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Nishiyama et al.

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[54] **FOUNDRY PATTERN ASSEMBLY**

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Related U.S. Application Data

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[30] **Foreign Application Priority Data**

Sept. 7, 1970 Japan 45-78320

[52] **U.S. Cl.** **164/230**

[51] **Int. Cl.²** **B22C 7/06**

[58] **Field of Search** 164/230, 28

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[57] **ABSTRACT**

A foundry core having a main part and a smaller auxiliary part imbedded therein is formed by the present foundry pattern assembly wherein the auxiliary part is supporting by the movable pattern members while the main part is formed thereabout. The auxiliary core was a casting space therein and support and cover members for the auxiliary core part and casting space are movably mounted on the pattern members.

4 Claims, 7 Drawing Figures

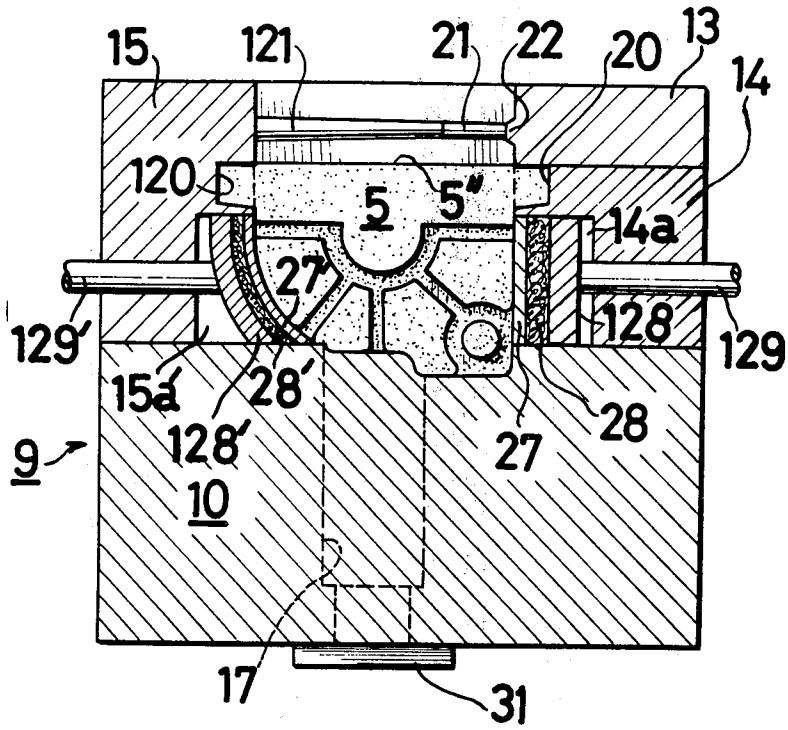


FIG. 1

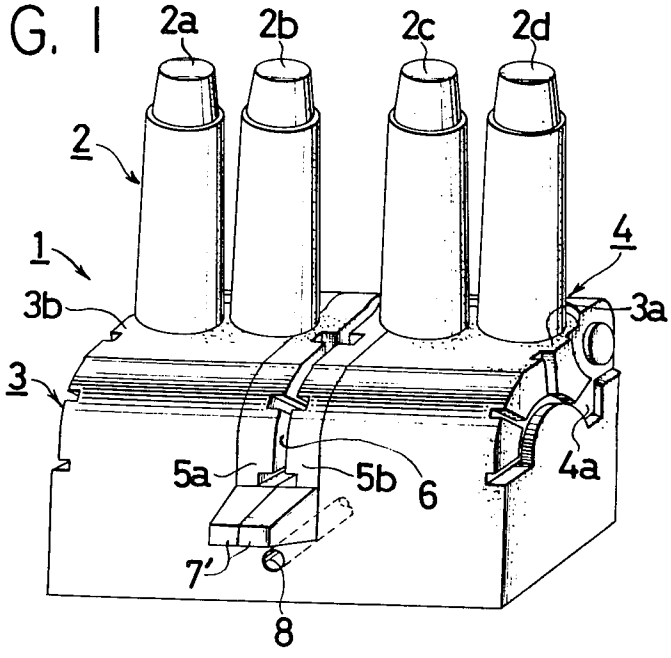


FIG. 3

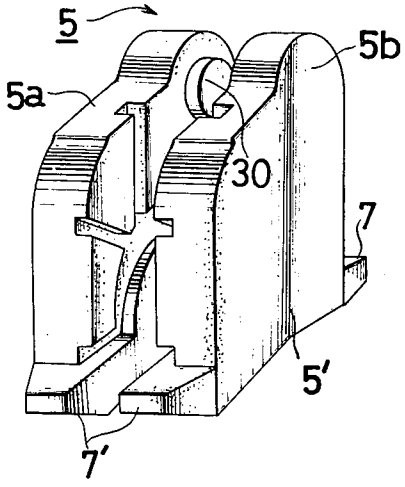


FIG. 4

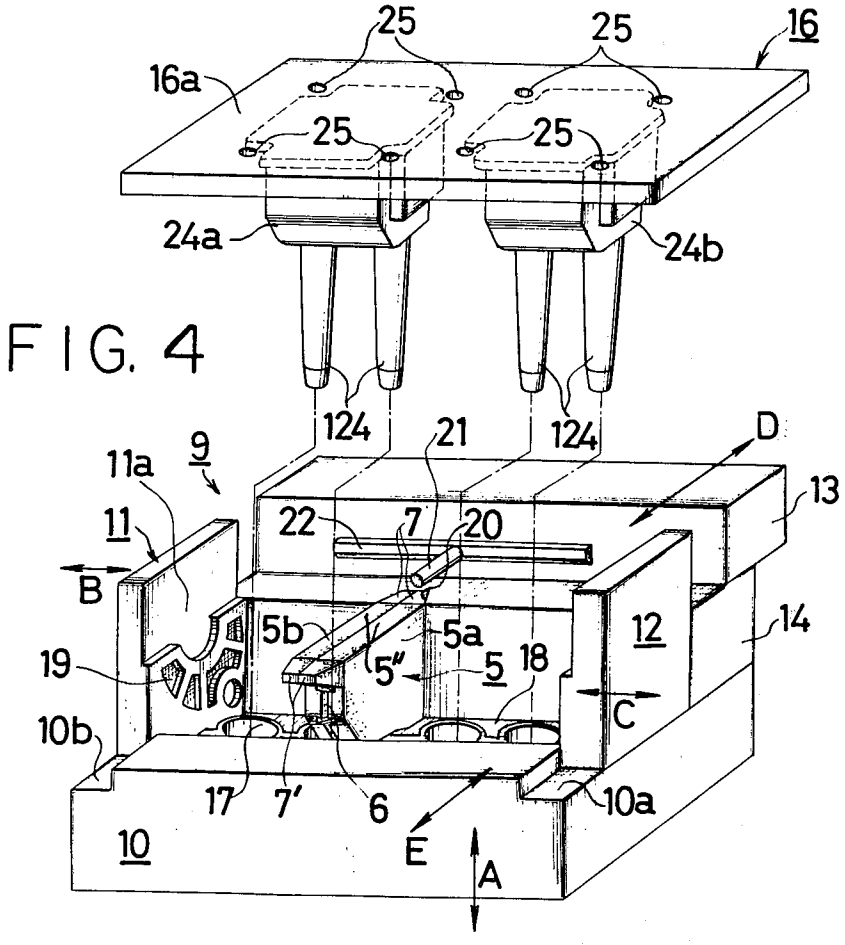


FIG. 5

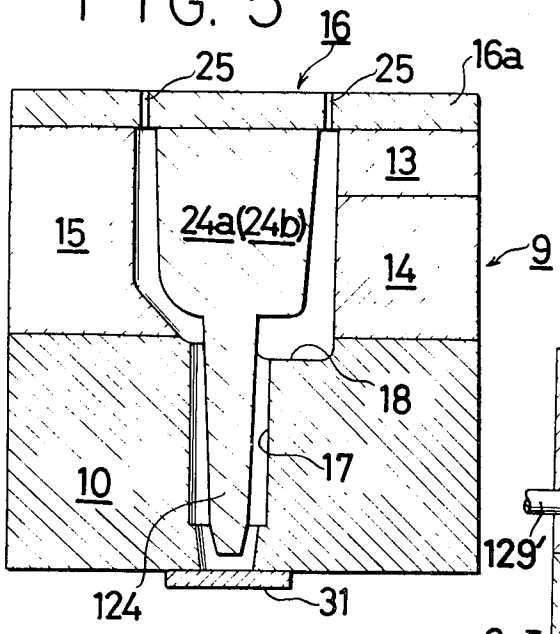


FIG. 6

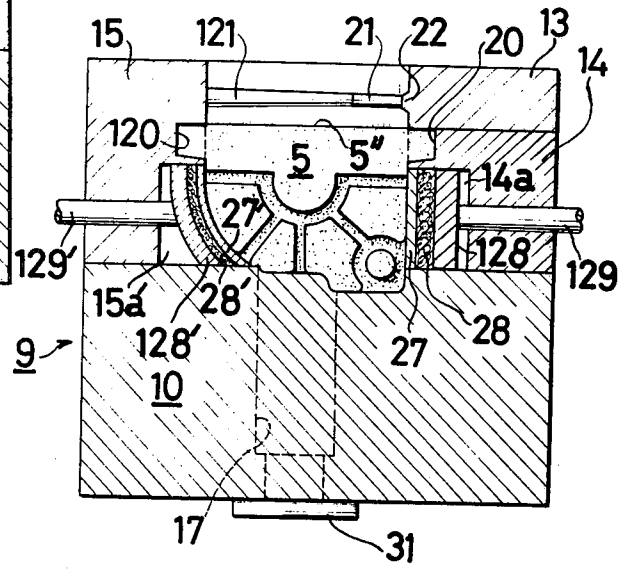


FIG. 2

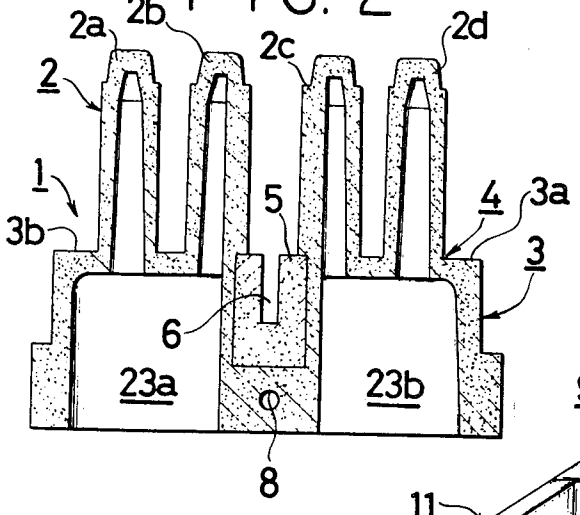
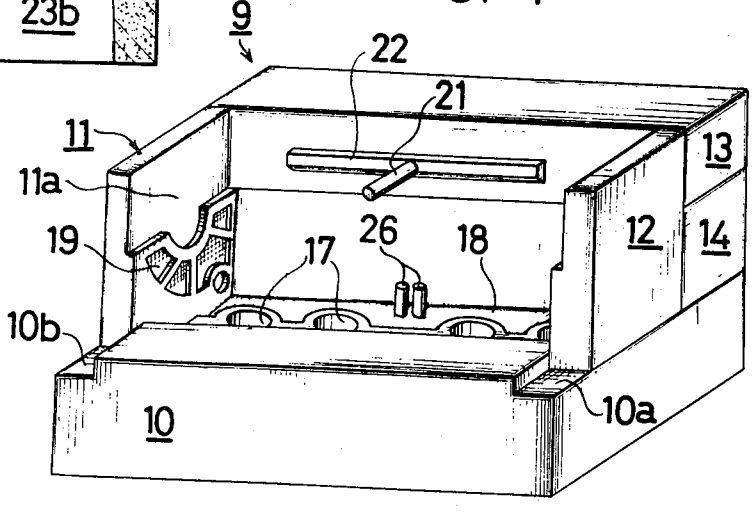


FIG. 7



FOUNDRY PATTERN ASSEMBLY

This is a division of application Ser. No. 177,942 filed Sept. 7, 1971 now U.S. Pat. No. 3756309.

