United States Patent

[11] 3,587,721

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[54] **CERAMIC GANG MOLD**
6 Claims, 14 Drawing Figs.

[52] U.S. Cl. 164/350, 164/361, 249/110
[51] Int. Cl. B22c 9/20
[50] Field of Search 164/361, 279, 290, 322, 350, 129, 137; 249/118, 119, 123, 126, 129, 130

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ABSTRACT: A composite ceramic shell mold for casting metal comprising a number of mold units ganged together so that all may be filled with molten metal through a single gate, each mold unit having a body of a standardized size and shape and differing from other units only in the presence or absence of certain extensions on that body, whereby all units may be made in one die in which inserts corresponding to the extensions are removed or put in place as required.

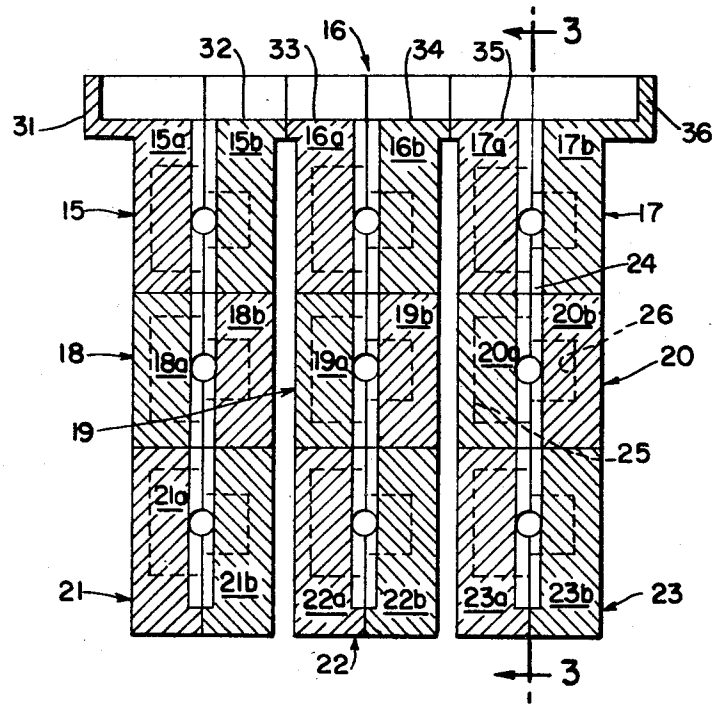


FIG. 1

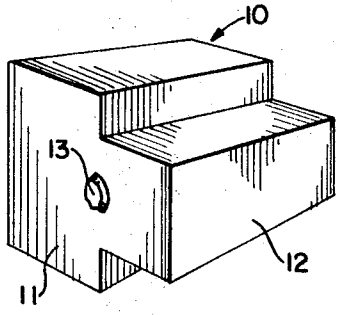


FIG. 2

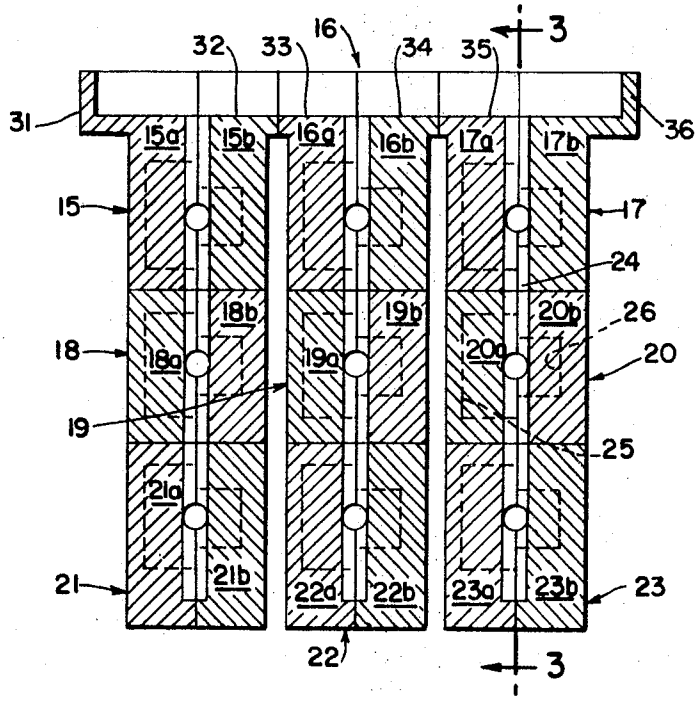


FIG. 3

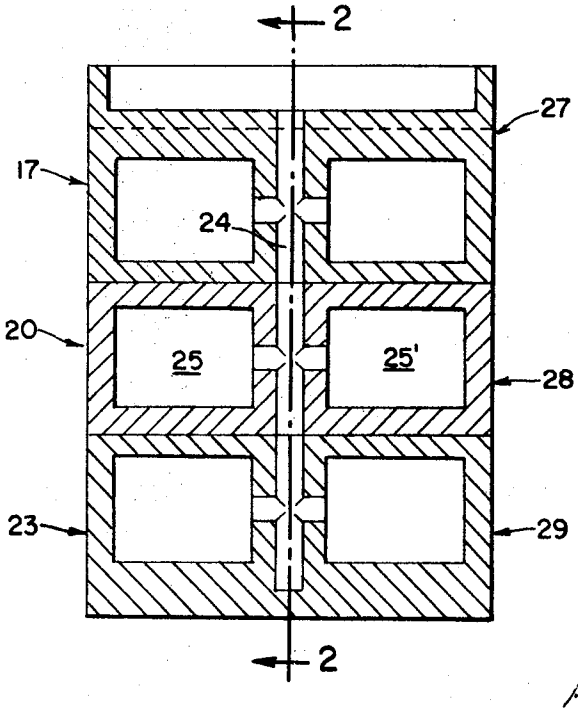
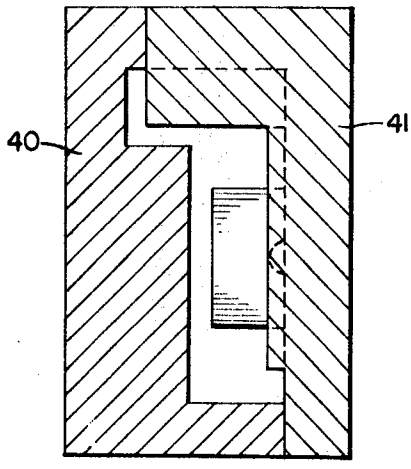


