plastisols. In its more specific aspects, the invention has for one of its objects the provision of a process for producing a cosmetic glove which is undetectable from a natural hand when being worn as a covering for a mechanical hand or for a mutilated natural hand, which process is cheap and easy to operate.

A further object of the invention is the production of a cosmetic glove of the above indicated character which substantially duplicates, in appearance and texture, a natural hand, and which renders undiscernible to an observer the presence of an artificial hand on a wearer thereof.

A still further object of the invention is to provide a cosmetic glove for use on artificial hands which is indistinguishable in appearance from a natural hand, duplicating in great fidelity all lines, markings, contours, as well as skin texture, of a natural hand.

Further objects of the invention will become apparent as the description proceeds and the features of novelty will be pointed out in particularity in the appended claims.

The present application is a continuation of pending application Ser. No. 5,716, filed February 2, 1948, now abandoned.

The process of the present invention as applied to the production of cosmetic gloves consists, in general, in obtaining an impression of a model hand, making a positive reproduction of the hand in the impression, forming a negative mold from the said positive, casting a glove in the mold, and coloring the glove.

In carrying out the process of the invention, the first step is to obtain an impression of the hand of a subject which is to serve as a model. In carrying out the present invention, it is preferred to use for making the initial impression an alginate impression compound such as those sold under the trade names of "Zelex" (produced by the L. D. Caulk Company, Milford, Delaware) or "Coeloid" (produced by the Coe Laboratories, Chicago, Illinois), both of which are composed of sodium alginate, an inert filler such as clay, whiting, or the like, and dehydrated calcium sulphate. A cylindrical or elliptical cylinder or tray, which conveniently is truncated, is prepared. Preferably, there may be employed a tray fashioned from thin sheet metal or screen and backed with a heavy sheet of vulcanized rubber or synthetic rubber. Into this tray is poured the impression compound, mixed with water containing phosphate ions, for example, trisodium phosphate, resulting in precipitation of a calcium phosphate in the impression compound. The hand of a subject which is to serve as a model is thrust into the liquid impression compound and allowed to remain there until the latter has hardened to a firm gel. The hand is loosened from the resulting impression by means of gentle muscular movements, water being poured down between the flesh and the impression, and with the aid of air introduced around the fingers and hand to prevent the creation of a vacuum, the model hand is withdrawn, leaving a cavity surrounded by a negative impression of the hand.

The impression compound employed must retain its consistency up to the boiling point of water. After the model hand has been removed, the impression is immersed in hot water in order to heat the gelled impression for the next step, which is the production of a positive from this negative impression in which all lines, markings and other characteristics in the model hand have been reproduced in full detail.

The impression when heated in the water bath is removed therefrom and drained, and into it is poured a resinous dispersion of the following preferred composition, the proportions being parts by weight:

Paste grade polyvinyl chloride-acetate copolymer	48
Tricresyl phosphate	26
Dibutyl phthalate	26
Polyethyl methacrylate	4

In preparing this dispersion, the polyethyl methacrylate (or polymethyl methacrylate) is dissolved in the plasticizer with the aid of heat to facilitate solution. The polyvinyl chloride-acetate copolymer which should contain over eighty-seven percent of polyvinyl chloride to retain fluidity over sufficiently long periods of time is incorporated in the solution until a paste is formed, the dispersion being prepared upon a three-roll ink or paint mill, the copolymer being added until the dispersion has the consistency of rather thick library paste.

The dispersion is poured into the impression and the latter rotated so that the paste is spread into a film over the entire surface of the impression. The paste, upon coming into contact with the hot walls of the impression, gels, forming a relatively thin skin of a flexible plastic material in the negative impression. This plastic skin or positive model, is a very accurate reproduction of the model hand used. In practice, from approximately five-tenths percent to approximately five percent by weight of the polyethyl methacrylate (or polymethyl methacrylate) may be dissolved in the plasticizer, and from forty-

five percent to fifty-five percent of the plasticizer may be employed. These percentages are percent by weight of the total composition.

The resulting plastic positive is heated in the impression to toughen it, and then in order to render this positive rigid, a mixture of sand and wax is tamped into the cavity within the plastic skin. It will be apparent that the impression of the hand of the model is hollow and open, as is the plastic skin positive. The resulting rigid positive is rendered ready for further treatment by having an electrode bar thrust into the wax-sand mixture to serve as a cathode hanger. The alginate impression compound is removed from the positive, leaving the positive an exact, rigid replica of the original hand. It may be desirable to fill in some of the deeper cracks in order to produce a glove of more uniform thickness and greater strength.