This invention relates to a foundry composite core comprising a main or larger core part and at least an auxiliary or smaller core part attached thereto.

The composite core of the above kind is utilized in such cases where a unifiedly prepared core is difficult to manufacture and/or to disengage it from the molded castings. In most of such cases, at least a part of the core is independently and separately blow-in molded beforehand and then inserted into a mating recess or the like female reception part formed in the main core body and then fixedly glued together.

More specifically in the case of the core adapted, in combination with a main core part for molding the crankcase forming part, for a common cylinder cover of a four-cylinder internal combustion engine, at least a core section for molding an intermediate bearing part of the engine is assembled together therewith. This core section consists of a pair of symmetrical core elements which are separately blow-in molded and assembled together to form a unit. This unit is inserted in a receiving recess formed in the main core section and glued thereto so as to provide a core assembly.

In order to provide the possibility for said insertion of the bearing core section abd gluing of the latter firmly to the main core section, the said bearing-core-receiving recess must be machined to a high precision degree and the tedious glueing job must be carried into effect by consuming much of skilled labor.

A frequent and substantial drawback encountered while transporting such composite cores resides in the disengagement of the bearing core section from the main core body when received mechanical shocks from outside. When the glued joints between the bearing core section and the main core body have been defectively prepared, the bearing core section may separate from position and become afloat in the molten metal in the coarse of casting of the cylinder cover. In addition, the removal of casting fins formed on the products at such areas corresponding to the fitting gaps between the bearing core section and the main core body of the core assembly is highly tedious and time-consuming.

The main object of the present invention is to provide an improved composite core, capable obviating substantially various conventional drawbacks above referred to.

A further object of the present invention is to provide an improved pattern assembly for the manufacture of the improved composite core according to this invention.

A specific object of the present invention is to provide an improved composite core specifically adapted for the manufacture of a cylinder block of a multi-cylinder internal combustion engine, as well as an improved pattern assembly for the manufacture of the improved composite core.

These and further objects, features and advantages will become more apparent when read the following detailed description of the invention by reference of the accompanying drawings in which:

FIG. 1 is a perspective view of an embodiment of the composite core according to the present invention.

FIG. 2 is an axially sectional view thereof, being drawn, however, on a slightly reduced scale.

FIG. 3 is an enlarged and exploded perspective view of a core section as a part of the composite core shown in FIGS. 1 and 2, said core section being adapted for casting an intermediate bearing part of a cylinder block casting.

FIG. 4 is a schematic perspective view of a pattern assembly adapted for use in the manufacture of the composite core shown in the foregoing.

FIGS. 5 and 6 are two separate cross-sections of the pattern assembly shown in FIG. 4, its upper pattern member being shown in FIG. 5 in its operational position to close and define the molding cavity of said assembly and being omitted to show in FIG. 6 only for simplicity of the drawing.

FIG. 7 is a similar view to FIG. 4, showing, however, a modified embodiment of the pattern assembly from the foregoing.

