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METHOD OF SHELL MOLDING

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This invention deals with the casting of metals and more particularly with the recently developed shell molding process for the production of molds and cores for the reception of molten metals. The shell process of producing molds and cores depends upon the action of a heated metal pattern or core box upon a mixture of sand and a thermosetting resin. The sand may conveniently be ordinary foundry sand of about #90 AFS and the resin is finely ground and partially cured phenol formaldehyde type of plastic. Usually about six or seven percent of resin is incorporated in the sand. This process has been extensively described in the recent technical literature and has gone into widespread commercial use and hence will not further be described here.

The shell molding process has been conspicuously successful in the production of castings to extremely close dimensional tolerances and in the yielding of a superior as-cast finish. An object of this invention is to improve the conventional shell molding process with respect to the as-cast surface condition without appreciably adding to the cost of the process or sacrificing any of the dimensional exactitude now obtained.

When finer as-cast finishes became desirable, the obvious expedient was the substitute finer sands or even silica flour for the usual #90 AFS sand. This was tried with two undesirable results. The finer sands required higher percentages of resin to give a mold of satisfactory strength, thereby increasing notably the cost of the process. The use of the finer sands and higher percentages of resin resulted in molds or cores which were too impermeable to permit the necessary rapid escape of gas. The gas trapped in the mold and against the molten metal produced blow holes and other surface defects.

Both of these difficulties were overcome simultaneously by the expedient of laminating the core or shell in a particular manner. In the preparation of these laminated cores or shells, the core box or pattern is first heated and then contacted momentarily with a sand-resin mix in which the sand is much finer than the #90 AFS sand normally used. This mixture consisted of fifteen percent of thermosetting resin mixed in a sand vehicle which was half fine silica flour and half #127 AFS sand. These shells were made by first exposing the pattern or core box heated to 350° F. to this particular mix for five seconds. All of the mix which had not adhered to the core box or pattern in this period of five seconds is then dumped off and the thin shell or core permitted to cure briefly. There was thus formed the first lamina of the core or shell.

The second lamina of the shell or core is prepared by applying another sand-resin mix to the first lamina immediately and without removing it from the pattern or core box. This second sand-resin mix is the conventional shell molding mix of six and one half percent thermosetting resin mixed with ninety-three and one half percent of #90 to 100 AFS sand. This much coarser and economical sand-resin mixture is permitted to remain in contact with the first lamina until a second lamina of

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the desired thickness has been built up. The excess of the second sand-resin mix is then removed. Due to the fact that the first lamina is very thin, heat from the hot core box or pattern very readily penetrates to the second sand-resin mix. The rough surface of the first lamina makes an ideal medium upon which to adhere the second lamina. The final result of this process is a laminated core or shell in which the lamina nearest the core box or pattern and hence the lamina against which the molten metal is cast presents a fine, smooth surface which is faithfully reflected in the finished casting. This first lamina is sufficiently thin that the escape of gas from the casting surface is not unduly impeded. The second lamina of the coarser and thermosetting resin poorer mix serves to give mechanical strength to the assembly so that it can be stripped from the core box or pattern, backed up with shot and finally poured without mechanical failure.

The particular mixture described above for the first lamina is by no means the only one suitable for use. From considerations of cost, type of metal to be cast, dimensions and contours of the castings, and the surface desired one skilled in the art could readily fabricate other sand-resin mixtures which would be appropriate for the specific application. For example, a very fine surface has been obtained when casting steel against a first lamina in which silica flour is the only refractory and is mixed with twenty-six percent of thermosetting resin. This first lamina is backed with any convenient coarser sand-thermosetting resin mix. This particular mixture treated as outlined above produces an initial lamina ranging between one sixteenth and three thirty seconds of an inch thick.

