June 10, 1958 C. E. NORTON ET AL 2,837,797

MOLD FOR MAKING CASTINGS

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Fig. 1

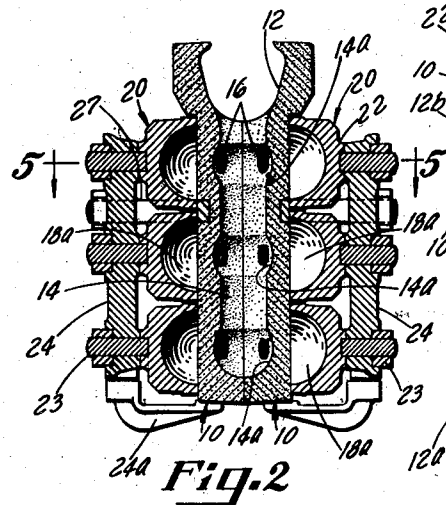


Fig. 3

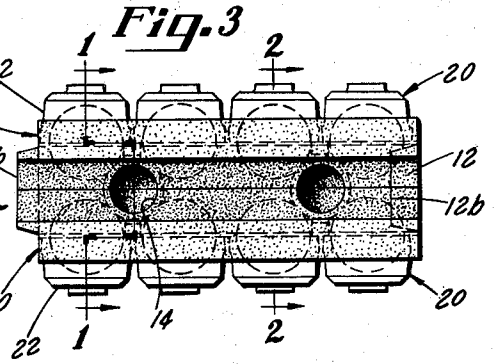


Fig. 2

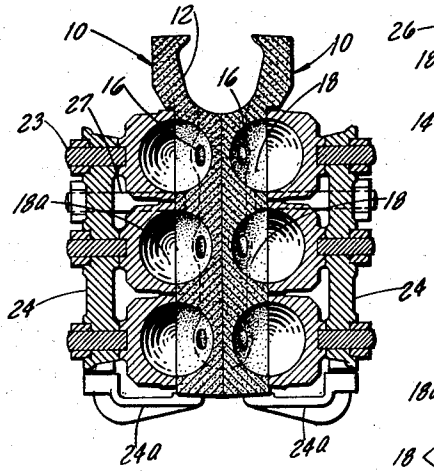


Fig. 4

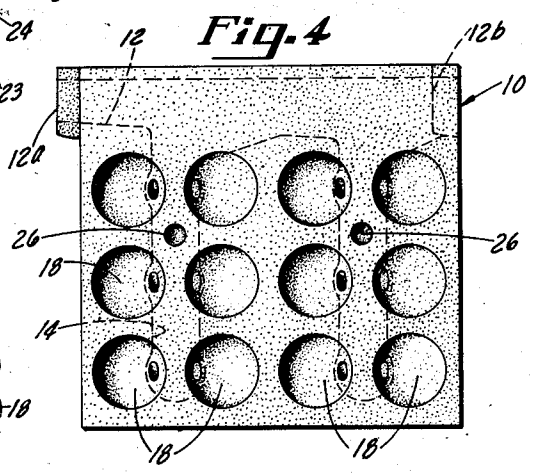
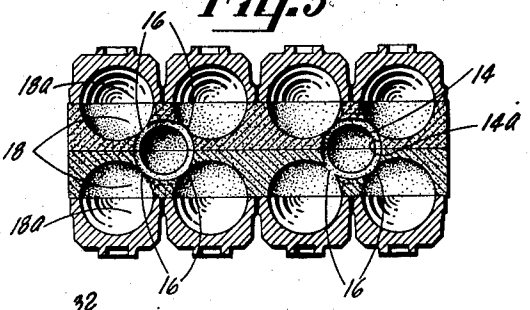