Referring now to FIGS. 1 and 2 of the accompanying drawings, the numeral 1 represents generally a first embodiment of the foundry core according to this invention. This core 1 has been designed, by way of example, for casting a cylinder block of a four-cylinder internal combustion engine. As seen, the core 1 comprises four substantially cylindrical projections 2*a*, 2*b*, 2*c* and 2*d*, generally represented at 2, and a main or crankcase-forming section 3 made integral with each other. These substantially cylindrical projections 2*a*–2*d* are arranged in line with each other and have such shape and dimensions as to shape the cylinder bores of the cylinder cover casting in cooperation with a master mold, not shown, as will become more apparent as the description proceeds. The cylinder-bore shaping section, generally shown at 2, and the crankcase-forming section 3 is united into a rigid one piece providing a core main body 4 which is combined with an intermediate bearing-shaping core section 5 which is shown rather schematically in FIGS. 1 and 2, yet more specifically in FIG. 3.

With increase of the number of the cylinders of the engine, the number of the intermediate bearings will be increased correspondingly. In such case, the number of the core, section must naturally be increased correspondingly, although not specifically shown.

Although in FIG. 2, the last core section 5 is shown only schematically in one piece, it consists of two symmetrical core elements 5*a* and 5*b* shown in FIG. 3 in somewhat separated position for better understanding. As may be supposed from FIG. 1, these core elements are glued together along their mating surfaces. The inner surfaces of the thus assembled bearing core 5 defining an intermediate bearing-shaping gap space 6. As seen from FIG. 3, the opposing inner surfaces of core elements 5*a* and 5*b* have been designed to shape the sides of the bearing part of a cylinder cover use of the core 1 and a master mold, not shown, cooperating therewith.

On the inside surface of core element 5*a*, there is formed with a cylindrical projection 30 adapted for tight engagement with a correspondingly shaped and dimensioned recess, not shown, formed on the inner surface of the mating core element 5*b*, when the both core elements are assembled together to provide a rigid unit, generally shown at 5 in FIGS. 1 and 2.

The bearing core unit 5 is formed with lateral projections 7 and 7′, as may well be supposed from observation at FIGS. 1 and 3 for mounting the core unit 5 in position on the pattern, as will be more fully described

hereinbelow by reference to FIGS. 4 and 5. Numeral 8 represents a runner only schematically and partially.

Next, referring to the mode of and an apparatus for the manufacture of the foundry core 1. In FIG 5, the numeral 9 represents generally a model assembly which is positioned below a resin-coated sand supply source, preferably a hopper of a conventional core blowing machine, not shown, and comprises a plurality of metallic pattern members 10–16.

First pattern member 10 is practically a provisionally stationary metal block and formed with a plurality of, four in this preferred embodiment, vertical bores 17 arranged along an axial line. At both ends of this block, there are formed with respective lateral shoulders 10*a* and 10*b*. The lower ends of the bores 17 are opened, but normally closed by a detachable closure strip 31, although its attaching and detaching means, preferably bolts-and-nuts, have been omitted from the drawing only for simplicity. In practice, the first pattern member is arranged vertically movable from a certain lower off-service position to its operating position shown in FIG. 5, although its guide means and drive motor such as a pneumatically or hydraulically operated piston-cylinder unit have been omitted from the drawing on account of their very popularity. Preferably, the cylinder of the unit is designed to be stationary, while the piston is mechanically connected with the pattern member 10 through a piston rod, not shown. This sliding movability is hinted by a double-headed arrow "A".

First pattern member 10 is formed with an axially extending shallow cavity 18 adapted for shaping the shoulder parts 3*a* and 3*b* on the main section 3.

Second and third pattern members 11 and 12 are arranged to be slidable horizontally by respective pneumatic or hydraulic motors, not shown, as hinted by respective arrows "B" and "C," so as to cooperate with the first pattern 10 for defining jointly a mold cavity. On the inside surface 11*a* of a second pattern member 11, there is provided with a complexedly undulated surface 19 so as to correspond to an end-bearing forming surface 4*a* of the foundry core 1. Although not shown, third pattern member 12 is also formed on its inside surface with a similar undulated end-bearing shaping surface.

At the rear side of the pattern, there are provided two overlappingly arranged fourth and fifth pattern members 13 and 14 which are arranged to be independently slidable in the direction of a common arrow "D" by means of respective pneumatic or hydraulic piston-cylinder units, not shown.

