

Sept. 14, 1954

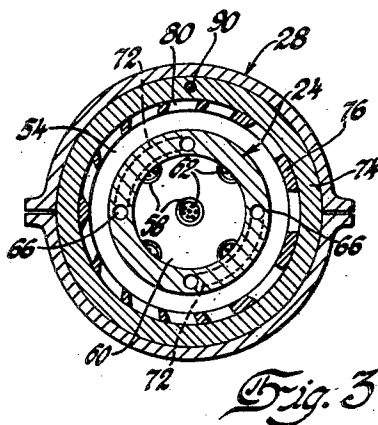
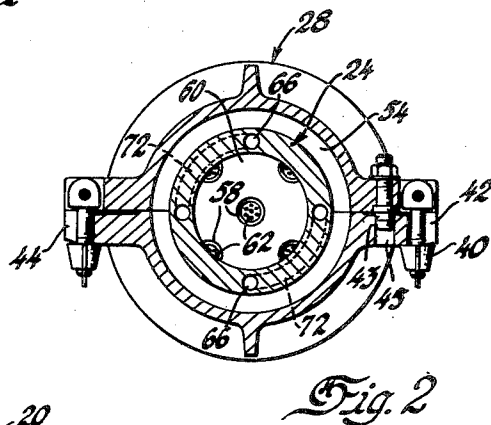
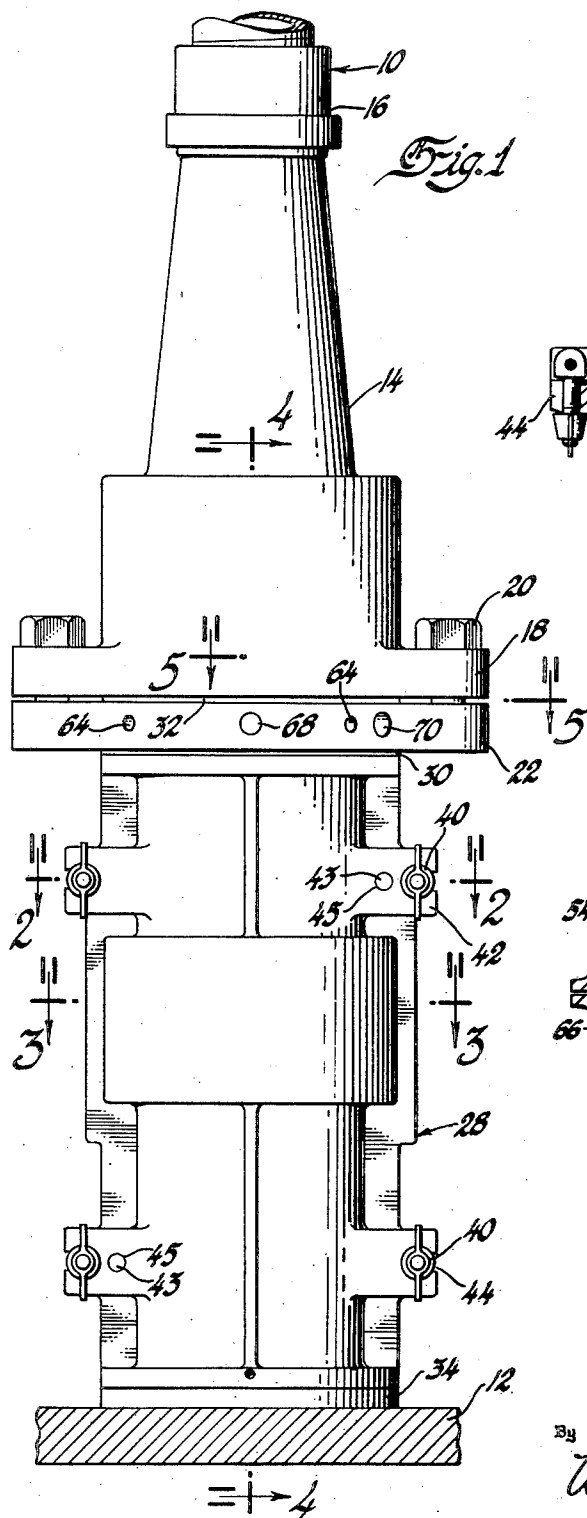
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MACHINE AND PROCESS FOR FORMING HOLLOW SAND-RESIN CORES