The next step is the production of a mold on this positive. Electroforming is employed, and it produces readily a hollow, one-piece seamless metal mold, the interior surface of which is an exact reproduction of the positive on which the metal is deposited.

In order to deposit the metal on the plastic positive surface, this surface must be rendered electrically conductive. This is accomplished by methods well known in the art, for example, by thoroughly cleaning the surface of the positive, followed by sensitization by immersion in a solution of stannous chloride, and then simultaneously spraying onto the sensitized surface an ammoniacal solution of silver nitrate and a solution of a suitable reducing agent. Preferably, there is added a small quantity of a wetting agent, for example, "Triton 720," which is an aryl-polyether-sodium sulphonate, produced by Rohm and Haas Co., Philadelphia, Pennsylvania, although such addition is not necessary. Hydrazine sulphate is a satisfactory reducing agent, although many others may be employed, as will be apparent. Actually, the silvering is not an essential step in the overall process, since conductivity may be obtained through the use of graphite, bronze powder, a chemically deposited copper film, and other methods well known in the art.

The electroforming itself is carried out in a manner well known in the art. Preferably, the deposit is controlled so as to be approximately two-hundredths inch thick and is entirely of nickel. However, multiple metal molds have been used satisfactorily, for example, molds constructed by depositing approximately five-thousandths inch nickel, covering this with approximately two-hundredths inch of copper, and depositing on the copper a final coating of about two-thousandths inch of nickel. For depositing the nickel, any suitable nickel salt bath that produces a non-porous uniform deposit may be employed, for example, the well known Watt bath, and the copper from a standard high acid copper bath. An all-chloride nickel bath alternatively may be employed with excellent results, and the various addition agents used in bright nickel electroplating are beneficial for this purpose also. In order to produce a mold of uniform thickness, it is desirable to employ, in addition to the usual anodes in the bath, an auxiliary anode, positioned centrally and approximately one inch from the palm of the hand. It is also desirable, to "steal" a certain proportion of the current from the fingertips by the use of a cathode screen, situated just off the ends of the tips of the fingers and at a distance from them, of approximately one and one-half inches. The excessively thick deposits normally encountered at edges and corners can be avoided readily in this manner.

Upon completion of the electrodepositing operation, it is only required to remove the wax-sand mixture from within and to pull out the plastic skin from the resulting mold. The first operation is performed by boiling the mold until the wax has melted and then draining out the wax and sand. Following this, the flexible plastic skin or glove may be collapsed and withdrawn. In the case of an exceptionally thick skin, small holes may be bored near the tips of the fingers to assist in removal of the plastic material. If desired, the silver may be removed from the interior of the mold at this stage, and the mold cleaned by being dipped into nitric acid, followed by ammonia and water. The mold now is ready for use, and can serve for the production of many thousands of cosmetic gloves. All features of the positive, which was an exact duplication of the original impression of the model hand in the alginate, are exactly duplicated in the mold.

The final cosmetic glove itself is cast from a vinyl chloride polymer or copolymer. In practice, there are employed polymers or copolymers containing between ninety-five percent and one hundred percent vinyl chloride, the remainder being vinyl acetate, methyl methacrylate, methyl acrylate, ethyl acrylate, diethyl maleate, or other well known vinyl compounds. Two such materials commercially available are known to the trade as "Vinylite VYNV–2" and "Geon 100x26," the former of which is a copolymer of vinyl chloride with small percentages of vinyl acetate, produced by the Bakelite Corporation, New York, the latter having a similar composition and produced by the B. F. Goodrich Chemical Company, Cleveland, Ohio. In the making of the glove, there is employed a grade of polymer the characteristics of which are such that a dispersion consisting of fifty percent polymer and fifty percent di-2-ethyl-hexyl phthalate as plasticizer for the polymer has a viscosity of less than fifty thousand centipoises. A dispersion of a resin of this type is made in a suitable plasticizer, together with stabilizing agents and pigments as required. An illustrative suitable composition is:

