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PATTERN COMPOSITION

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2 Claims. (Cl. 22—164)

1

This invention relates to pattern materials used in the so-called lost wax method of investment casting.

It is among the objects of my invention to provide a pattern material or composition for use in investment molding that will be substantially free from deleterious shrinkage as it solidifies in the pattern mold or after removal therefrom or will have an accurate and determinable or predictable shrinkage upon solidification.

Another object of my invention is to provide a "wax" or pattern material that will leave no or substantially no objectionable residue in the investment mold cavity or pores thereof when the pattern is "burned out" or dissipated by heat.

Another object is to provide a wax or pattern material so substantially devoid of effective over-all thermal expansion characteristics as when the pattern is being "burned out" of the investment that it will not deleteriously tend to burst, injure or enlarge the investment cavity.

A further object is to form a pattern without the use of great or excessive injection pressure and/or without substantial dependence thereupon for the purpose of obtaining a desirable relation between the external contour of the pattern and the internal contour of the pattern mold. Another object is to provide a pattern material of high fluidity at a temperature not greatly in excess of room temperature, such as about 125° F.

Another object is to provide a pattern material characterized by its ability to "pipe" while solidifying in a pattern mold in such a way as to conform externally to the shape of the mold while consuming or satisfying its tendency to shrink in or by internal piping.

Another object is to provide a pattern material which upon solidification in a pattern mold will be capable of carrying out some or all of the foregoing objects and will also be free or substantially free from the tendency to fracture, crack or have surface or structural imperfections.

Another object is to provide a pattern material and a method of making patterns with which the shrinkage or expansion of the material upon solidification may be controlled or predicted and determined with substantial accuracy. Another object is to provide a pattern material having some or all of the above mentioned characteristics and a method for making such material that is economical of time, labor and raw materials and that can be practiced advantageously and beneficially throughout a wide range of sizes, shapes and forms of patterns.

2

Another object of my invention is to provide a pattern material having some or all of the above mentioned characteristics which is not adversely or deleteriously affected by the constituents of investment materials of known and desirable composition with which the pattern material necessarily comes into contact. I have in mind such investment material as comprise a finely divided refractory and various binders such as plaster of paris or ethyl silicate for example.

A more specific object is to provide a pattern material and method of making same employing one or more of the more readily obtainable higher fatty acids and the commercially available salts thereof along with a commercially available plasticizing agent wherewith to carry out some or all of the above stated objects.

Other objects and advantages of my invention will become more fully apparent from the following description of that form or those forms of my invention which as at presently advised are deemed to be preferable and illustrative of my best understanding of the principles involved therein. Essential characteristics of my invention are summarized in the claims.

A preferred and illustrative practice and embodiment of my invention entails the employment of a higher fatty acid such as stearic acid, metal salts of a compatible fatty acid such as aluminum stearate and magnesium stearate and preferably a compatible plasticizer or stabilizer comprising polyisobutylene.

While I have mentioned a preference for including the use of a plasticizer still I have found that a mixture or compound comprising a fatty acid of melting point substantially above room temperature with the metal salts thereof is of itself an advantageous and useful pattern material. For example a mixture of 32 ounces of stearic acid, 1 ounce of aluminum stearate and 1 ounce of magnesium stearate will have many of the advantages of my invention, and a pattern made of this mixture, composition, compound or solution will have an approximate external form and surface shrinkage of only about 0.007" per inch in its external maximum dimension upon solidification, and will have within its wall and body sections the compensating internal voids or pipes discussed more fully below. The pattern made of this composition has the advantage of being relatively inflexible in the sense that the pattern will not tend to

change its shape at room temperature after having been formed, but by the same token if the pattern involves thin wall sections cast about an incompressible central core I have observed that in some instances the inflexibility of the composition may tend to cause fracture of a thin section within the mold probably as it takes its final setting upon solidification. Therefore according to my present understanding I feel that the composition used without the addition of any plasticizing material should preferably be used to form patterns having relatively thick wall sections if the same are to be cast about a central core or used in making patterns without cored out portions.