Filed Dec. 26, 1951

2 Sheets-Sheet 1



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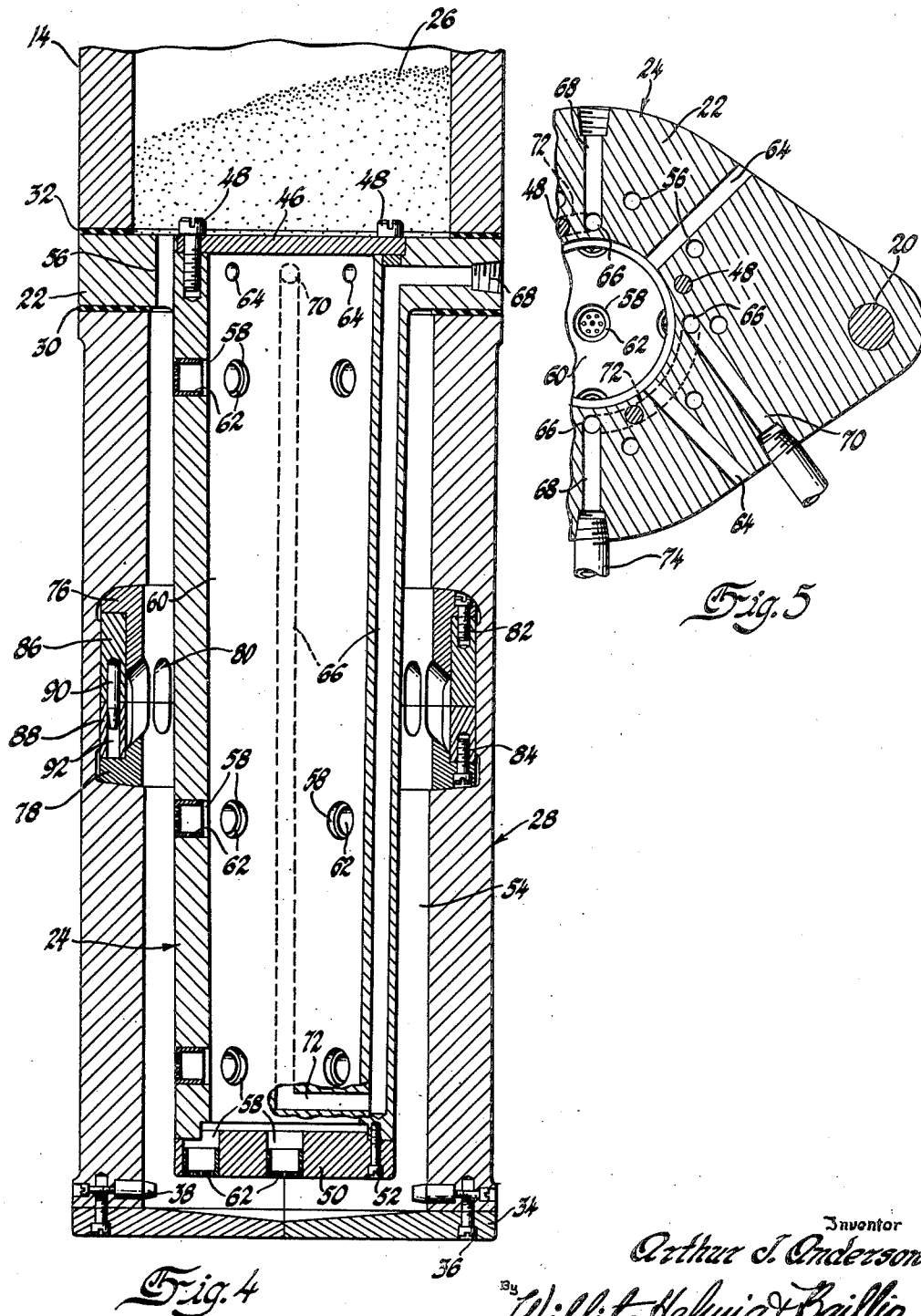
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UNITED STATES PATENT OFFICE

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MACHINE AND PROCESS FOR FORMING
HOLLOW SAND-RESIN CORES

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8 Claims. (Cl. 22-10)

1

This invention relates to the forming of hollow sand cores for metal casting operations; and particularly to a machine and process for forming shell-type sand-resin cores.