Fig. 5



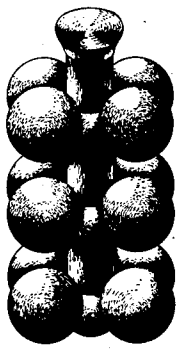


Fig. 6

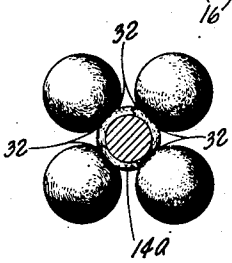


Fig. 7

INVENTOR.
CHARLES E. NORTON
HARRY A. PORTER JR.
BY Henry Kozak

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MOLD FOR MAKING CASTINGS

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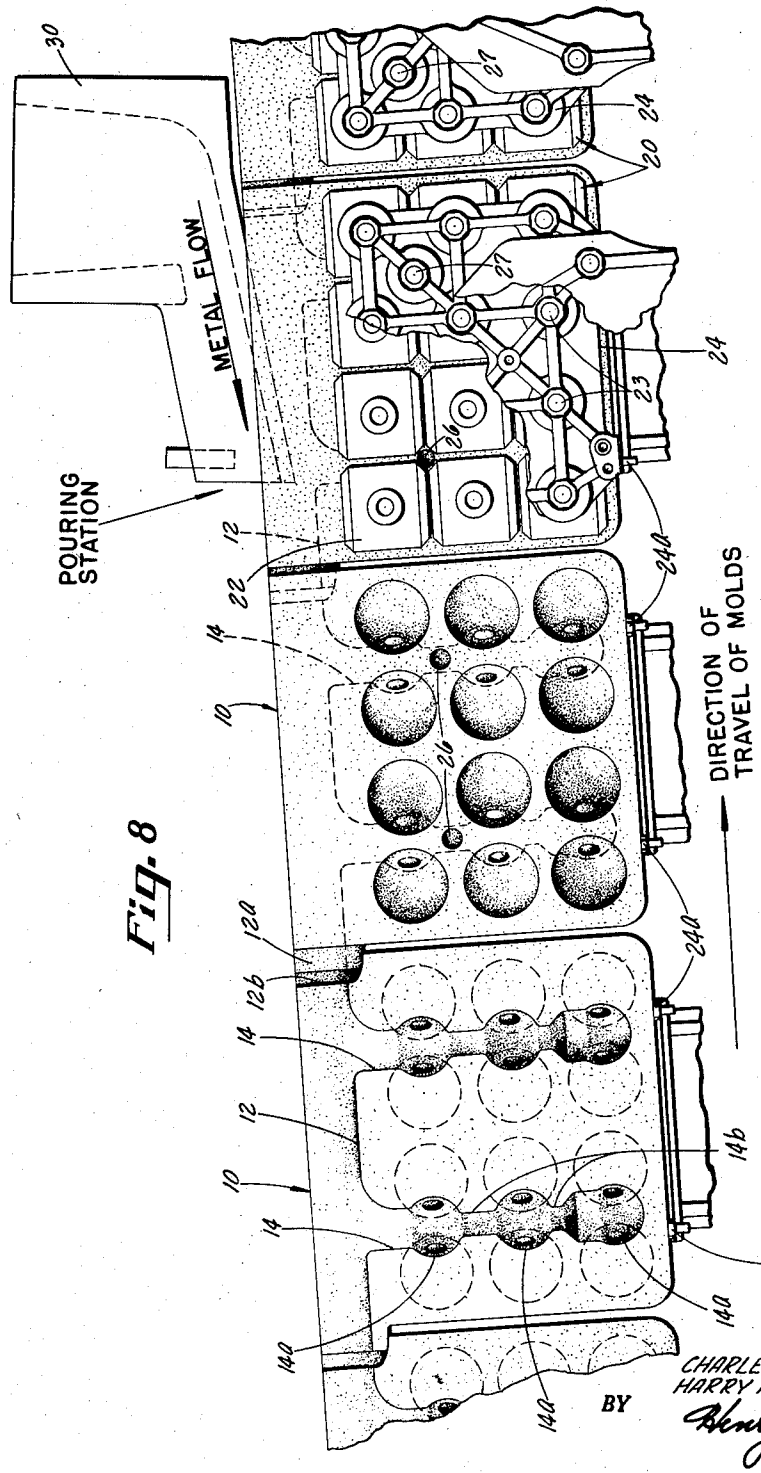