Resin	parts (by weight) 50
Plasticizer (di-2-ethyl-hexyl phthalate or a mixture of di-2-ethyl hexyl phthalate and a polymer of low molecular weight)	parts 50
Stabilizer (basic lead silicate or strontium resinate, or tetraphenyl tin)	parts 4

This composition has the viscosity of a rather thin library paste, and it can be poured with ease. The procedure consists in deaerating the paste by the application of vacuum, and pouring it into a mold, the preparation of which has been described above. An additional deaerating step may be carried out at this point, if desired. The mold next is heated to the boiling point of water for a period of from five to forty-five seconds, depending upon the speed of gelation of the particular compound employed. At the end of this period, the mold is chilled, and the paste is drained from it as thoroughly as is possible at room temperature. The mold subsequently is drained at 65° C. and at 90° C. for a typical compound. Drainage of the liquid paste is nearly complete, the only plastic left in the mold being that which gelled upon application of the heat.

At this stage the plastic is entirely too weak for use as a glove, and its physical properties can be improved only slightly by prolonged exposure at temperatures in the neighborhood of 100° C. In order to develop the ultimate strength of the material, exposure to a much higher temperature is necessary. For this purpose, a temperature of substantially 380° F. is preferred, although the optimum temperature for this final treatment may vary between 320° F. and 420° F. This treatment may be effected conveniently by immersing the mold in a pot of oil or glycerine maintained at the desired temperature. For a nickel mold two-thousandths inch thick, a time immersion of approximately four minutes usually is satisfactory.

An alternate procedure is to conduct the heating at about 380° F., in a circulating air oven for approximately five minutes, followed by an immersion for three minutes in the heat transfer liquid.

Upon being cooled, a thin glove the thickness of which

was determined by the time of gelation at 100° C. is removed from the mold. The mold is in a single piece, and is a negative of the glove. The cosmetic glove which is formed is an excellent duplicate of the hand of the model, accurate in shape, and exquisite in skin detail. It does not require being reversed after the fashion of gloves made on dipping forms. The resulting glove is thin-walled and seamless.

The final step consists in coloring the glove. It will be apparent that the basic colors are incorporated in the resin paste compound. What remains is to color the veins, the finger nails, the knuckles, and to break up the monotony of the color over the entire surface. This may be done by allowing soluble colors to diffuse into the deposited resin, but preferably it is done by using insoluble colors which cannot subsequently migrate in service.

To this end, the glove conveniently is turned inside out, and pigments, which have been ground into a solution of the same resin of which the glove is made, are applied. An equally effective method is to grind the pigment into the resin-plasticizer mixture employed, place this upon the surface as required, and seal the color to the surface by the application of a good solvent such as cyclohexanone or a solution of the resin in cyclohexanone. Small amounts of acetone, methylethyl ketone, methylene chloride, or propylene oxide may be added to increase the "bite" of the solution or solvent. In this way, the added color is caused to adhere to the glove proper and is covered with a layer of plastic material which prevents its being rubbed off. It is to be noted that the color is underneath the glove rather than on top so that very little abrasive action is encountered in service. If desired, natural hair or "nylon" threads, or other synthetic fiber, dyed to the desired shade, may be inserted by means of crochet needles or hooks. In this way, a most lifelike appearance is achieved.

It will be seen from the foregoing that the improved cosmetic gloves or other final hollow seamless articles produced by the present process are produced, in general terms, by introducing a fluid dispersion of a vinyl chloride polymer and a plasticizer therefor into a hollow, seamless, permanent mold composed of metallic nickel, through a sprue opening in the mold, slush-molding the said dispersion in the mold under conditions avoiding appreciable chemical interaction between the dispersion and the mold, removing surplus fluid dispersion from the mold through the said sprue opening while leaving a continuous and flexible seamless hollow casting on the interior walls of the mold, heating the resulting casting to curing temperature while on the mold walls, separating the resulting cured casting from the mold walls, and removing the resulting continuous and distortion-free hollow shape from the mold through the sprue opening thereof without impairment of the mold, which is usable indefinitely repeatedly for producing duplicates of the shape initially cast in the mold.