Recently developed techniques in foundry practice incorporate the use of thin-walled dispensable molds and cores composed of sand and plastic binder. These procedures, frequently referred to as "shell molding" processes, are particularly suited for the production of precision castings in a wide variety of metals.

A principal object of this invention is to provide an inexpensive apparatus and process for rapidly and conveniently forming hollow sand-resin cores for high production use in the shell molding process. Another object of the invention is to provide a core-forming machine and process which produce accurate shell-type cores for precision casting wherein the formed thin-walled cores possess good dimensional stability, satisfactory gas permeability, smooth surfaces and adequate strength. Furthermore, the process is not only rapid and relatively simple, but it also results in considerably improved working conditions in foundries.

Essentially the shell molding process consists of using a thermo-setting plastic or resin as a binder for the sand grains to form thin-walled molds. The molding material, which is generally a dry mixture of a major proportion of silica sand and a minor proportion of the thermosetting binder, is used in powder form with no water being added. Phenol formaldehyde and melamine formaldehyde resins are typical examples of the type of thermosetting resin binder used. The sand employed is preferably free of metal oxides, clay, moisture and organic matter.

These sand-resin molds are prepared by allowing the dry mixture of sand and resin powder to come into contact with a hot metal pattern for a short period of time. A layer of the mix adheres to the metal surfaces due to the heating of the resin which entraps the sand with which it is intimately mixed, thereby accurately reproducing pattern details. Metal patterns must be employed because they are subjected to elevated temperatures. Pattern temperatures in the range between 250° F. and 350° F. are typical, but temperatures up to 800° F. may be advantageously employed under particular conditions. The half patterns, gate and runner are preferably all permanently fixed on metal plates. The pattern temperatures and the length of time the molding material is allowed to remain in contact with the hot metal surfaces determine the resulting thick-

2

ness of the mold. Mold build-up time ranging from a few seconds to approximately one minute are appropriate for various applications.

After this short time interval, any excess dry sand and resin are removed, and the closely adhering sand-resin layer is preferably cured by heating to a temperature within the broad range of approximately 300° F. to 1300° F. for a short period of time, usually from a few seconds to five minutes, while in contact with the metal pattern. This baking operation results in the conversion of the resinous material to a hard, insoluble binder which securely bonds the sand grains together. After the removal of the pattern and mold from the curing oven, the mold is stripped from the pattern. The formed molds are, in effect, thin shells which have sufficient strength and stiffness to make them suitable for many casting operations.

The inability to economically produce shell-type sand-resin cores of satisfactory quality has heretofore been an important factor in preventing the wide use of such cores in the shell molding process. This problem has been minimized in accordance with the present invention by the provision of an assembly which may be used in conjunction with a conventional core-blowing machine to produce hollow sand-resin cores for foundry operations.

Other objects and advantages of this invention will more fully appear from the following description of a preferred apparatus and process embodying the invention, reference being made to the accompanying drawings, in which:

Figure 1 is an elevational view of the core-forming machine embodying the invention;

Figure 2 is a sectional view, along the line 2-2 of Figure 1, showing the formed core-defining cavity;

Figure 3 is a sectional view along the line 3-3 of Figure 1;

Figure 4 is a vertical sectional view, along the line 4-4 of Figure 1, showing the venting arrangement and other details of construction; and

Figure 5 is a sectional view, with parts broken away, generally along the line 5-5 of Figure 1.

Referring more particularly to the drawings, Figure 1 shows a core-forming assembly embodying the invention which is positioned between an air supply means, indicated generally at 10, and a rest table 12 of a conventional core-blowing machine. An upwardly tapered magazine 14 for containing a sand-resin molding mixture of the type hereinbefore described is shown as located beneath and communicating with the air supply

means. The magazine has its upper end provided with an opening, not shown, through which the sand-resin mix and compressed air may be introduced into the magazine. The upper end of the magazine may be adapted to threadedly engage a flanged collar 16 on the adjacent portion of the air supply means, as shown, or it may be fastened thereto by bolts or other suitable means.