Fig. 8

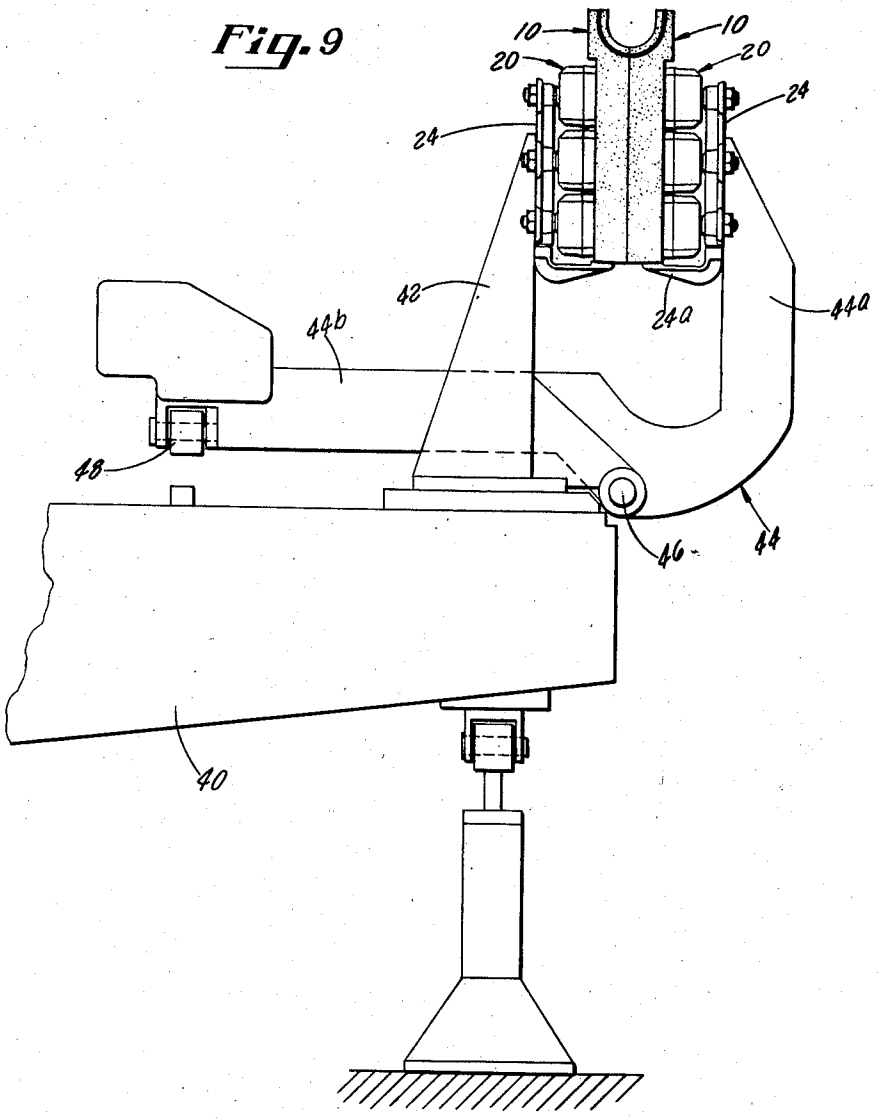
INVENTOR.
CHARLES E. NORTON
HARRY A. PORTER JR.
BY Henry Kozak

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MOLD FOR MAKING CASTINGS

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Fig. 9



INVENTOR.
CHARLES E. NORTON
HARRY A. PORTER JR.
BY Henry Kozak

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2,837,797

MOLD FOR MAKING CASTINGS

Charles E. Norton, Highland Park, and Harry A. Porter, Jr., North Riverside, Ill., assignors to National Malleable and Steel Castings Company, Cleveland, Ohio, a corporation of Ohio

Application October 1, 1953, Serial No. 383,674

13 Claims. (Cl. 22—126)

This invention relates to the making of metal castings, and more particularly to the mold in which the castings are produced.

