

Jan. 22, 1957

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2,778,077

SHOT COMPACTING IN THE SHELL MOLDING PROCESS

Filed Oct. 20, 1955

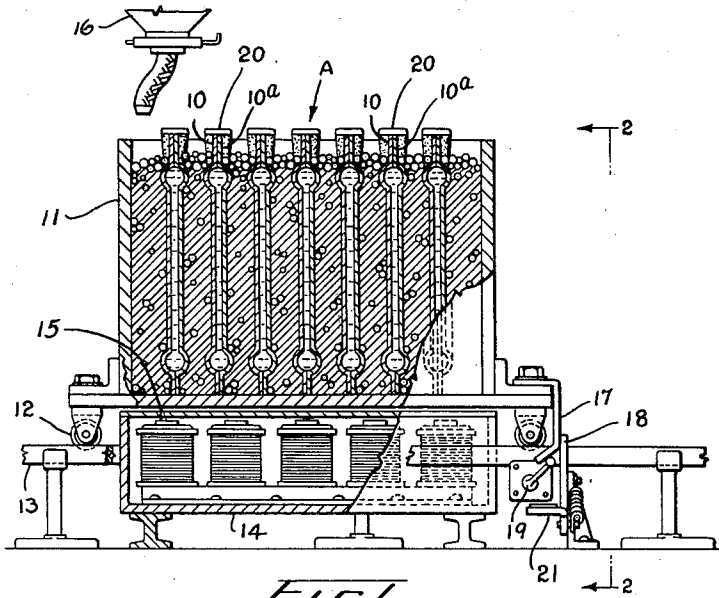


FIG. 2

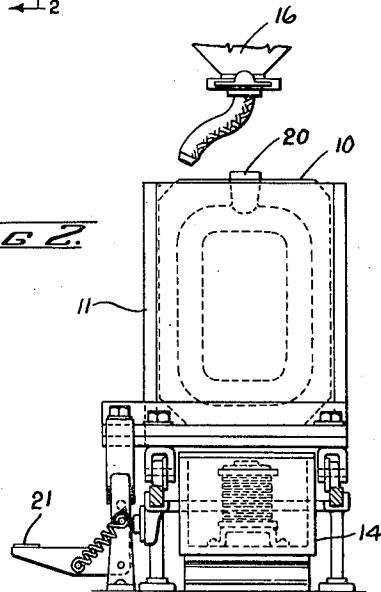
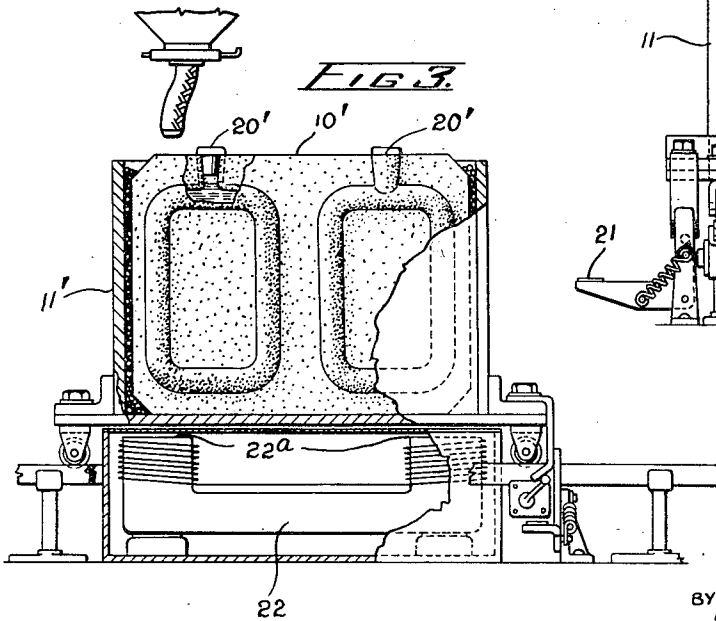


FIG. 3



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1

2,778,077

SHOT COMPACTING IN THE SHELL MOLDING PROCESS

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Application October 20, 1955, Serial No. 541,749

9 Claims. (Cl. 22-90)

This application is a continuation-in-part of my co-pending application Serial No. 317,555, filed October 29, 1952, now abandoned.

This invention relates to a method for backing shell molds in the operation of casting by the shell molding process.

In the process of shell molding, thin shell waste molds are made by placing a powdered mixture containing dry sand and thermoplastic synthetic resin in contact with heated metal patterns. The heat softens the plastic, which bonds the sand particles together to form stable negative impressions of the patterns. A pair of molds is made for each casting to be produced. After they are stripped from the patterns, each pair of molds, one of which includes a gate and runner, are clamped or adhered together in a box or "flask" with the gate vertical, backed with loose steel shot or other porous material, and filled with molten metal. The backing or bedding material is required to help the thin mold shell to resist the hydrostatic pressure of the liquid metal as it flows into the mold.