Due to the inherent nature of the shell molding process, it is obviously impossible to set any definite and inflexible times and temperatures for the formation of each of the lamina. Since the setting of the partially cured thermosetting resin is a function of both time and temperature, and since this is further complicated by the necessity for transmitting the heat to the resin through a layer of sand which is a poor conductor of heat, advance determination of times and temperatures has been found to be impracticable and must be experimentally determined in each instance. It is of course to be anticipated that a higher core box or pattern temperature will result in a shorter period and conversely a lower temperature will require a longer period. The temperatures of the metal in the core box or pattern will usually fall within the range of 350° to 450° F. Exposure times of the first lamina have been as short as one and one half to two seconds.

It is to be understood that the term mold as employed in the subjoined claims is to be construed as to include structures usually termed cores in factory parlance.

This invention is an improvement on an invention described and claimed in a copending United States patent application Serial No. 291,064, filed May 31, 1952, in the names of Elbert E. Ensign, Royal A. Van Patten, and Donald B. Whitcomb and assigned to the assignee of the instant invention.

I claim as my invention:

1. The process of preparing a shell mold comprising applying to a heated metal surface a loose first mixture of sand and a thermosetting resin, permitting the resin portion of this sand-resin mixture adjacent the heated metal surface to cure at least sufficiently to produce a thin, self-supporting lamina of sand-resin, removing the excess of non-adhering loose first sand-resin mixture, permitting the resin in the sand-resin lamina to cure further, reapplying a loose, second sand-resin mixture to substantially the entire area of the rough surface of the thin lamina, maintaining this loose, second sand-resin

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mixture in contact with the thin lamina until the desired thickness of shell has been produced, removing the excess loose, second sand-resin mixture and curing the laminated mold formed, said first sand-resin mixture comprising sand substantially finer than the second sand-resin mixture.

2. The process of preparing a shell mold comprising applying to a heated metal surface a loose first mixture of sand and a thermosetting resin, permitting the resin portion of this sand-resin mixture adjacent the heated metal surface to cure at least sufficiently to produce a thin, self-supporting lamina of sand-resin, removing the excess of non-adhering loose first sand-resin mixture, permitting the resin in the sand-resin lamina to cure further, reapplying a loose, second sand-resin mixture to substantially the entire area of the rough surface of the thin lamina, maintaining this loose, second sand-resin mixture in contact with the thin lamina until the desired thickness of shell has been produced, removing the excess loose, second sand-resin mixture and curing the laminated mold so formed, said first sand-resin mixture being substantially higher in resin content and comprising substantially finer sand than the second sand-resin mixture.

3. The process of preparing a shell mold comprising applying to a heated metal surface a loose first mixture of sand and a thermosetting resin, permitting the resin portion of this sand-resin mixture adjacent the heated metal surface to cure at least sufficiently to produce a thin, self-supporting lamina of sand-resin, removing the excess of non-adhering loose first sand-resin mixture, permitting the resin in the sand-resin lamina to cure further, reapplying a loose, second sand-resin mixture to substantially the entire area of the rough surface of the lamina, maintaining this loose, second sand-resin mixture in contact with the thin lamina until the desired thickness of shell has been produced, removing the excess loose, second sand-resin mixture and curing the

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laminated mold so formed, said first sand-resin mixture comprising substantially only silica flour and a thermosetting resin and said second sand-resin mixture comprising ordinary foundry sand and a thermosetting resin.

4. The process of preparing a shell mold comprising applying to a heated metal surface a loose first mixture of sand and a thermosetting resin, permitting the resin portion of this sand-resin mixture adjacent the heated metal surface to cure for a period of time not exceeding five seconds and at least sufficiently to produce a thin, self-supporting lamina of sand-resin, removing the excess of non-adhering loose first sand-resin mixture, permitting the resin in the sand-resin lamina to cure further, reapplying a loose, second sand-resin mixture to substantially the entire area of the rough surface of the thin lamina, maintaining this loose, second sand-resin mixture in contact with the thin lamina until the desired thickness of shell has been produced, removing the excess loose, second sand-resin mixture and curing the laminated mold so formed, said first sand-resin mixture comprising sand substantially finer than the second sand-resin mixture.

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