By the addition of a plasticizer to the composition comprising a fatty acid and a metal salt thereof I am able to control and reduce the shrinkage in the external form and dimensions of the pattern in determinable and predictable amounts and proportions down to substantially no measurable shrinkage whatever. For example if to the above mentioned proportions there is added as little as about 3% by weight of polyisobutylene, the shrinkage of the pattern material is reduced from about 0.007" per inch down to about 0.005" per inch whilst retaining all of the other desirable characteristics of my invention including piping and so reducing the apparent inflexibility of the pattern as to facilitate the making of thin wall sections of the pattern without substantial risk of having the pattern fracture during solidification or prior to removal from the mold. That is to say, the plasticizer probably both reduces external shrinkage per se and also appears to reduce the rate of shrinkage whereby a small percentage of plasticizer, such as the 3% first above mentioned, appears to retard the rate of shrinkage so that if the pattern be removed from the mold while at a temperature above room temperature but cold enough to retain its form and withstand handling, it will probably be preserved against fracture because its rate of external shrinkage is slow enough to resist fracture in the mold before it is removed.

Continuing the foregoing example if the proportion of plasticizer were increased to about 13% by weight of the whole mass I have found that the shrinkage of the external dimensions thereof upon solidification of mass is substantially eliminated whilst the other desirable characteristics and results are enhanced and preserved.

Turning back now to the illustrative composition of the fatty acid and the salts thereof without the addition of any plasticizer I have found it practicable and preferable to mix such an acid as stearic acid in the dry powder form and the aluminum and magnesium salts thereof in dry powdered form in the proportions above described and then heat the mixture up to about 150° F., melting and dissolving the constituents into a substantially clear liquid solution. I believe that the stearic acid tends to melt first and that the salts are dissolved therein. At least I have learned that it is desirable to stir the solution until the last of the more or less crystalline or flaky particles of the constituents are melted or dissolved into what appears to be a homogeneous liquid of even consistency. This solution if therepon allowed to cool appears to solidify completely at about 110° F., and if permitted to solidify it can thereafter be remelted upon being raised to approximately 125° F. Then in the molten form at about 125° F. it may be poured or injected into the pattern mold for the making of

patterns for the purposes herein mentioned. Alternatively the mass after first being brought to a clear liquid solution at about 150° F. may then be poured or injected directly into the pattern molds at that temperature or at lower temperatures down to about 125° F. within which range of temperatures I have found its fluidity and other pouring and running characteristics advantageous for introduction to the pattern mold.

It is my observation that one of the characteristics or properties of the material embodying my invention is that when it enters and fills the mold that it tends to solidify first throughout its area of contact with the mold or core surfaces which surfaces apparently first chill the external and adjacent surface portions of the material. Then a piping effect takes place wherewith the pattern material throughout the various sections thereof appears to form an internal void within its body. This void I believe to be fairly describable as an internal pipe, borrowing the term from the familiar ingot mold terminology. I believe it to be characteristic of the mode of operation of my invention that this internal piping or voiding directs or diverts the inherent shrinkage of the material in a direction normal to the adjacent mold surface and preserves the external dimensions and contours of the finished pattern. The advantage of this mode of operation in my material is that the external dimensions of the pattern are preserved with no actual or determinable shrinkage whilst the actual volume of material comprising the pattern may shrink. It also follows that when the pattern is sought to be driven from the investment there is literally less of the pattern material to be driven away since the volume of the pipe or internal void is correspondingly substracted from the gross volume and mass of the pattern.

