METHOD OF SHELL MOLDING

Elbert E. Ensign, Ypsilanti, Royal A. Van Patten, Garden City, and Donald B. Whitcomb, Ypsilanti, Mich.; said Van Patten assignor to Ford Motor Company, Dearborn, Mich., a corporation of Delaware

No Drawing. Application May 31, 1952
Serial No. 291,064
9 Claims. (Cl. 22—193)

This invention relates to the founding art and more specifically to that portion of the founding art which is concerned with the casting of metals in the so-called "shell" molds. This type of molding has been widely described in the recent technical literature. Basically, shell molding comprises the preparation of a metal-enclosing mold by showering a mixture of sand and thermosetting resin upon a metal pattern heated to a temperature in the neighborhood of 350°—450° F. The sand is usually ordinary foundry sand of about 90 A. F. S. size containing about 7 percent of partially cured phenol formaldehyde resin. The heat of the mold completes the cure of the thermosetting resin in situ and causes the formation of a rigid mold which can be stripped from the heated pattern and employed to receive molten metal.

While this process has proven very useful and has come into widespread commercial use, certain inherent limitations have become apparent and this invention has resulted from efforts to circumvent such limitations.

To secure good contact between the heated pattern and the sand resin mixture it is the practice of the art to rely completely upon the force of gravity. To enable the completed mold to be stripped from the pattern, it has been found necessary to lubricate the pattern periodically with a heat stable lubricant, as for instance, a five percent silicone emulsion in water. These two factors have caused difficulties in building up a proper shell thickness when the face of the pattern is approximating parallel to the force of gravity. Under these circumstances, there is little or no force tending to impel the sand-resin mixture against the lubricated vertical portions of the pattern. A similar problem exists when an effort is made to fill a heated metal core box with the sand-resin mixture to cast a core. In the usual practice, the heated core box is filled with the sand-resin mixture and after allowing sufficient time for the resin to initially set, the core box is inverted to remove the excess molding compound. This inevitably resulted in some portion of the newly formed hot plastic core being attached to an upper horizontal surface or to a vertical surface and hence unsupported against gravity except by its own rigidity and its adherence to the lubricated core box. These two forces are often insufficient to support the weight of the core and consequently a portion of the core wall either deforms or sloughs off completely.

It has been found that these difficulties can be avoided if the mold or core is formed in a two-step operation rather than a one-step operation. According to this invention, and using the core box as an example, a core is formed by filling the hot core box with the sand-resin mixture, quickly dumping the excess mixture, permitting the thin shell so formed to cure from the heat of the core box and then refilling the core box with further sand-resin mixture and permitting this mixture to remain in place until a core of the desired thickness has been built up.

When the initial charge of sand-resin mixture is placed in a heated core box and then quickly dumped, there results a very thin shell of sand-resin mixture over the entire interior of the core box. Because this shell is very thin, the resin portion thereof quickly becomes heated and cures and results in a thin, light, but comparatively strong shell. The inner surface of this shell is of course rough and forms an ideal surface to receive the final charge of sand-resin with perfect adherence. When the final charge of resin is placed into the shell lined core box, the heat from the core box penetrates the initial thin shell and cures the immediately adjacent resin to a depth dependent upon the time contact permitted. By regulating the length of time the second charge of sand-resin mixture is permitted in contact with the original shell, the thickness of the final shell can be regulated. When the desired thickness is attained, the core box is dumped, the resin permitted to cure further if necessary, the core box is split along the parting line and the completed core removed.

Due to the inherent nature of this shell mold process, it is impossible to set definite numerical time and temperature limits for the two steps involved. As those skilled in the art will readily appreciate, the curing time of the resin is a direct function of the temperature to which it is exposed. Substantially the same results can be obtained by prolonged contact with a pattern or core box at a comparatively low temperature, or by brief exposure to such a metal surface at a rather elevated temperature. However, with a core box at a conventional temperature of 350° to 450° F., the first application of the sand-resin mixture is preferably limited to two seconds and at these temperatures should, under no circumstances, exceed five seconds. Before this thin shell is burdened with a thicker shell necessary to retain molten metal, it should be permitted to cure for a period of time not exceeding twenty seconds. The first application of the sand-resin mixture may then be made and permitted to remain in place for a period of time normally about thirty seconds but which may be extended up to two minutes if necessary.

In addition to enabling the preparation of molds or cores otherwise impossible by shell molding, the use of laminated shells enables the conservation of the expensive thermosetting resin. For example the resin content of the thin initial lamina of the mold can be increased from the usual seven percent to the range of ten to fifteen percent resulting in the production of a very thin but strong lamina. Similarly under some circumstances it may be desirable to decrease the concentration of resin in the first sand-resin mixture and use the higher concentration of resin in the second lamina.

It is to be understood that the term mold as employed in the subjoined claims is to be construed to include structures conventionally referred to as cores.