If the backing of the molds is not sufficiently firm, the molds will be distorted or part slightly under the pressure of the metal, and serious dimensional errors in the castings will be caused. Gaps at the parting line also produce metal fins that must be cleaned off, and this increases the cost and may affect the dimensions. Firm compacting of the backing material against the shell mold is thus of paramount importance.

The object of this invention is to provide an inexpensive and convenient method for firmly compacting metal shot in the molding box.

A further object of the invention is to provide an arrangement for compacting the backing shot which by virtue of the employment of a magnetic field will produce "grain orientation" in the casting and thus produce increased strength characteristics in the castings.

In general terms, the method for backing shell molds according to the invention comprises the steps of assembling a mold in a mold box, using particulate magnetic backing material to back the mold in the mold box, and producing a magnetic field within the mold box to compact the shot.

In an article entitled "Shell molding process" by Roy W. Tindula, of the Office of Technical Services, U. S. Department of Commerce, in Foundry, July 1952, pages 201 to 204, 206 and 208, it is pointed out that tolerances in shell molding of .002 to .003 inch per inch are possible, and that tolerances of about .003 to .007 inch per inch have been achieved. In another article dealing with the same subject, entitled "Shell molding—its mechanics and applications," published in Foundry, June 1952, the authors Bernard N. Amos et al. point out at pages 289 and 290 that the method of closing shell molds depends upon the degree of tolerance desired in the castings, and that steel shot used for backing should be vibrated during backing up to compact it. However, a greater degree of compacting and closer tolerances are obtained by the magnetic

2

compacting method according to the invention: Tolerances of from .001 to .002 inch per inch are routinely achieved, with a maximum outside diameter variation between the dimension along the parting line, and the dimension 90° from the parting line, of .003 inch per inch.

An embodiment of the invention is illustrated in the accompanying drawings, in which each reference character denotes the same part in the various views, which are as follows:

Fig. 1 is a generally longitudinal section through the assembly including the mold box and the electromagnetic unit, showing the mold box at the shot pouring station and aligned with the electromagnetic unit.

Fig. 2 is a section taken on the line 2—2 in Fig. 1.

Fig. 3 is a view like Fig. 1 of a modified version of the assembly using a different form of electromagnetic unit.

The embodiment of the invention illustrated in Figs. 1 and 2 is adapted for a molding arrangement as shown in which shell molds 10 are disposed in a box or "flask" 11 mounted on flanged wheels 12 which run on a gravity conveyor track 13 passing the various stations where different steps of the molding process are carried out.

The bottom of the box 11 is made of a non-magnetic material such as wood or aluminum and has sufficient clearance under it for installation of an electromagnet unit 14 disposed between the rails of the conveyor track, so that the bottom of the box 11 just clears the faces of the poles 15 of the electromagnet unit. The number of poles 15 is sufficient to maintain a generally uniform magnetic field in the box 11. The molds are arranged in an upright position so that the parting lines 10a of the mold are generally parallel to the axes of the magnets. The field will thus be generally symmetrical around, and aligned with, the parting line of each of the molds 10 arranged in the box. A completely symmetrical field around each parting line would of course be assured if each mold is disposed immediately above the pole of a corresponding electromagnet when the box is in position for pouring ferrous shot as shown for mold A in Fig. 1, but this ideal arrangement may be departed from as shown if sufficient magnets are used to produce a generally uniform field in the box; about five electromagnets may be used for a box of about three cubic feet capacity and holding up to seven molds, each 16 inches deep and 11 inches wide.

To position the box conveniently and accurately above the electromagnetic unit and under a shot hopper 16 arranged above the conveyor track, a projection 17 from the base of the box may be arranged to engage with a stop latch 18 on the conveyor track so that the box will be stopped at the proper location on the track over the poles of the electromagnet.

An automatic switch 19 on the conveyor track may be used to turn on the power to the magnets automatically, by arranging it as shown to engage the projection 17 on the box. The switch is connected to an alternating current power supply so that as soon as the box is positioned over the electromagnet unit, the power is turned on and the magnet energized. A suitable power input for a box of the size described is 40 amps. at 220 volts A. C.

As soon as the magnet is energized, shot is fed to the box from the shot hopper 16 to fill up the spaces between the molds. Stoppers 20, which may be of soft rubber, are placed temporarily in the mold gates to prevent shot from entering the molds.

While the box is being filled with ferrous shot, the shot becomes magnetized by induction and the force of gravity tending to compact the shot around the molds is augmented by the magnetic forces which convert each particle of shot into a magnet whose poles are oriented

along the lines of force of the magnetic field. Since each mold is positioned over the axis of an electromagnetic core or is aligned with the space between two like electromagnetic poles, the generally symmetrical distribution of curved lines of force around each mold and crossing its parting line urges the individual particles of shot while they are still in a relatively loose, moveable condition to follow these inclined lines of force transversely toward each other and thus toward the faces of the molds as well as downwardly toward the magnets. Therefore, the magnetic forces not only materially supplement the normal influence of gravity in urging the shot downwardly but they also urge the shot in a sideways direction, and thus they materially increase the degree of compacting of the shot that would be produced by gravity alone and provide a much firmer backing for the mold.