Another characteristic of this form of pattern material embracing my invention is that the pattern upon being heated as when the same is burned out of the investment does not exhibit the characteristics of thermal expansion in the sense that its external form of dimensions do not appear to expand or so substantially swell or enlarge as to exert deleterious pressures or bursting pressures within the investment cavity. As presntly advised I believe that the pattern in the course of being "burned out" of the investment cavity while changing from the solid to the liquid form probably tends to occupy substantially the whole volume of the investment cavity including the piped or voided part of the sections of the pattern. It is a characteristic of my material, however, that patterns made according to my invention do not deleteriously react upon the investment material and the surface of the cavity thereof in the course of being burned out and in the course of changing from the solid to the liquid and perhaps also to the varoporous state therein so long as the "burning out" is done with the ordinary care of present known practice in this art as by raising the temperature of the investment and pattern gradually up to about 850° F. to 1300° F. over a period of from about three to twelve hours. Compared with known and common practice I have observed that pattern material of my invention may be burned out somewhat more rapidly than other pattern materials known to me by virtue, I believe, of its lower melting point and greater fluidity.

While I have mentioned the aluminum and magnesium salts of stearic acid as preferable salts to be mixed or dissolved therewith I do

not care to be limited to specific salts or the stearate salts of specific metals but rather teach that my purpose is to employ salts which produce the mode of operation that I have observed. For example these salts seem to reduce the coarseness of the crystalline or fibrous structure of cast or molded stearic acid and promote the piping thereof wherewith to preserve the external form and dimensions of the pattern and to give the same mechanical strength, hardness and particularly surface hardness and resistance to distortion and cold flow at or around room temperature.

The aluminum and magnesium stearates appear to serve to reduce the size of the stearic acid crystals or crystal-like or flake structure that occurs when the stearic acid solidifies from the molten state. Other metal stearates may be used in place of aluminum and magnesium stearates, but aluminum and magnesium stearates have as presently advised been found most satisfactory. Aluminum stearate, if used without the addition of magnesium stearate, appears to lose its ability to refine the crystals of stearic acid after the wax-like composition has been held molten for several hours. Magnesium stearate, if used without aluminum stearate, does not appear to lose its efficiency when the mass is held in a molten state, but appears to have a tendency to make the wax-like product somewhat brittle. It is preferable, as I now believe, to use the magnesium stearate alone if only one metal stearate is to be employed. Better results appear to be obtained if both aluminum and magnesium stearates are used within the proportions indicated. Larger amounts of the metal stearates are preferably to be avoided since these metallic stearates appear to tend to leave residues when burned, and I have not yet observed that larger proportions of the metal stearates in the formula improve the properties of the composition for use in the making of patterns.

As presently advised a preferred range of constituents comprises 8 parts by weight stearic acid and from about ½ part to 1 part by weight of the aggregate of metallic salts of stearic acid, the latter preferably comprising substantially equal parts of aluminum stearate and magnesium stearate. While it is not impracticable to depart from these proportions which I now prefer I have observed that lesser proportions of the metal stearates tend to weaken the pattern material and reduce the accuracy to which the external dimensions may be held. Greater proportions of the metal salts to the stearic acid than that which I prefer tend, I now believe, to leave residue in the cavity of the investment mold or in the pores thereof albeit increasing the proportions of the metal salts up to about 3 parts to 8 parts of stearic acid has not been observed by me to effect deleteriously the structural characteristics of the pattern material as such.

One of the advantages I have observed in the forms of my invention with which I have been presently able to experiment is that my material tends to fill the pattern mold cavity and solidify in the mold while corresponding to the form and shape of the mold accurately without the aid or necessity for the application of abnormally high pressures upon the material while it is solidifying in the mold. For example if the shape of the mold cavity and the form and disposition of the sprue hole with respect thereto permits proper venting of the cavity and filling thereof by my material in the liquid state, then I have observed

that substantially the mere static head of the liquid in the sprue hole sufficient to fill the cavity by gravity is sufficient to produce a satisfactory pattern with its external surfaces corresponding to the internal surfaces of the mold cavity within the limits of shrinkage herein mentioned and discussed. Generally speaking I have observed that my invention differs from the accepted practice in this art as now known to me in that I am able to make superior patterns without excessive injection pressures on the material either to force it into the mold cavity or to maintain a high hydrostatic pressure on the material in the cavity during its solidification.