Having thus described our invention, what we claim as new and wish to secure by Letters Patent is:

1. The process for making seamless cosmetic gloves for covering prosthetic hands, which comprises inserting a model natural hand in a fluid gelable alginate composition, effecting gelation of the composition about the hand, thereby obtaining an elastic accurately duplicating, seamless negative impression of the hand, removing the model hand from the said impression, flowing a viscous resinous dispersion composed essentially of polyvinyl chloride-acetate copolymer and liquid plasticizer therefor into the impression, gelling the dispersion peripherally around the impression until all surfaces of the impression are covered by gelled resin, removing ungelled dispersion from the impression, thereby leaving the impression lined continuously with a hollow flexible seamless positive accurately duplicating all details of the original model hand, filling the positive while in the impression with a removable core to render the positive rigid, removing the now-rigid seamless positive from the impression, coating the positive exteriorly with an electrically-conductive material for making the positive electrically-conductive, electrodepositing a continuous layer of nickel on the positive, removing the rigid core from the positive, collapsing the positive away from the deposited nickel, removing the collapsed positive from the deposited nickel layer, thereby leaving the deposited nickel as a hollow seamless mold interiorly duplicating all surface details of the model hand, casting a gelable resinous dispersion composed essentially of polymerized vinyl chloride and a plasticizer therefor in the resulting mold by heating the mold with the dispersion therein until gelation of the resin on the surfaces of the mold is effected, to form a seamless glove which faithfully reproduces all surface details of the original model hand, heating the resulting gelled glove in the mold to a temperature of from approximately 320° F. to approximately 420° F., until the gelled glove develops properties of toughness and wear-resistance, and removing the resulting glove from the mold.

2. The process for making seamless cosmetic gloves for covering prosthetic hands, which comprises inserting a model natural hand in a fluid gelable alginate composition, effecting gelation of the alginate composition about the hand, thereby obtaining a seamless high fidelity duplication of all details of the hand in a negative impression thereof, removing the hand from the resulting elastic impression while avoiding distortion of the details of the impression, filling the impression with a gelable fluid resinous dispersion composed essentially of a vinyl chloride polymer and a plasticizer therefor, peripherally congealing the dispersion in the impression on the surface thereof to form a continuous seamless layer of congealed resin thereon accurately reproducing the details of the impression, removing the resulting seamless positive from the impression without deformation, electrolytically coating the positive with nickel while imparting high fidelity reproduction of all details of the impression and positive in the resulting seamless nickel coating, removing the positive from the metal coating, thereby leaving a hollow seamless metal mold accurately reproducing all details of the positive and the impression, casting fluid coagulatable or gelable glove material composed essentially of a fluid dispersion of a vinyl chloride polymer and a plasticizer therefor in the mold, coagulating or gelling the said dispersion adjacent to all surfaces of the mold, removing uncoagulated or ungelled dispersion from the mold while leaving the resulting coagulated seamless glove in the mold, heating the coagulated glove in the mold to a temperature of from approximately 320° F. to approximately 420° F. until maximum tear-resistance and toughness are developed, removing the resulting seamless glove from the mold, and pigmenting and veining the seamless glove to reproduce accurately the appearance of the model hand.

3. A process for producing cosmetic gloves, which comprises producing an accurately detailed seamless, resilient negative impression of a model natural hand, producing from the impression a hollow, flexible positive of the hand which exteriorly substantially exactly duplicates the detailed impression of the hand, electroforming a hollow, seamless nickel mold on the positive, removing the positive from the mold, casting a glove in the mold by introducing into the mold a fluid gelable resinous dispersion composed of substantially fifty parts by weight of a resin selected from the group consisting of vinyl chloride polymers and copolymers with vinyl acetate and containing from ninety-five percent to one hundred percent vinyl chloride, any remaining resin being selected from the group consisting of vinyl acetate, methyl methacrylate, methyl acrylate, ethyl acrylate and diethyl maleate, and fifty parts by weight of di-2-ethyl hexyl phthalate, the said resinous dispersion having a viscosity of less than fifty thousand centipoises, filling the mold with the

said dispersion, peripherally coagulating the dispersion over the interior of the mold to produce a glove duplicating exactly the details of the mold and thereby the original impression of the hand, draining uncoagulated dispersion from the mold, heating the mold with glove therein to approximately 320° F. to approximately 420° F. until the glove develops maximum toughness and tear-resistance, removing the glove from the mold, applying and distributing pigment interiorly of the glove until the glove duplicates by transmitted light the appearance of a natural mating hand, and transfixing and anchoring in the glove filaments distributed thereon, the filaments matching natural hairs on the natural mating hand thereby duplicating in appearance all details of the natural mating hand.