FIG. 4A



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FIG. 4B

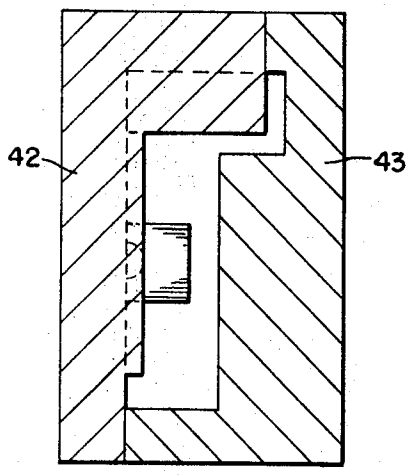


FIG. 4E

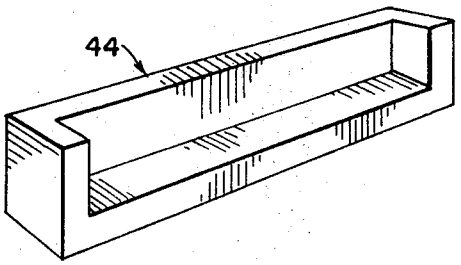


FIG. 4D

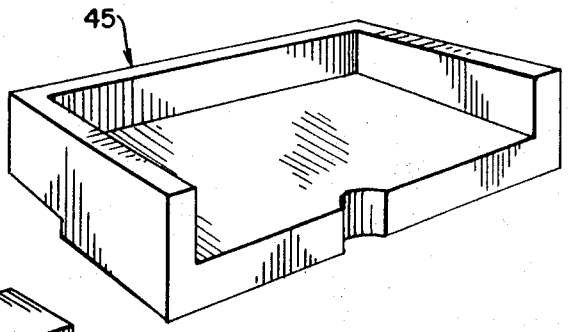


FIG. 4C

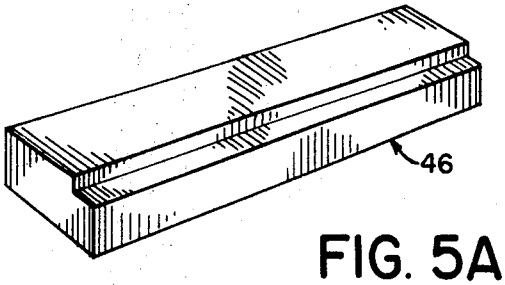


FIG. 5A

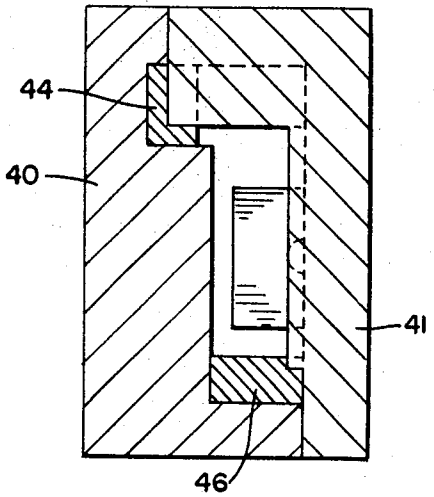
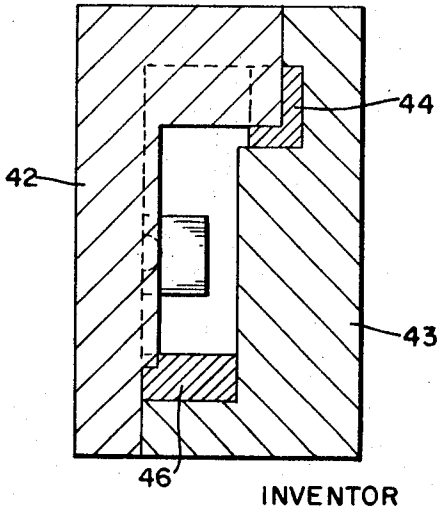