Another and related characteristic of the preferred form of my invention as I have observed it is the high degree of fluidity of material in the liquid state at about the temperature of 124° to 125° F., i .e., at the melting point thereof. Using the preferred proportions of the fatty acid and the salts without the organic polymer as a plasticizer I have observed that this composition in the liquid phase just at about its melting point looks much like and has pour characteristics and fluidity much the same as very light machine oil or pentrating oil. This high degree of fluidity at the modest temperature of about 124° to 125° F. permits the ready filling of the pattern mold cavity while the material is in its free flowing liquid state. This characteristic taken with the non-shrinking characteristic above expressed measures one of the substantial advantages of my invention as compared with existing practice in which it is oft times necessary to force the material into the mold cavity in a more plastic than liquid state to minimize the shrinkage of material in the mold.

When there is added to the composition herein presently discussed the plasticizing agent such as polyisobutylene little change in the fluidity of the material has been noted by me. This plasticizing agent when of low molecular weight is a viscous liquid at room temperature and being quite compatible with the higher fatty acids that I employ is preferred by me as the plasticizer as presently advised for this reason among others. By way of further example I have also found it practicable to use as a plasticizing agent a hydrocarbon polymer of higher molecular weight which I have observed to be a more rubber-like substance at room temperature. When this type is employed as the plasticizer in the proportions presently to be described it has been my observation that the composition is a little less fluid at substantially the same melting point, to wit, about 124° to 125° F. and seems to have the pour characteristics and viscosity more nearly resembling the lighter automobile engine lubricating oils such as S. A. E. 20.

As presently advised the materials which I have found satisfactory and preferable for use as the so-called plasticizing agent through which as above described I am able to control and predict the last increments of shrinkage of the outside form of dimensions of patterns made according to my invention are synthetic hydrocarbon polymers which are probably entirely saturated and are compatible with the higher fatty acids and metallic salts thereof, particularly stearic and palmitic acids and their magnesium and aluminum salts. Such materials comprise as I believe essentially different ranges of molecular weights of polyisobutylene. At molecular weights of about one thousand the material is nearly water white and is a true liquid of high

viscosity. At about three to four thousand molecular weight the material is amber in color and as the weights run up to about 150,000 the materials have more the characteristics of rubber-like solids. I do not exclude copolymers of polyisobutylene which include copolymers of hydrocarbons and resin forming constituents that do not impair the compatability above mentioned and harmonize with the practice, operation and purposes of my invention. Such plasticizing materials are obtainable from Advance Solvents and Chemical Corporation, 245 Fifth Avenue, New York, New York. The literature available to me indicates these materials to be different grades of similar constituents varying in their chemical weights and other characteristics as more fully described in the literature of Advance Solvents and Chemical Corporation. The literature describing these products as known to me and published by Advance Solvents and Chemical Corporation comprises, its bulletin dated June 25, 1941 entitled Vistac-Resin V Emulsion, the pamphlet issued by Advance Solvents and Chemical Corporation under date of January 29, 1943, entitled Vistanex, the bulletin issued by the same company dated June 1, 1944, entitled Vistac and a printed folder without date issued by the same company entitled Vistanex Polybutene in Heat Resistant Rubber Compounds.

To prepare a pattern material comprising a plasticizer in addition to the acid and salt constituents above described, I prefer to first prepare the molten solution of the acid and salt and then work the organic polymers described above into the solution while maintaining the temperature or appropriately raising the temperature while stirring the mixture to dissolve all the constituents and bring about the homogeneous liquid characteristic desired. For example if the fatty acid and salt mixture such as 8 parts by weight stearic acid, ¼ part by weight aluminum stearate and ¼ part by weight magnesium stearate is in clear dissolved solution at 150° F. and it is desired to add from about 3% to about 13% by weight of the low molecular weight polymer, the latter may be poured directly into the solution and satisfactorily incorporated in the mixture or solution by stirring without substantially raising the temperature. In some cases the incorporation of the polymer into the mixture and solution is facilitated by raising the temperature as to about 200° F. and stirring until the polymer is completely dissolved and taken into solution with the other constituents. If the higher molecular weight polymers are to be added then I have observed it to be preferable to raise the temperature while stirring up to about 350° F. to 400° F. to insure a uniform homogeneous liquid mass with all the constituents in liquid solution or state.