A front or sixth pattern member 15 is movable in the direction of an arrow "E" by a pneumatic or hydraulic motor as before.

At an intermediate point between the both ends, the fifth pattern member 14 is formed with a recess 20. In the similar way, sixth pattern member is formed with a recess 120. These recesses 20 and 120 are adapted for receiving respectively the lateral projections 7′ and 7 of an assembled bearing core section 5, so as to properly position the latter in the moldable cavity of the pattern unit when assembled together as will be more specifically described hereinafter. As seen most clearly in FIG. 6, pattern members 13 and 15 are formed with inwardly projecting runner-forming bars 21 and 121, respectively. These bars 21 and 121 are so designed and dimensioned, jointly to form the runner 8 in the foundry core 1 during manufacture thereof.

Fourth pattern member 13 is formed with an innerwardly projecting, horizontally extending bar adapted for shaping a corresponding runner part, not appearing in FIGS. 1 and 2.

Seventh or upper pattern member is shown generally at 16 in FIG. 4 and provided rigidly with a pair of mandrel roots 24*a* and 24*b*, so as to shape the hollow inside spaces 23*a* and 23*b* in the core 1, respectively. A number of material-blow-in holes, designated by a common reference numeral 25, are formed through the plate-like base portion 16*a* of the upper member 16 which is movable from its upper off-service position to its lower operating position by means of a pneumatic or hydraulic piston-cylinder unit, not shown. This off-service position can substantially be assumed to be that shown in FIG. 4, when seen FIGS. 4 and 5 jointly. The operative position of the upper pattern member 16 relative to other members 10, 13, 14 and 15 may most clearly be seen from FIG. 5. Each two mandrels, designated by common numeral 124 depend rigidly from the root 24*a* or 24*b*, respectively. Material-blow-in holes 25 are connected with the material supply source, not shown. Naturally, the mandrels 124 are arranged concentrically with the vertical bores 17, although the upper pattern member 16 is shown in FIG. 4 as somewhat laterally offset in its position relative to that of the remaining pattern members shown therein.

In order to prepare the shell core unit 1 shown in FIG. 1, all the pattern members 10–16 are positioned in their off-service position and they are throughly and carefully cleaned in advance, so as to remove dirty substance occasionally depositted on the working or inner surfaces of these members which are then sprayed with a solution of conventional parting agent such as silicon resin, polyvinyl alcohol, paraffin or the like.

Then, the first or lower pattern member 10 is pneumatically or hydraulically elevated in its position from below to its upper operating one shown in FIG. 4. Next, second and third pattern members 11 and 12 are brought to their working position shown in FIG. 4 so as to snugly engage with the shoulders 10*a* and 10*b* on the first member 10.

Further, front pattern member 15 and rear pattern members 13 and 14 are advanced towards the pattern center, yet the upper rear member 13 is at its somewhat receded position relative to the lower rear member 14 as shown in FIG. 4. Then, the intermediate core section 5 held in its inverted position is brought into position with its lateral projections 7 and 7′ kept in mating engagement with recesses 20 and 120, respectively. Further, the once receded member 13 is advanced to its final operating position. Finally, the upper pattern member 16 is lowered towards the pattern center so as to occupy its final operating position. The relative position of these pattern elements 10 – 16 and with each other and with the core section 5 will be most clearly seen from observation of FIGS. 5 and 6, thus the pattern being closed completely. It should be mentioned, however, that in FIG. 6, the upper pattern member 16 has not yet been brought into its pattern closing position.

The core section 5 consisting of a pair of opposing core elements 5*a* and 5*b* has been preparatorily and separately prepared by the conventional shell core preparation process by use of proper molds and on a conventional core blowing machine. In practice, however, each of the core element 5*a* or 5*b* represents a

concave outer side surface as clearly seen in FIG. 3 at 5', although in FIGS. 1 and 4, these outer surfaces are drawn into plane surfaces only for simplicity of the drawing. The bottom surfaces of these core elements 5*a* and 5*b* appear at top of the up-and-down inverted core section 5, as shown at 5'' in FIGS. 4 and 6. The inverted core section position within the closed pattern unit comprising said members 10 – 16, especially by the mutual engagement between at 7 and 20; 7' and 120, respectively, and by the additional tight contact between the lower surface of fourth pattern member 13 and the now upper top surfaces 5'' of the core elements 5*a* and 5*b*.

