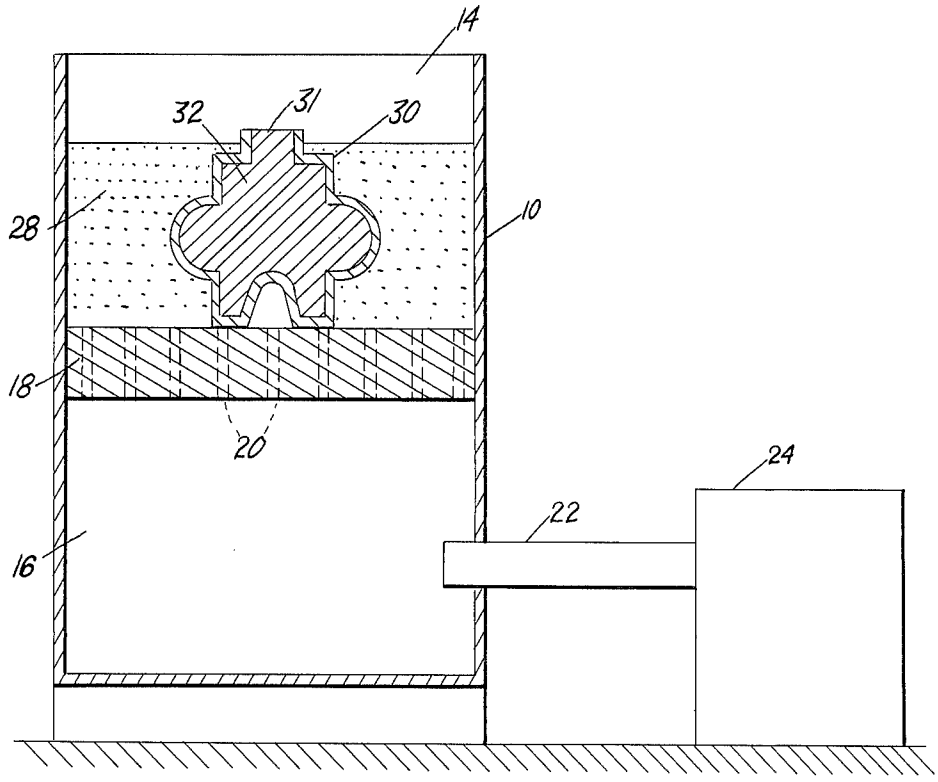
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METHOD OF REMOVING EXPENDABLE PLASTIC PATTERNS

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METHODS OF REMOVING EXPENDABLE PLASTIC PATTERNS

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This invention is a continuation in part of my application Serial No. 149,582, filed November 2, 1961, now abandoned.

This invention relates to the metal casting processes, and more specifically to methods of removing expendable plastic patterns from refractory and other gas permeable shell molds.

The precision casting process, commonly referred to as the "Lost Wax" process, has consisted of making a plastic, wax or other expendable pattern of the part which is to be cast, placing the pattern in a container, and then investing the pattern in a slurry of refractory material which subsequently solidifies and hardens into a solid mass around the pattern. The mold so formed is usually backed by a heat resistant flask to provide support therefor and the expendable pattern is removed by means of heat. The mold, having a pattern cavity formed therein, is then fired to burn out combustible materials and is subsequently filled with molten metal to form a metal casting. In relatively massive molds of this type, there is litttle difficulty in removing the pattern by heat since the mass of the surrounding refractory material and the metal flask liner adequately prevent the melting plastic, wax or other expendable pattern material from expanding and causing a crack or fracture in the mold cavity.

More recently the art has progressed to a point where a lightweight mold is fabricated by surrounding the expendable pattern with a thin shell of refractory. Material, usually built up in several layers, provides a thin-walled, low mass, highly gas permeable ceramic shell, which for a considerable range of castings, may be cast without additional support, thus saving considerably on mold weight, material cost, and process time. Such a shell is fully described, for example, in Patent No. 2,948,935 of August 16, 1960. It is a particular feature of the shells therein described that thin, gas-permeable walls are produced permitting superior filling characteristics as well as more rapid cooling due to the much decreased mass of insulating refractory material. This produces a casting having a small grain size, as is usually desirable.