It has been my observation that substantially regardless of the temperature required to take the organic polymer into solution that the several solutions retain their desirable characteristics of fluidity above mentioned at or about substantially the same melting point, i. e., around 125° F.

A practicable broad range of proportions of the ingredients for preferred forms of my invention is:

	Per cent by weight
Stearic acid	47 to 95
Aluminum stearate	17½ to 2½
Magnesium stearate	17½ to 2½
Plasticizer	18 to 0

Using the low molecular weight polyisobutylene, as I prefer, the following table indicates the amount of shrinkage upon solidification (for the longest dimension of the pattern) in inches per inch for patterns made by adding varying proportions by weight of the plasticizer to a solution of 8 parts by weight stearic acid and ¼ part by weight of each of aluminum and magnesium stearate:

Per cent by weight of polyisobutylene	Shrinkage of Pattern in inches per inch
3	0.005
5.5	0.003
8	0.0025
10.5	0.001
13	0.000

The foregoing table is based upon tests in which the pattern material was introduced into the mold at or about 150° F. It may also be observed that in such a composition comprising 13% plasticizer, but introduced to the pattern mold at about 200° F. a slight enlargement of the longest dimension of the pattern was observed upon measurement of the cast pattern at room temperature after initial solidification thereof in the mold and removal from the mold while warm, to the extent of about 0.001 inch per inch. As presently advised I believe that the other essentially polyisobutylene plasticizers when added to the same solution in substantially the same proportions will have substantially the same results and effects in terms of controlling external shrinkage or absence thereof as stated above.

A preferred specific formula for my composition from which patterns free from external shrinkage are desired is:

	Percent by weight
Stearic acid	82.0
Aluminum stearate	2.5
Magnesium stearate	2.5
Polyisobutylene	13.0

As presently advised I believe that various other of the carboxylic acids having characteristics not radically remote from stearic acid and capable of performing similar offices and functions within the broad precepts and principles of my invention may well be employed in the practice of my invention, preferably with the metal salts thereof, or with the metal salts of equivalent acids, all with or without the plasticizers in the same or substantially the same way as hereinabove described. For example the known characteristics of palmitic acid are so similar to stearic acid that my best information and belief is that a composition in which palmitic acid and the aluminum and magnesium salts thereof are treated and used in substantially the same as the within described stearic acid and salts will give substantially the same results. As presently advised I can neither affirm nor deny the specific limitations of the range of chemical equivalents within my invention and have made reference to the higher fatty acids and salts thereof generally and to palmitic acid and its salts specifically as well as to specific plasticizers by way of exposition rather than limitation.

In making patterns with my compositions usual known methods may be employed, having in mind that I have found it advantageous and

desirable to employ pattern molds which are adapted to remove heat from the liquid material without unreasonable delay. Steel molds and most metal molds at room temperature have been found satisfactory in this respect when my material is introduced thereinto at the temperature hereinabove mentioned. If non-conducting molds such as rubber are employed I prefer that they be chilled prior to the introduction of my pattern material thereinto.

While I have set forth and described my invention with reference to preferred forms and embodiments thereof and have undertaken to exemplify the basic principles and precepts thereof, changes, modifications and improvements therein will occur to those skilled in the arts to which my invention pertains without departing from the spirit and scope thereof, and I do not care to be limited to the preferred and specific forms and teachings hereof nor in any manner other than by the claims appended hereto.

I claim:

1. A pattern composition for use in investment molding consisting essentially of about 8 parts by weight of stearic acid and about ¼ to 3 parts by weight of a stearate of a metal of the class consisting of magnesium and aluminum.

2. A pattern composition for use in investment molding consisting essentially of about 8 parts by weight of stearic acid, about ¼ part by weight of magnesium stearate and about ¼ part by weight of aluminum stearate.

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