The lower portion of the magazine is shown as provided with outwardly extending flanges 18 which are secured by screws 20 to similar flanges 22 formed on the upper end of a hollow venting member or cartridge, indicated generally by 24. The details of construction of the venting assembly will be hereinafter more fully explained. As shown in Figure 4, a suitable quantity of the sand-resin mixture 26 is contained in the magazine prior to the actual blowing operation.

A split core box or pattern, which is indicated generally at 28 and is shown as being substantially cylindrical, surrounds the venting member 24 and has its upper edge position immediately beneath the flange 22 and separated therefrom by a suitable compressible heat-resistant gasket 32. A similar gasket 32 is also positioned between the flange 22 and the lower edges of the magazine 14. The core box, which is constructed of cast iron, aluminum, or other suitable metal, is adapted to be heated so that the thermosetting resin binder in the molding mixture 26, upon contacting the hot core box, readily melts and bonds the sand particles together. Plates 34 form the bottom of the core box and are secured to its cylindrical side walls by screws 36. The side walls of the core box 28 are provided near the lower edge with dowel pins 38 so as to define suitable core prints in the hollow core to be formed.

It will be noted that the core box shown is longitudinally divided into half patterns which are secured together by pivotal bolt and wing nut assemblies 40. This arrangement permits the rapid assembly and disassembly of the two core box halves. Lugs 42 are shown as formed near the upper and lower ends of the core box to support and be clampingly engaged by the nut and bolt assemblies 40, the bolts being pivotally mounted on one core box half and adapted to extend through the slots 44 on the other half. Dowel assemblies 43 may be fastened to a pair of the lugs 44, as shown in Figure 2, and project through appropriate openings 45 in adjacent lugs to facilitate alignment of the core box halves.

As can be seen from Figures 2 through 4, the hollow venting member or cartridge 24, preferably of metal, is positioned within the core box 28 and extends longitudinally throughout almost the entire length of the core box. As previously indicated, this venting member is supported within the core box by screws 20 which fasten the upper end flange 22 to the magazine 14. A plate 46 is shown as attached to the upper end of the venting member by screws 48, while the lower end of the venting member is closed by another plate 50 secured in position by screws 52 or other suitable means. It will be understood, of course, that these plates may be formed integral with the side walls of the venting assembly where methods of fabrication indicate the advisability of so constructing the assembly. The side and bottom walls of the venting assembly thereby formed are spatially separated from the walls of the core box 28 to provide an interjacent core-defining cavity 54. In general, it may be stated that a cast iron venting assembly is preferable to

one of aluminum inasmuch as the former has less tendency to adhere to the molding mixture.

Blowholes 56 for admitting the sand-resin molding mix 26 are shown as provided in the outwardly extending flange or blowhead portion 22 at the upper end of the venting assembly. The bottom and side walls of the venting assembly have a plurality of air passages or vents 58 extending from the interior 60 of the venting assembly to the core-defining cavity 54 to permit the escape of air which is displaced from the blowholes 56 and the cavity 54 upon the admission of the sand-resin molding mix into the cavity. As shown in the drawings, each of these air vents contains a cup-shaped insert 62, preferably of brass or other metal, which is provided with small venting holes. The cross-sectional area of these latter holes is sufficiently small to eliminate the possibility of sand grains passing therethrough, thereby preventing the molding material from passing out of the cavity 54 and into the interior of the venting assembly during the blowing operation. The air vents 58, of course, are located at appropriate positions to allow for the rapid and efficient escape of the air displaced from the cavity 54 to prevent the occlusion of air in the molding mixture. The positions of these vents will necessarily vary with the shape and size of the core being formed. For maximum efficiency, the ratio of the total vent area of the venting assembly to the total cross-sectional area of the blowholes should be retained fairly close to an optimum value of five to one.

Transversely extending air outlet openings or escape ports 64 are shown as formed in the upper flange portion 22 of the venting member 24 to convey the air displaced from the interior of the venting assembly to the atmosphere.

It should be noted that the blowholes 56 and the air vents 58 communicate with the core-defining cavity 54 through the unheated venting assembly 24, thereby precluding the possibility of the said-resin molding mixture fusing within these holes and vents. Thus, the molding mixture is prevented from obstructing the passage of fresh molding mix through the blowholes or the passage of the displaced air through the air vents.