The invention concerns a composite mold by means of which cast articles, such as balls or similar objects, having a sound internal structure are produced. The mold is particularly suited for quantity production of castings. The composite mold, in accordance with this invention, is composed of a section made of a refractory material, such as sand, and a section of high-heat conducting material, such as metal or graphite. The mold assembly is so formed that the downsprue, feeders, in-gates, and a portion of the mold cavity are contained in the refractory section while the high-heat conducting section contains only the complementary mold cavity. The downsprue which serves to feed the molten metal into the mold cavity is preferably vertically positioned and the feeder and in-gates which communicate with the downsprue and the mold cavity are suitably disposed at vertically spaced intervals along the downsprue. In this arrangement the portion of the mold cavity in the high-heat conducting or metal section of the mold is farthest from the downsprue and feeder, resulting in what is termed "progressive solidification" of the molten metal. Thus, the section of the casting most distant from the in-gate will solidify first, with solidification progressing toward the in-gate, feeder and downsprue, where the metal remains molten. In this manner molten metal is constantly fed to the casting and the last to solidify are the in-gates, feeders, and the downsprue. This results in the production of castings which are free of shrinkage cavities.

In the preferred form of this invention, the mold is of a double composite construction, in which the refractory section of the mold comprises a pair of cores composed of sand or other ceramic material in face-to-face contact, each core containing the complemental half of a horizontal runner extending across its upper end and the complemental half of a downsprue leading downwardly from the runner. At vertically spaced intervals along the downsprue are feeders which are in the form of bulbous enlargements of the downsprue. In-gate passages lead from the feeders to the mold cavity portions formed on the outer side of each core. The metal section of the mold is composed of two parts, each of which is disposed in engagement with outer side of one of the cores and contains mold cavity portions which are complemental to those in the core. The cores are thus sandwiched between the metal portions and the entire mold assembly is suitably clamped together. This arrangement conveniently permits the casting of a cluster of four objects at each level along the downsprue so that any desired number of castings, in multiples of four, may be economically produced per each downsprue. Moreover, each mold preferably contains two or more downsprues leading from the top runner, each downsprue through its feeders supplying metal to clusters of four mold cavities disposed at vertically spaced intervals.

This arrangement provides maximum yield of castings for a given mold size. Also, the molding costs is reduced by the use of the metal or permanent mold sections, since these are used over again in the casting process.

The various features and advantages of our invention will appear from the following description taken in conjunction with the drawings, in which:

Fig. 1 is a vertical sectional view of a mold embodying the invention, taken along line 1—1 of Fig. 3.

Fig. 2 is a vertical sectional view taken along line 2—2 of Fig. 3.

Fig. 3 is a plan view of a mold embodying the invention.

Fig. 4 is a side elevational view of the outer side of one of the core sections of the mold.

Fig. 5 is a horizontal sectional view taken along line 5—5 of Fig. 1.

Fig. 6 is a perspective view of the castings produced in the mold shown in Figs. 1 to 5.

Fig. 7 is a plan view partly in section of the castings shown in Fig. 6.

Fig. 8 is a side elevational view partly in section of a group of molds embodying the invention arranged in end-to-end relationship.

Fig. 9 is a fragmentary view of a continuous casting machine having molds embodying the invention applied thereto.