However, the problem of providing an expandable pattern and a method of removing the pattern from such shells, particularly an organic thermo-plastic pattern, without cracking the shell has been a substantial one, and has effectively delayed the advent of a practical shell mold technique. The problem was first attacked by substituting a frozen mercury pattern for the more conventional wax or plastic pattern. But this technique required highly specialized equipment, since the complete shell building operation had to be carried out at temperatures below the freezing point of mercury. Due to the exceptionally high costs involved, this technique has not proved competitive for the production of commercial type castings.

The first practical method of removing an expendable pattern from a shell mold is disclosed in U.S. Patent 2,815,552 and consists of utilizing a solvent vapor which permeates the shell and dissolves the wax pattern surface before the body of the wax becomes heated sufficiently to expand and fracture the shell. This technique has met with some success, but is not considered ideal for several reasons. In the first place, the solvent, trichloroethylene, is relatively toxic. Too, the solvent rapidly looses its solvent action due to dissolved wax, at which time the solvent must be removed and distilled before it can

again be used for effective palttern removal. Most important, it can only be used to remove one class of pattern material, namely wax, and cannot be used with modern organic thermo-plastic pattern materials, such as polystyrene and polyethylene, for example.

A more recent so-called "flash firing" technique as set forth in said Patent No. 2,948,935 involves subjecting the shell and plastic or wax pattern to high temperatures of about 1500–2000° F. Such practice causes the surfaces of the pattern instantaneously to melt and change to a volatile liquid or gas which can leave the shell cavity through the permeable shell or otherwise, in theory, before the bulk of the pattern has expanded sufficiently to cause a shell fracture. This procedure probably has been the most commonly used method of pattern removal, but is subject to limitations and is not considered an ideal method from a production standpoint, particularly with the use of organic thermo-plastic patterns. With regard to its limitations, the "flash firing" technique depends on direct radiation of heat onto the shell surface, hence, plastic or wax that permeates the shell as a gas upon "flash firing" tends to form an insulating barrier in the vicinity of the shell, thereby detracting from the effect of the radiation. Further, a shell may have a shape wherein the sprue portion of the mold is physically blocked from radiation by the surrounding patterns. In such areas the pattern will melt relatively slowly, causing the shell to crack.

Further disadvantages result from the inconvenience of having to fire the shell when it may not be desired to process it through by casting it.

In general, the problem of pattern removal has not been satisfactorily solved in the case of high temperature softenable organic thermo-plastic pattern materails such as polystyrene and polyethylene which are particularly desirable as pattern materials due to their inherent stability and rapid injection cycle which permits the economical manufacture of expendable patterns necessary to the manufacture of precision castings by the "Lost Wax" process.

It is, therefore, a primary object of this invention to provide methods for removing high temperature softenable organic thermo-plastic patterns from ceramic shell molds of the relatively thin type of said Patent No. 2,948,935 without the disadvantages inherent in hitherto known techniques, especially the cracking of the shell mold.

It is another object of the invention to provide a method of removing patterns which is simple and efficient, and one which enables the shell, after its pattern has been removed, to be stored indefinitely prior to the firing operation.

In brief, the methods of carrying out this invention involve the novel concept of heating the shells by conduction by means of a high temperature resistant, particulate material capable of existing in a fluidized state, for example, powered metals, carbon sands, high temperature glass beads or grains or other ceramic materials, and other metallic or refractory materials. Utilizing such a material to eliminate plastic patterns, temperatures of upwards of 1000° F. and preferably upwards of 1500° F. enable initiation of pattern removal to be accomplished in less than about a minute, which is uniquely effective in eliminating shell damage.

It is believed the basic reasons for the success of the method of the invention is due to the fact that conducted heat conveyed to all areas of the shell simultaneously is effective in melting the pattern surfaces before the bulk of the pattern can heat up and crack the shell and also because a shell may be eliminated regardless of the humidity conditions prevailing, and without the drying requirements found necessary heretofore.

The apparatus for carrying out the methods of the invention when utilizing the preferred particulate material is somewhat related to the apparatus shown and described in my Patent No. 2,985,929, wherein a fluidized bed of particulate material may be maintained, but further provides for heating the gas blown through the bed to fluidize the particles therein to a fluidizing gas temperature of above 350° F. and upwards, so that the particles will be heated and act as a heat transfer medium for melting or otherwise eliminating the pattern in a mold submerged therein.