In order to further aid in eliminating the danger of plugging the blowholes or air vents with the molding material, particularly if it is found that the venting assembly heats excessively during constant use, this assembly may be provided with appropriate coolant passages 66. These coolant passages are shown as extending longitudinally within the side walls of the venting assembly and are connected to appropriate inlet and outlet openings 68 and 70, respectively, in the flange or blowplate 22. In the cooling arrangement shown in the drawing, each diametrically opposite longitudinally extending portion of the coolant passages 66 communicates with a similar radially adjacent portion through circumferential or transverse connecting ducts 72 in the side walls of the assembly near its lower end. Such a construction permits a fluid coolant, such as water, to enter an inlet opening 68, travel downwardly throughout substantially the entire length of the venting assembly, cross over to another longitudinally extending coolant passage and return upwardly to an outlet opening 70. Suitable tubes or hoses 74 may be provided to connect the openings 68 and 70 with a coolant supply system. This provision for cooling pre-

vents the formed core from tending to adhere to the surfaces of the venting assembly due to sticking of the plastic molding mix and also effectively precludes the possibility of the sand or molten resin from clogging the blowholes or air vents.

It will be appreciated, of course, that the modification of the core-forming machine shown in the drawings is especially adapted for one particular use and that the general structure may be modified to adapt it to form the particular core shape desired. Inasmuch as the modification shown is used in forming a cylinder liner core for internal combustion engines, the core pattern is provided near its central portion with a pair of ring members 76 and 78 which are formed with interconnected radially extending recesses 80. These recesses provide for the scavenging air ports in the cylinder liner casting. The ring members 76 and 78 are securely held in position by screws 82 and 84 which threadedly engage a pair of annular supporting members 86 and 88, respectively. Aligning pins or dowels 90 are shown as positioned within longitudinally extending recesses 92 to provide for the proper alignment of the members 76, 78, 86 and 88.

The sequence of operation of the above-described core-forming machine is as follows. First the magazine 14 is filled with a suitable quantity of the sand-resin mixture. Then the air supply outlet 10, the magazine 14 and the venting assembly 24, secured together by the collar 16 and screws 20, are elevated, or the rest table 12 is lowered, to provide for the positioning of the hot core box. Meanwhile the core box is preferably cleaned and prepared in the usual manner and heated to the appropriate temperature. As hereinbefore indicated, I have found that a core box temperature within the range between 250° F. and 350° F. is appropriate for various applications, although in certain instances temperature up to 800° F. may be advantageously used. A temperature of approximately 325° F., however, appears to provide optimum results under most conditions of operation.

Following this heating step, the hot core box is placed in position on the rest table 12 and the latter raised (or the air supply outlet 10, together with the connected magazine and venting assembly, lowered) into position so that the venting assembly extends into the core box. The flange 22 is thus firmly seated upon the upper end of the core box to provide an air-tight connection between these members.

As indicated above, either the air supply outlet or the rest table of the core-blowing machine may be the movable portion, the latter being the reciprocable member in the modification shown. A vertically movable shaft or piston, not shown, which can be hydraulically or otherwise suitably actuated, may support either the air supply means or the rest table and move the core box into engagement with the venting assembly.

When the core-forming assembly is thus in position preparatory to the blowing operation, air is fed into the magazine from the air supply means 10. This air, which is preferably introduced under a pressure of 40 to 50 pounds per square inch, forces the dry sand-resin molding mix through the blowholes 56 and into the core-defining cavity 54. In the arrangement shown, the air is not intermixed with the molding material as the latter enters the cavity 54, but instead the compressed air functions as a ram to drive

the sand-resin mix into this cavity. This sand thus is rapidly deposited on the bottom and along the sides of the core box and builds up until the cavity is completely occupied. The air which is displaced from the cavity 54 is thereby forced through the vents 58, into the interior 60 of the venting assembly, and out through the transversely extending air escape ports 64 into the atmosphere.

The blowing time may vary considerably, of course, but a blowing period of approximately fifteen seconds has proved to be highly satisfactory for most purposes when the modification of the invention shown is employed.