As soon as the box has been filled with shot the upper surface may be levelled by an operator and preferably though not necessarily, a momentary surge of direct current is passed through the coils of the magnets to compact the shot still further. A momentary D. C. power input applied for 10 milliseconds by an electronic switch, and giving a peak current of 100 amps. at 220 volts, will drop the level of the shot in the box by about an inch, and produce ideal compacting. Even if it were applied without previous magnetic compacting, it is obvious that a substantially firmer backing would be produced by this step. Following this, the operator depresses a latch release pedal 21 (or alternatively an automatic arrangement may be provided for releasing the latch) and the box rolls along the track to the pour-off station where molten metal is poured into the molds. During this operation the inherent insulating quality of the shell molds causes a slight lag in the conduction of the heat of the metal to the ferrous shot, which provides sufficient time for the metal to freeze in the molds before the residual magnetism is lost. After the metal has frozen, the heat which has been conducted to the ferrous shot demagnetizes the shot, and the contents of the box are emptied at a shake-out station. By means of a vibratory screen the shot is separated from the castings and the adhering molds. Loose sand is separated from the shot by screening, and the shot is conveyed back to the shot hopper, while the molds are broken away from the castings and carried to a sand reclaiming unit.

A forced draft of refrigerated air from a nozzle (not shown) in the shot hopper 16 may be used to cool the shot and render it susceptible to prompt re-magnetization.

A beneficial degree of "grain orientation" is produced in the castings by the magnetic field derived from residual magnetism maintained in the shot until, as stated above, the heat of the metal is sufficiently transferred to the shot to de-magnetize it. This "grain orientation" conforms to the magnetic lines of force, and if desired may be aligned with the vertical axis of the molds by placing each mold directly over the pole of an electromagnet.

As pictured in Fig. 3 of the drawings, a single electromagnet 22 in a U-shape may be used instead of a number of magnets. In this arrangement molds 10' are arranged in a box 11' so that the parting lines enter generally parallel to the plane joining the poles 22^a of the magnet, thus achieving a generally symmetrical distribution of lines of force around the parting lines, which in the drawing are in the plane of the shell.

It will be understood that it is intended to cover all changes and modifications of the embodiment of the invention, described herein for the purpose of illustration, which do not constitute departures from the spirit and scope of the invention.

What I claim as my invention is:

1. In the shell molding process, the steps of assembling a mold in a mold box, producing a magnetic field sub-

stantially symmetrically around the mold, and backing the mold in the mold box with particulate magnetic backing material while maintaining the magnetic field.

2. In the shell molding process, the steps of assembling parts of a mold in a mold box, producing a magnetic field substantially symmetrically around a parting line of the mold, and filling the space between the outer surface of the mold and the walls of the mold box with particulate magnetic material.

3. In the shell molding process, the steps of assembling parts of a mold in a mold box, producing a magnetic field from below the mold substantially symmetrically around a parting line of the mold, and backing the mold by filling the remaining space in the mold box with particulate magnetic material while maintaining the magnetic field.

4. In the shell molding process, the steps claimed in claim 3 in which the particulate magnetic material is ferrous shot.

5. In the shell molding process, the steps of assembling a mold in a mold box, producing a magnetic field in the remaining space in the mold box substantially symmetrically around the mold, compacting loose particulate material in the said space by filling the space with ferrous shot while maintaining the magnetic field, and pouring molten metal into the mold while residual magnetism remains in the shot.

6. In the shell molding process, the steps of arranging the relative positions of a shell mold in a mold box and an electromagnet so that the shell mold is disposed in generally symmetrical relationship with at least one pole of the electromagnet, energizing the electromagnet, and pouring particulate magnetic material into the box around the mold while the electromagnet is energized.

7. In the shell molding process, the steps of arranging the relative positions of a shell mold and mold box and an electromagnet so that the shell mold is disposed in generally symmetrical relationship with at least one pole of the electromagnet, energizing the electromagnet, pouring ferrous shot into the box around the mold while the electromagnet is energized, and pouring molten metal into the mold while residual magnetism remains in the shot.

8. In the shell molding process, the steps of assembling parts of a mold in a mold box, arranging the relative positions of the mold and an electromagnet so that the mold is disposed near a pole of the electromagnet with the axis of the magnetic pole lying substantially in the plane of a parting line of the mold, energizing the electromagnet, and pouring particulate magnetic material into the box around the mold while the electromagnet is energized.

9. Apparatus for shell molding comprising a track, a mold box movable along the track, a plurality of shell molds spaced from each other in the mold box, a shot pouring unit disposed above the track, an electromagnetic unit disposed under the track at the location of the hopper and comprising a plurality of electromagnets spaced from each other in conformity with the mutual spacing of the molds, and means for locating the mold box on the track with each of the molds in vertical alignment with one of the electromagnets.

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