What is claimed is:

1. The process of preparing a shell mold comprising applying to a metal surface heated to a temperature of about 400° F. a loose mixture of sand and a thermosetting resin, permitting the loose sand-resin mixture to remain in contact with the heated surface for a period of time not exceeding two seconds to produce a thin self supporting lamina of sand-resin at least a portion of which is supported against gravity only by its own rigidity and adherence to the metal surface, promptly removing the excess loose sand-resin mixture, permitting the resin in the adhering lamina to cure further, reapply-
ing more loose sand-resin mixture to substantially the entire area of the rough surface of the thin lamina, maintaining this loose sand-resin mixture in contact with the thin lamina until the desired thickness of shell has been produced, removing the excess loose sand-resin mixture to substantially the entire area of the rough surface of the thin lamina, maintaining this loose sand-resin mixture in contact with the thin lamina until the desired thickness of shell has been produced, removing the excess loose sand-resin mixture and curing the laminated mold so formed, said first mentioned sand-resin mixture having a resin content of ten to fifteen percent and said second mentioned sand-resin mixture having a resin content of three to seven percent.

3. The process of producing a laminated hollow shell core comprising filling a heated core box with a loose mixture of sand and a thermostetting resin, permitting the resin portion of the sand-resin mixture adjacent the heated metal surface to cure, for a time not in excess of 5 seconds only sufficiently to produce a thin self-supporting lamina of sand-resin mixture at least a portion of which is supported against gravity only by its own rigidity and adherence to the wall of the core box, promptly removing the excess loose sand-resin mixture, permitting the resin in the adhering lamina to cure further, reapplying more loose sand-resin mixture to substantially the entire area of the rough surface of the thin lamina, maintaining this loose sand-resin mixture in contact with the thin lamina until the desired thickness of shell has been produced, removing the excess loose sand-resin mixture and curing the laminated mold so formed, said first mentioned sand-resin mixture having a resin content of ten to fifteen percent and said second mentioned sand-resin mixture having a resin content of three to seven percent.

4. The process of producing a laminated hollow shell core comprising filling a heated core box with a loose mixture of sand and a thermostetting resin, permitting the resin portion of the sand-resin mixture adjacent the heated metal surface to cure, for a time not in excess of 5 seconds only sufficiently to produce a thin self-supporting lamina of sand-resin mixture at least a portion of which is supported against gravity only by its own rigidity and adherence to the wall of the core box, promptly removing the excess loose sand-resin mixture, permitting the resin in the adhering lamina to cure further, again filling the heated core box with another loose sand-resin mixture having a resin content substantially less than the first mentioned sand-resin mixture, maintaining this loose sand-resin mixture in contact with the thin lamina until the desired thickness of core has been produced, removing the excess loose sand-resin mixture and curing the laminated core so formed.

5. The process of preparing a laminated hollow shell core comprising filling a core box heated to a temperature of about 400° F. with a loose mixture of sand and a thermostetting resin, permitting the loose sand-resin mixture to remain in contact with the heated core box for a period of time not exceeding two seconds to produce a thin self-supporting lamina of sand-resin mixture at least a portion of which is supported against gravity only by its own rigidity and adherence to the metal surface, promptly removing the excess loose sand-resin mixture, permitting the resin in the adhering lamina to cure further, reapplying more loose sand-resin mixture to substantially the entire area of the rough surface of the thin lamina, maintaining this loose sand-resin mixture in contact with the thin lamina until the desired thickness of shell has been produced, removing the excess loose sand-resin mixture and curing the laminated core so formed.

6. The process of producing a laminated hollow shell core comprising filling a heated core box with a loose mixture of sand and a thermostetting resin, permitting the resin portion of the sand-resin mixture adjacent the heated core box to cure, for a time not in excess of 5 seconds only sufficiently to produce a thin, self-supporting lamina of sand-resin mixture at least a portion of which is supported against gravity only by its own rigidity and adherence to the wall of the core box, promptly removing the excess loose sand-resin mixture, permitting the resin in the thin sand-resin lamina to cure further, reapplying more loose sand-resin mixture to substantially the entire area of the rough surface of the thin lamina, maintaining this loose sand-resin mixture in contact with the thin lamina until the desired thickness of shell has been produced, removing the excess loose sand-resin mixture and curing the laminated core so formed.
the wall of the core box, the improvement comprising permitting the resin portion of the sand resin mixture adjacent the heated metal surface to cure for a time not in excess of five seconds and only sufficiently to produce a thin self-supporting lamina of sand resin mixture, removing the excess of the non-adhering loose sand resin mixture, permitting the resin in the sand resin lamination so produced to cure further, refilling the heated core box with a second loose sand resin mixture which is much poorer in resin than the first employed sand resin mixture, maintaining this second loose sand resin mixture in contact with the thin lamination until the desired thickness of core has been produced, removing the excess loose sand resin mixture and curing the laminated core so formed.

References Cited in the file of this patent

UNITED STATES PATENTS

2,441,695 Feagin et al. May 18, 1948
2,614,303 Duncan Oct. 21, 1952
2,772,458 Henry Dec. 4, 1956

FOREIGN PATENTS

832,934 Germany Mar. 3, 1952

OTHER REFERENCES

The Foundry, October 1950, pages 162, 164 and 168.