Following the blowing operation, a short time interval may be allowed for the thermosetting resin binder to "set" in the hot core box, a period of time ranging from a few seconds to approximately one minute being appropriate for various applications. A mold build-up time in the order of about ten seconds is usually sufficient, and oftentimes the setting of the resin will take place to a sufficient extent during the short blowing period. The rest table is next lowered, or the air supply outlet 10 raised, to withdraw the venting assembly 24 from within the core box 28. The latter is then removed from the rest table, and the closely adhering sand-resin layer is preferably baked for a short period of time, usually from a few seconds to five minutes in a curing oven, while in contact with the core box. The curing of the formed core is preferably accomplished in a recirculating air oven which is maintained at a temperature between 550° F. and 1300° F. I have found that a five minute bake at a temperature of 650° F. or a 60 to 90 second bake at approximately 1300° F. provide excellent results.

After the removal of the baked core and supporting pattern from the curing oven, the wing nuts of the nut and bolt assemblies 40 are loosened to permit the disassembly of the two halves of the core box 28 and the stripping of the cured core therefrom, thus completing the operating cycle. Of course, most efficient use may be made of this machine if it is kept in operation almost continuously. This may be accomplished by blowing and baking one core while another one is being stripped from a core box and readied for use and while another core box is being heated.

The magazine 14 is preferably designed to contain more sand-resin mix than is necessary for the formation of one core, it being desirable in most instances to form this magazine of sufficient size so that it can be retained beneath the air supply means for a multiplicity of shots. With such an arrangement, the rest table 12 is preferably the reciprocable member, and the attached venting assembly remains connected to the air supply means until the molding mixture in the magazine is exhausted. It also is usually desirable to mount the magazine on a traverse mechanism so that it may be readily moved between the air supply means and the sand-resin supply or to connect both the air and molding mixture supplies directly with the magazine so that adjustments permitting each to communicate at the proper times with the magazine may be readily made.

Various modifications in the arrangement and details of the specific embodiment described and shown herein will be apparent to those skilled in the art and are contemplated as within the scope of the present invention as defined in the appended claims.

I claim:

1. An apparatus for forming hollow sand-resin cores for use in foundry casting operations, said apparatus comprising a magazine for containing a dry mixture of sand and a thermosetting resin binder, a core box adapted to be heated positioned adjacent and communicating with the outlet end of said magazine, and a blowhead structure provided with a flange portion clamped between said magazine and said core box and an elongated hollow portion projecting into said core box, the walls of said hollow portion being spatially separated from said core box to define a core-forming cavity therebetween, said walls being provided with air vents extending from said cavity to the interior of said hollow portion of the blowhead structure and air escape ports extending from said interior through said flange portion to the atmosphere.

2. A machine for forming shell-type sand-resin cores for use in the shell molding process, said machine comprising the combination of a magazine for containing a dry mixture of sand and a thermosetting resin binder, a hollow metallic core pattern adapted to be heated positioned adjacent the outlet end of said magazine, an elongated hollow cartridge located within said pattern and having its side walls spatially separated therefrom to form therewith an interjacent core-defining cavity, means for forcing said sand-resin mixture from said magazine into said cavity, slotted vents extending from said core cavity through the walls of said cartridge to the interior thereof to permit the air displaced from said core cavity upon the admission of said mixture into said cavity to flow into the interior of the cartridge, and air escape ports extending from said interior to the atmosphere to convey the air displaced from said interior bore to the atmosphere, the walls of said cartridge being provided with coolant passages for conveying a fluid coolant therethrough.

3. In a core blowing machine for forming hollow cores for use in the shell molding process, a magazine for containing a dry molding mixture of sand and a thermosetting resin binder, a generally hollow water-cooled blowhead assembly secured to the outlet end of said magazine, a metal core box adapted to be heated, said core box being reciprocable relative to the blowhead assembly into and out of position around said assembly, the walls of said core box being spatially separated from the walls of said assembly to provide a core-defining cavity therebetween, vents in the walls of said blowhead assembly permitting communication between said cavity and the interior of said assembly, and air outlet openings connecting said interior with the atmosphere to allow the escape of air displaced during blowing operations, said core box consisting of two halves detachably secured together to permit the ready removal of the formed core therefrom.