Referring to the drawings, the mold comprises an inner section of low-heat conductive ceramic material, which preferably is in the form of a pair of sand cores 10 in face-to-face engagement. The cores are provided at their upper ends with a horizontal runner 12 for receiving molten metal, each core containing in its inner face one-half of the runner. Likewise, the cores are provided with downsprues 14 leading from runner 12, each core containing half of the downsprue along its inner face. At vertically spaced intervals along each downsprue, bulbous enlargements thereof are formed to provide feeders 14*a*. Each feeder 14*a* has a pair of angularly disposed in-gates 16 which lead to the mold cavity portions 18 formed in the outer sides of the core. Engaging the outer face of each core is a permanent mold section 20 which contains the complementary halves 18*a* of the mold cavities. The complementary cores are thus sandwiched between the permanent sections 20. Each permanent mold section 20 is formed of high-heat conductive material, such as metal or graphite. In the embodiment shown in the drawing, each outer section is preferably composed of separate elements 22, each of which contains a single mold cavity 18*a*. Elements 22 are suitably secured by means of fastening members 23 to a back plate 24 which may be mounted on a conveyor system or continuous molding machine. Back plate 24 at its lower end is provided with arms 24*a* for supporting core 10.

It will be understood that cavities 18*a* may all be formed in a unitary member, if desired. However, with the mold section formed of separate elements 22, greater accuracy in spacing of the mold cavities is obtained and the possibility of warpage that exists with a unitary outer section during the casting process is avoided.

Each core 10 is provided with dowel receiving openings 26 in its outer face which receive dowel projections 27 provided in the back plate 24 for accurately positioning the core relative to the permanent mold section. Each core 10 is also provided at one end of runner 12 with an extension 12*a* thereof, and at the other end of the runner with a recess 12*b* for receiving the extension 12*a* of the adjacent mold, as may be seen in Fig. 8. In this manner a continuous runner is formed for receiving molten metal during the casting process.

It will be noted that four mold cavities are formed at each feeder location along the downsprue so that a four-

casting cluster is produced at each level. Thus, in the embodiment illustrated 12 castings are produced per downsprue, or 24 per mold. It will be apparent that the height of the mold may be increased to permit the casting of additional clusters along the downsprue. Also, more than four mold cavities may be formed at each feeder location along the downsprue so that a greater number of castings per downsprue may be obtained.

While a single mold assembly has been shown in Figs. 1 to 5, it is contemplated that in commercial production of the castings a series of the mold assemblies will be arranged in end-to-end relationship, as shown in Fig. 8, so as to form a continuous runner **12** for the flow of molten metal. The molds will preferably be arranged to move uphill at an angle of about 2 to 5 degrees to the horizontal under the pouring station. The molds may be applied to a conveyor system or to a continuous casting machine of the type shown in the P. M. Payne Patent No. 2,326,164.

In the production of castings, the molten metal flows from a pouring box **30** into the runner **12** from whence it flows successively into the downsprues **14** and feeders **14***a* which are located downhill from the pouring station and fills the mold cavities. The molds should travel toward the pouring station at such a rate of speed that the flow of metal into the downsprues will occur as close as practicable to the pouring station. Since the metal in the outer half of each mold cavity is in contact with high-heat conducting material it will cool considerably more rapidly than the inner half of the casting which is formed in the sand core. This results in progressive solidification of the castings from the rapidly cooling portions thereof to the in-gates as aforementioned. Thus each feeder **14***a* provides a reservoir of molten metal which feeds into the solidifying casting, thereby eliminating the formation of shrinkage cavities which would be present in the casting if the solidification were not directed toward the in-gate of each feeder. The feeders are in the hottest portion of the mold and provide an adequate supply of molten metal to the castings as the latter progressively solidify from the high-heat conducting part of the mold to the in-gates in the low-heat conducting cores. The resulting castings are therefore sound internally.

As the downsprue is formed in the cores which have a low degree of heat conductivity, it can be of relatively small diameter and yet provide the feeders with molten metal during the solidification of the castings.

It will be understood that whether a single mold assembly or a series of mold assemblies is poured the same beneficial results of the invention are obtained. A feature of the mold construction is the provision of a very short in-gate **16** whereby each casting is joined to the feeder **14***a* by a sharp fillet as at **32**. This permits the castings to be detached from the feeder **14***a* without any objectionable projection or hollows remaining in the surface of the castings.