The preparatory pattern preparation and setting job including the insertion of core section 5 in position will consume, as an example, only about 30 seconds.

Means for holding the core section 5 in position may take a different form. In FIG. 7, an alternative of such positioning means is shown. A pair of tapered positioning pins 26 are fixedly studded on the upper surface of the first pattern member 10 and within the scoper of cavity 18. In this case, core elements 5*a* and 5*b* are formed with respective reception female openings, not shown, for snugly receiving these positioning pins 20.

After blow-forming of the core unit 1 to be described, the positioning lateral projections 7; 7' or positioning female openings said above can easily be cut-out or filled-in by a simplest job, so as to provide a complete and defectless core unit 1.

With the pattern members 10, 14 and 15 brought to their operating position to close the pattern or model unit 9 as shown in FIGS. 5 and 6, the casting space 6 is tightly closed by contacting these pattern members 10, 14 and 15 with the outline-defining parts of the core section 5, thereby assuring the shell-forming material to be described from invasion into said space 6 during the shell-core forming step to be described.

In the embodiment adapted for attaining a more effective seal against the casting space 6 and shown in FIG. 6, an inner and lower part of fifth pattern member 14 which is to be kept in presure engagement with defining a corresponding part of the outline of said casting space 6, is made an independently movable cover member consisting of an heat-insulating plate 27, a buffer and backing plate 28 made of asbestos or the like heat-resistant fibrous material, and a piston-like member 128 rigidly united with each other and mechanically connected with a pneumatic or hydraulic piston-and-cylinder unit, not shown. This covering unit consisting of the aforementioned parts 27, 28, 128 and 129 is slidably received in a recess 14*a* formed in the fifth pattern member 14 as shown, and kept in pressure contact in its operating position shown in FIG. 6 with the right-hand side of the core section 5.

At the left-hand side of core section 5, there is a similar, yet opposingly acting covering unit which consists of similar parts 27', 28', 128' and 129' and substantially received movably in a corresponding recess 15*a* formed in the front pattern member 15. The parts 27', 28', 128' and 129' correspond substantially to those which have been designated 27, 28, 128 and 129 respectively in the foregoing.

Upon the closure of the pattern unit 9 in the above mentioned way, the shell-forming material is blown from the supply source, preferably a hopper, not shown, positioned at a certain higher level, through the holes 25 into the molding cavity defined by the inner operating surfaces of the pattern members 10 – 16.

siliceous sand:		
40 mesh		10 wt.%
65 mesh		40 wt.%
100 mesh		40 wt.%
150 mesh		10 wt.%
	total	100 wt.%
binder:		
phenolic resin	2.5	wt.% of said sand
hardening agent:		
hexamethylenetetramine	15	wt.% of said binder
dispersing agent:		
calcium stearate	0.1	wt.% of said sand

The blow-in pressure amounted to about 3 kg/cm^2.

Upon finishing the blow-in molding the core unit 1 within the inside cavity of the pattern assembly 9, a baking step is carried out at 250° – 300°C. The blow-in and baking steps extend for about 90 seconds. For the baking purpose, these pattern members 10 – 16 are fitted with electric resistance means arranged within the interior of each thereof, although not shown by virtue of the very popularity. These heating means are preferably formed into resistance coils, totally of 54 kilowatts, as an example.

Upon finishing this baking step, the pattern assembly is dismantled by energizing the respective pneumatic or hydraulic piston-cylinder unit, not shown, for receding the members 10 – 16 from their operating to their off-service position so as to open the molding cavity. Then, the shell core unit 1 having the intermediate core section 5 rigidly embedded therein and baked together effectively in non-detachable way, is taken out from the opened pattern assembly. For increasing the rigid and baked combination of the core section 5 with main core section 4, the former section 5 may preferably be formed with inverted taper, preferably at each outer side surface of each of the core elements 5*a* and 5*b*.