4. A process for producing seamless cosmetic gloves for covering prosthetic hands, which comprises producing an accurately detailed seamless, resilient negative impression of a model natural hand, producing from the impression a hollow seamless mold which interiorly duplicates the detailed impression of the hand, casting a seamless glove in the mold by introducing into the mold a fluid gelable resinous dispersion composed of substantially fifty parts by weight of a resin selected from the group consisting of vinyl chloride polymer and copolymer containing from substantially ninety-five percent vinyl chloride to one hundred percent thereof, any remaining resin constituent being selected from the group consisting of vinyl acetate, methyl methacrylate, methyl acrylate, ethyl acrylate, and diethyl maleate, and fifty parts by weight of a plasticizer consisting essentially of di-2-ethyl hexyl phthalate, the said resinous dispersion having a viscosity of less than fifty thousand centipoises, filling the mold with the said dispersion, peripherally gelling the dispersion over the interior of the mold, draining ungelled dispersion from the mold thereby producing a glove consisting of a resinous skin, heating the glove in the mold to develop maximum tensile strength and tear-resistance, applying and distributing pigment interiorly of the glove until the seamless glove duplicates when viewed exteriorly thereof the appearance of a natural mating hand, and, after removing the glove from the mold, transfixing and anchoring in the glove filaments distributed thereon in natural position, the filaments matching natural hairs on the natural mating hand thereby duplicating in appearance all details of the natural mating hand.

5. The process for making seamless cosmetic gloves for covering prosthetic hands, which comprises investing a model natural hand in a fluid gelable alginate, effecting gelation of the alginate about the hand, thereby obtaining a seamless duplicating negative impression of the model natural hand, removing the hand from the impression while avoiding any mutilating distortion of the surface details of the impression, introducing a gelable resinous composition consisting essentially of plasticized polyvinyl chloride-acetate copolymer into the impression until all surfaces of the negative impression are covered by the resinous composition, effecting a peripheral gelation of the resin on the covered surfaces of the impression, thereby producing a seamless positive duplicate of the model hand invested in the negative alginate impression, filling the positive duplicate with a removable core adapted to render the positive duplicate rigid when removed from its alginate investment, removing this rigidified positive from the negative alginate impression, rendering the positive electrically conductive, immersing the resulting electrically-conductive positive as a cathode in an electro-forming nickel bath, electrodepositing on the positive a continuous, seamless layer of nickel, controlling the deposition of the nickel for producing a deposit of uniform thickness throughout, removing the resulting coated form from the bath, removing the rigidifying core from the form, collapsing the positive away from the coating nickel and removing the positive from within the said nickel, thereby leaving the electrodeposited nickel as a hollow seamless mold interiorly duplicating all surface characteristics of the resinous positive and hence of the original natural model hand, cleaning the mold, casting a final gelable polyvinyl chloride composition in the mold by introducing into the mold a plasticized polyvinyl chloride resin material, heating the said material to gelation temperature by heat transmitted to the composition through the mold for effecting peripheral coagulation of the composition in the mold to form a seamless glove of substantially uniform thickness, heating the glove in the mold to curing temperature for developing maximum tensile strength and high tear-resistance in the glove, pigmenting the glove interiorly thereof, and removing the finished seamless glove from the mold.

6. In a process for producing cosmetic gloves, the steps of obtaining an accurately detailed impression of a model natural hand, producing from the impression an open seamless, one-piece, nickel mold which duplicates the detailed impression of the hand, casting in the mold a gelable vinyl chloride polymer plastisol, peripherally gelling the plastisol on the inner surfaces of the mold by heating the mold and its contained plastisol at atmospheric pressure and at approximately 212° F. until the plastisol gels on the inner surface of the mold, to duplicate the details of the mold in the resulting gelled plastisol and thereby the original impression of the hand, thereby casting a seamless, one-piece glove which duplicates all details of the model natural hand, imparting maximum tear-resistance and tensile strength to the resulting cast glove by heating the glove while in the mold to a temperature of from approximately 320° F. to approximately 420° F. until the glove is cured to ultimate strength with the exclusion of appreciable thermal decomposition of the glove, and interiorly pigmenting the glove until it duplicates the appearance of a mating hand when the resulting pigment is viewed through the entire thickness of the glove.

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