It will be noted that the bulbous shape of feeders **14***a* serves to properly space the mold cavities **18** and also to ensure the proper in-gate size.

In the cores **10** shown in Fig. 8 the portions **14***b* of the downsprue **14** between feeders **14***a* are of smaller diameter than the upper and lower ends of the downsprue. This construction provides adequate flow of metal to the feeders and results in a smaller amount of metal in the sprue, with corresponding saving, as compared with the metal which remains in the downsprue shown in Figs. 1 to 5.

In Fig. 9 is shown the manner in which the molds may be mounted in a continuous casting machine. The casting machine is generally in the form of a ring-like structure which rotates about its vertical axis (not shown). The molds are disposed end-to-end along the entire periphery of the machine. The member **40** radiates from the center of the machine and rigidly secured thereto is the arm **42** which carries the inner half of the mold assembly. A member **44** is pivoted to the machine as at **46** and comprises a vertical arm **44***a* which carries the outer half of the mold assembly. Member **44** also has a horizontal arm **44***b* which is counterweighted to maintain the outer half of the mold assembly engaged with the inner half thereof. The end of arm **44***b* is provided with a roller **48** which is adapted to engage a cam on the machine as the latter rotates to cause member **44** to rock outwardly, thereby withdrawing the outer half of the mold assembly from the inner half so that the castings may be expelled.

While the mold assembly has been shown with mold cavities for the production of ball-shaped castings, such as are used in grinding operations in the ore and cement industries, it will be apparent that mold cavities of other shapes may be used without departing from the spirit of the invention.

The terms and expressions which we have employed are used as terms of description and not of limitation, and we have no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof, but recognize that various modifications are possible within the scope of the invention claimed.

Having thus described our invention, we claim:

1. In a mold assembly for the production of ball-shaped castings, a low-heat conductive section and a high-heat conductive section, each of said sections having a single flat abutment surface in face-to-face contact with the corresponding surface on the other of said sections, each section containing the complemental half of a mold cavity, opening onto its abutment surface and facing the cavity in the other section, said low-heat conductive section having a downwardly extending passage for conducting molten metal to said cavity.

2. A mold assembly constructed in accordance with claim 1 in which a plurality of mold cavities are provided in vertically spaced relationship.

3. In a mold assembly for the production of ball-shaped castings, a low-heat conductive section and a high-heat conductive section arranged side by side and being in face-to-face contact along a common plane, said low-heat conductive section having a downwardly extending passage for the reception of molten metal, a plurality of ball cavity portions in said low-heat conductive section opening onto said plane and being in close communication with said passage, and ball cavity portions in said high-heat conductive section complemental to the cavity portions in said low-heat conductive section.

4. A mold assembly for the production of ball-shaped castings comprising a pair of upright cores of low-heat conductive material in face-to-face contact, a downwardly extending passage along the inner faces of said cores for the reception of molten metal, each of said cores comprising a flat outer side surface containing at vertically spaced intervals a plurality of ball cavity portions recessed into said surface and disposed in close communication with said passage, and sections of high-heat conductive material engaging in generally coplaner relationship said outer side surfaces of said cores, each of said last-named sections containing ball cavity portions complemental to the cavity portions in said low-heat conductive cores.

5. A core for face-to-face engagement in substantially a common plane with a complementary core in a mold assembly for the production of castings, said core having the complemental half of a runner extending across the upper end thereof, said runner being extended beyond one end of said core, said core being recessed at the other end of said runner to receive the extension of the runner of an adjacent core to form a continuous runner when said core is arranged end-to-end with similar cores,

a complemental half of a downsprue passage leading from said runner formed in one face of the core, and mold cavity portions opening on the opposite face of the core and being in close communication with said passage, said opposite face comprising a substantially flat vertically extending surface interrupted by said cavity portions.