An example of the core unit 1 has the following main dimensions:

overall length:	480 mm
overall height:	410 mm
overall width:	240 mm
height of section 3:	230 mm
outside dia. of each of projections 2:	74 mm
center-to-center distance between two neighboring cylinders:	100 – 120 mm
bore of each cylinder of casting	ca. 74 mm

The blow-in and baking steps were completed within 90 seconds.

Finally, the pattern assembly was opened and the formed and baked core were taken out from the pattern assembly. These pattern-opening and core removal steps were completed within 30 seconds.

Although not specifically shown, the core section 5 is formed preferably with inverted tapers, especially at the outer side surfaces of the core elements 5*a* and 5*b*, so as to effectively prevent otherwise possible disengagement of the section 5 from its embedded and baked-up position from its mating main body section 3 during a casting step of the metal product, or during handling and transporting operation of the core unit 1.

It will be seen that the thus prepared core unit 1 represents no disadvantageous idle gaps between the sections 3 and 5 by virtue of the tight and rigid baked combination therebetween, and thus a highly reliable, precise and substantially permanent fixture of the bearing-

forming section 5 with the main section 3. It is also highly advantageous to prevent casting fins to develop on the molded castings prepared by use of the core unit 1 in combination with a mating main mold, not shown.

In the foregoing description, the composite core unit 1 and its manufacturing pattern assembly were directed to those which concern with a common cylinder cover of an internal combustion engine, but the invention is not limited only thereto, and can find its broad use in other and various purposes.

We claim:

1. The pattern assembly for preparing a composite core having a larger main core with a smaller previously formed auxiliary core section imbedded therein, said auxiliary core section having a casting space therein, said pattern assembly comprising a plurality of pattern members relatively movable between non-operable positions remote from each other and operable positions adjacent each other wherein said pattern members define a mold cavity, at least one of said pattern members having means for keeping said smaller auxiliary core section in position within said cavity during the formation of said larger main core thereabout and cover means mounted on said section members for covering said casting space during the formation of the larger core section around the smaller core section.

2. The pattern assembly for preparing a composite core having a larger main core with a smaller previously formed auxiliary core section imbedded therein said auxiliary core section having a casting space therein, said pattern assembly comprising a plurality of pattern members relatively movable between non-operable positions remote from each other and operable positions adjacent each other wherein said pattern members define a mold cavity, at least one of said pattern members having means for keeping said smaller auxiliary core section in position within said cavity during the formation of said larger main core thereabout, and additional positioning means movably mounted on said pattern members for movement into engagement with said smaller core section to support said smaller core section and cover said casting space therein during the formation of the larger core section around the smaller core section.

3. The pattern assembly for preparing a composite core having a larger main core with a smaller previously formed auxiliary core section imbedded therein, said pattern assembly comprising a plurality of pattern members relatively movable between non-operable positions remote from each other and operable positions adjacent each other wherein said pattern members define a mold cavity, at least one of said pattern members having means for keeping said smaller auxiliary core section in position within said cavity during the formation of said larger main core thereabout wherein said positioning means comprises pin means secured on one of said pattern members defining the bottom of said cavity, said pin means cooperating with corresponding recesses in said smaller core section for locating said smaller core section.

4. The pattern assembly for preparing a composite core having a larger main core with a smaller previously formed auxiliary core section imbedded therein, said pattern assembly comprising a plurality of pattern members relatively movable between non-operable positions remote from each other and operable positions adjacent each other wherein said pattern members define a mold cavity, at least one of said pattern members having means for keeping said smaller auxiliary core section in position within said cavity during the formation of said larger main core thereabout, and additional positioning means movably mounted on said pattern members for movement into engagement with said smaller core section to support said smaller core section during the formation of the larger core section around the smaller core section.

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