For the purpose of explaining further objects and features of preferred embodiments of the methods of the invention, reference is now made to the following specification together with the drawing wherein is shown apparatus which may be used in the practice of the preferred method of the invention.

The preferred method of the invention incorporates the concept of heat transfer by conduction and enables either plastic or wax patterns to be eliminated from the shell in a practical and economical manner preferably by the use of fluidized solid particles as the heat transfer medium. This medium permits a choice of temperatures up to 1500–2000° F. and provides a clean and rapid method of both wax and plastic pattern elimination. In carrying out this invention, any finely divided refractory material may be used as the medium, but zircon sand is preferred due to its uniformity of particle size and thermal transfer characteristics.

As shown in the drawing, a steel tank **10** is provided, being divided into an upper compartment **14** and a lower compartment **16** by a gas permeable high temperature resistant membrane **18**, consisting of a refractory material, either metal or ceramic, having a plurality of apertures **20** therein. A heater and blower mechanism **24** passes heated gas at any desired temperature through a pipe **22** into lower compartment **16** for movement upwardly through tank **10.**

In practicing the method of the invention with such apparatus, zircon sand **28** is placed in upper compartment **14** which is heated by air in turn heated by gas or electrical means in heater and blower mechanism **24.** The heated air or gas under pressure is passed upwardly through apertures **20** in the plate **18** causing the zircon sand **28** to fluidize or act as a material having liquid characteristics. A shell **30** having a plastic or other pattern **32** therein is placed either in inverted or upright position on plate **18,** preferably upright with its sprue opening or mouth **31** above the upper surface of the fluidized zircon sand **28.** In practice, it will be found that a sand temperature of between 1000 and 2000° F. is suitable to carry out a successful elimination of shell containing plastic patterns. Gases will be immediately given off from the patterns and its has been found that it is only necessary to partially eliminate the patterns during the immersion. For example, a shell may have its major portion submarged for less than a minute, say 40 seconds at temperatures 1500° F. Less time is effective at higher temperatures. After this treatment the plastic in the shell may be permitted to burn until the plastic is removed, or the shell may be transferred directly into a firing furnace for the final firing operation. Initial temperatures of the furnace are unimportant but should be preferably above the melting point of the plastic pattern material, while final firing temperatures may be of the order of 1500–2000° F. This treatment may also be used to remove wax patterns and is particularly valuable in cases where the wax gates are completely insulated from a radiated heat source. Wax sprues which previously required venting in the conventional flash firing technique will be found to eliminate without utilizing such relief procedures. The short heating cycle recommended above is preferred since such treatment ensures that sand cannot accidentally enter the eliminated shell to cause eventual casting scrap. The short cycle also results in an economical and fast operation from a production standpoint.

The invention, then, provides novel methods for removing patterns from shell molds without damage to the molds, as has been particularly difficult to achieve with plastic patterns and relatively thin-walled molds, and in fact, enhances mold characteristics for storage and subsequent firing.

Various modifications of the methods of the invention, herein not specifically disclosed yet within the spirit of the invention and the scope of the appended claims will be apparent to those skilled in the precision casting art.

What is claimed is:

1. A method of removing an expandable pattern of a heat softenable wax material from a shell mold comprising immersing said mold containing said pattern in a fluidized particulate material at a fluidizing gas temperature greater than 350° F. to soften said pattenr within one minute without damaging said shell.

2. A method as claimed in claim **1** wherein said temperature is greater than 1000° F. to soften said pattern.

3. A method as claimed in claim **2** wherein said temperature is about 1500° F.

4. A method of removing an expandable plastic pattern from a shell mold comprising immersing said mold containing said pattern in a bed of fluidized particulate material at a fluidizing gas temperature of about 1500° F. for one minute to soften the surface of said plastic pattern without melting said plastic pattern to contaminate said medium, removing said mold with said softened pattern from said bed and thereafter firing said mold at a temperature of between 1500–2000° F. to remove said pattern from said mold and harden said mold.

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