6. A mold assembly for the production of castings comprising a pair of upright complementary cores of low-heat conductive material in face-to-face engagement, along the inner sides, said cores containing a runner extending lengthwise across the top thereof, said cores having a downsprue leading from said runner, each of said cores having a plurality of mold cavity portions communicating with said downsprue, and a mold section of high-heat conductive material engaging the outer side of each of said cores in substantially coplaner relationship and having mold cavity portions complemental to said cavity portions in said cores to form complete mold cavities.

7. A mold assembly for the production of castings comprising a pair of cores in face-to-face contact and having along the engaged faces thereof a top runner and a downsprue passage leading from said runner, said cores containing mold cavity portions opening on the outer faces thereof, each of said outer faces comprising a substantially flat abutment surface interrupted by said cavity portions, said cavity portions being in close communication with said passage, and high-heat conductive mold portions engaging said outer faces in substantially coplaner relationship, said last-named portions having mold cavity portions complemental to said cavity portions in said cores, and means for positioning said cores relative to said mold portions, said means comprising at least one recess in the outer face of each of said cores and at least one projection on each of said high heat conductive mold portions adapted to be received in said recess.

8. A mold assembly for the production of castings comprising a pair of mold sections, each of said sections comprising a generally flat abutment surface, a plurality of mold cavity portions recessed into said surface, one of said sections being formed of low-heat conductive material and having a downwardly extending passage for the reception of molten metal, the other of said sections being formed of high-heat conductive material, said cavity portions in said low-heat conductive section being disposed adjacent to and in close communication with said passage, said surfaces on said sections being in face-to-face engagement, with the cavity portions in one of said sections being in complementary relationship to the cavity portions in the other of said sections to form a plurality of complete mold cavities.

9. A mold assembly for the production of castings comprising an upright section of low-heat conductive material and an upright section of high-heat conductive material, each of said sections comprising a generally flat side surface in engagement in substantially coplanar relationship with the corresponding surface on the other of said sections, said first-named section having a vertical downsprue, a feeder portion in said downsprue, in-gates communicating with said feeder, and laterally disposed mold cavity portions opening onto said side surface and positioned at substantially the same level as said feeder portion, said cavity portions being in communication with said in-gates in close relationship to said downsprue, said second-named section having mold cavity portions complemental to said cavity portions in said first-named section.

10. A mold assembly for the production of castings comprising an upright back plate member, and a low-heat conductive section of ceramic material and a high-heat conductive metallic mold section in flat face-to-face contact along a common plane, each section containing a complemental half of a mold cavity, said low-heat conductive section having a top runner and a downwardly extending passage for conducting molten metal to said cavity, a short in-gate connecting said passage with the cavity in said low-heat conductive section, said metallic mold section being secured to said member, and said member having means in the form of a horizontal arm underlying said low-heat conductive section for supporting the same.

11. In a composite mold assembly an upright core of low-heat conductive ceramic material, said core having a trough extending along its top for passage of molten metal, a downsprue passage extending downwardly from said trough, a mold cavity portion in said core in close communication with said passage, said cavity portion opening on a face of said core, and a mold section of high-heat conductive metallic material in face-to-face contact with said core, said high-heat conductive section having a mold cavity portion complemental to said cavity portion in said core.

12. A composite mold assembly comprising a pair of upright low-heat conductive ceramic sections in face-to-face contact, a downsprue passage recessed into the contacting faces of said sections, a mold cavity portion recessed into the outer face of each of said sections and being in close communication with said downsprue passage, and a high-heat conductive metallic mold section in face-to-face contact with the outer face of each of said first named sections, said high-heat conductive section having a mold cavity portion on its inner face complemental to said cavity portion in the opposing low-heat conductive section.

13. A composite mold assembly comprising a pair of upright outer high-heat conductive graphite mold members and a low-heat conductive unit of ceramic material interposed between and in vertical face-to-face contact with said outer members, and complemental mold cavity portions recessed into the contacting faces of said members and said unit to form complete mold cavities, said unit having a downsprue passage for conducting molten metal, said cavity portions in said unit being in close communication with said passage.

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