4. An apparatus for forming hollow cores for use in casting cylinder lines of internal combustion engines, said apparatus comprising the combination of a magazine provided with an inlet opening for admitting a dry molding mixture of sand and a thermosetting resin binder and an outlet opening for said molding mixture, a generally tubular split metal core box adapted to be heated positioned adjacent said outlet opening, a generally tubular venting assembly secured to the outlet end of said magazine, means for reciprocating said core box and venting assembly relative to one another to alternatively move said assembly into and out of said core box, said vent-

ing assembly, when positioned within said core box, having a portion of its walls spatially separated therefrom to form a core-defining cavity therebetween, the distance between the walls of said venting assembly and said core box determining the thickness of the core to be formed, a plurality of blowholes through the upper wall of said venting assembly and connecting the outlet opening in the magazine and said cavity for admitting the molding mixture from said magazine to said cavity, means for blowing said molding mixture from said magazine through said blowholes and into said cavity, the walls of said venting assembly being provided with a plurality of slotted vents communicating between the interior of said assembly and said cavity to permit the passage of air and to prevent the passage of the molding mix into said interior during the blowing of the molding mixture into said cavity, and air escape ports extending from the interior of the venting assembly to the atmosphere.

5. A machine for forming thin-walled hollow sand cores for use in precision casting operations, said machine comprising a magazine for containing a dry mixture of sand and a thermosetting plastic binder, said magazine having an outlet for said mixture in one wall thereof, a generally hollow venting structure directly attached to and extending from the outlet wall of said magazine, and a core box adapted to be heated having imperforate side walls positioned around said venting structure and removable relative thereto, said side walls and said venting structure being spatially separated to form a core-defining cavity therebetween, said cavity communicating with the outlet of said magazine, said venting structure having walls provided with vents providing communication between said cavity and the interior of said structure and between said interior and the atmosphere external of the core box.

6. An apparatus for forming hollow sand cores comprising a magazine for containing a mixture of sand and a thermosetting binder, said magazine having an outlet for said mixture in one wall thereof, a water-cooled metallic venting member attached to and extending from the outlet wall of said magazine, a core box adapted to be heated having imperforate core-defining walls detachably positioned around said venting member and spatially separated therefrom a distance equal to the wall thickness of the core to be formed, the space between said walls of the core box and said venting member communicating with the outlet of said magazine, said venting member having a plurality of vents providing communication between said space and the interior of said venting member to permit air displaced from said space to flow into the interior of said member, and a plurality of air escape ports providing communication between the interior of said member and the atmosphere external of the core box.

7. A method of forming a hollow thin-walled core which comprises heating a hollow metallic pattern member, inserting an unheated venting member into said pattern member, blowing a sufficient amount of a molding mixture of sand and thermosetting binder into a space between said members so as to fully occupy this space, permitting the molding mixture to remain in contact with said members for a period of time sufficient to fuse a substantial portion of the sand and binder into a thin-walled hollow core, thereafter removing said venting member from within

9

said pattern member, and finally stripping said hollow core from said pattern member.

8. In the art of making hollow shell-type sand-resin cores of a mixture of sand and thermosetting resin binder for foundry operations, the process which comprises heating a hollow metallic core box to a temperature above the melting point of said binder, positioning said core box around a venting member so as to provide a space between said member and said core box, cooling said venting member by circulating water through the walls thereof, blowing a sufficient amount of a molding mixture of sand and thermosetting resin binder into the space between said core box and said venting member so as to fully occupy this space, permitting the molding mixture to remain in contact with said core box for a period of time sufficient to melt the resin and bond the sand particles together, thereafter retracting said core box and the formed thin-walled hollow core adhering thereto from around said venting member, subsequently curing said hollow core by

10

baking while in contact with said core box, and finally removing said core box from around the cured core.

5 References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
891,508	Tabor et al.	June 23, 1908
2,630,608	Granath	Mar. 10, 1953

FOREIGN PATENTS

Number	Country	Date
227,968	Great Britain	Jan. 29, 1925
571,188	Great Britain	Aug. 10, 1945

OTHER REFERENCES

- The Foundry, October 1950, pages 162, 164 and 168.
 Bakelite Phenolic Resins for the Croning Process, pages 5-7.