FIG. 6A



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FIG. 5B

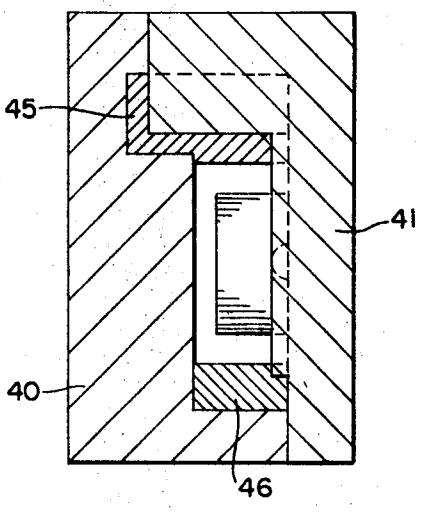


FIG. 6B

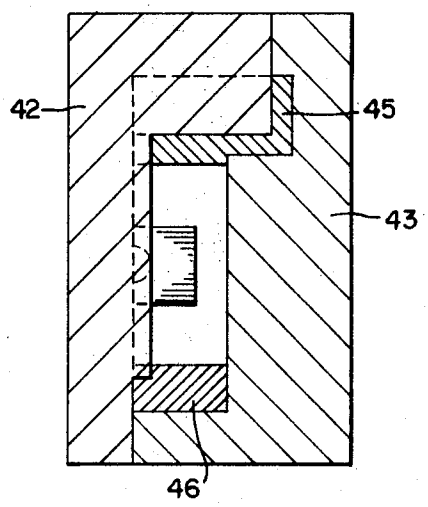


FIG. 7

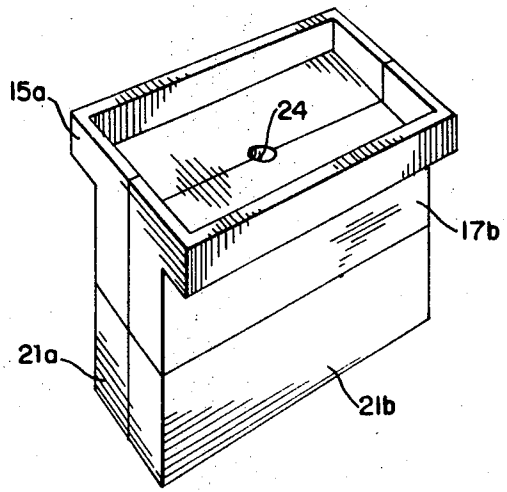
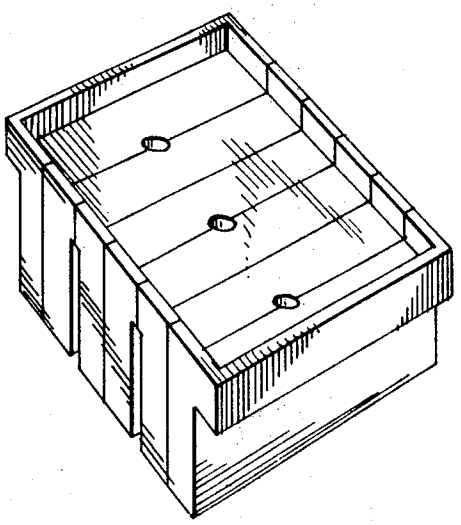


FIG. 8



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CERAMIC GANG MOLD

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the construction and method of making ceramic casting molds. In particular the invention concerns a ceramic gang mold for casting a plurality of parts simultaneously and comprising a number of cojoined mold units of various forms permitting assembly into the composite structure. The form of these mold units is such that a single die means (usually a pair of dies) can be used to fashion all of the desired forms of mold units with the proper use of special inserts for the die.

2. Description of the Prior Art

It is well known to form ceramic molds in a master die so that a plurality of finished parts can be cast in each individual mold. This is merely a question of designing the die so that it defines the desired number of part-forming cavities in the mold all connected through suitable sprue passages to the gate into which the molten metal is poured. Beyond a certain point it becomes disadvantageous to multiply the number of part-forming cavities in a given mold unit because tooling costs increase correspondingly. Hence proposals have been made to cojoin a plurality of units together into a composite or "gang" mold.

The ganging of shell molds as it is known in the prior art is based on the concept of designing the individual mold units in the first instance so that one standard unit can be assembled with others in the gang. Hence, a conventional composite mold structure constitutes only the physical assembly of one mold shape repeating many times, and as such is does not offer significant advantages over the use of each such mold unit separately. One common inadequacy in prior art gang molds is that the composite structure often does not have a single gate into which the molten metal can be poured for immediate flow to all of the part-forming cavities.

SUMMARY OF THE INVENTION

Broadly stated, the ceramic gang mold of the invention for casting a plurality of parts simultaneously comprises a plurality of mold units of a plurality of forms. All of these forms include a body of identical shape defining one or more part-forming cavities and a sprue passage extending into the cavities and through the body. All of the units also have one or more juncture surfaces, each juncture surface on each unit being identical to at least one other juncture surface on at least one other unit. At least one of the forms of mold units further includes a gate-defining portion extending from the body with access therethrough to the sprue passage in the body. At least one of the forms of the mold units further includes a sprue-closure portion extending from the body and closing off the sprue passage in the body. The molds are cojoined at their identical juncture surfaces to form a (gang) mold with a single gate communicating with all part-forming cavities through the sprue passages which are all closed remote from the gate.

A principal feature of the invention is the identical shape of the bodies of the units and the fact that the units differ only in the presence or absence of extensions on that standard body. For example, one unit with a gate-defining portion at one end and a juncture surface at the other may be joined to another unit with only a sprue-closure portion to form a complete gang with one gate. Or a similar pair of units may be integrated with the first by means of juncture surfaces on the gate-defining portions. The combinations and permutations possible with these basic units are many.

Not only does such a design permit a wide variety of composite structures to be built up in a compact manner, but all of the units in the gang can be made from a single die means by the proper use of a few simple inserts. Hence the invention contemplates a method for producing molded parts of a plurality of shapes from a die with a given forming cavity which

comprises the following steps: First there is located in the cavity an insert blocking off a portion of the cavity. A part is then molded in the remainder of the die cavity to produce a first shape. Then the insert is removed and another part is molded in the cavity to produce a second shape identical to the first but for an extension thereon similar to the previously blocked off portions of the cavity.

This technique has several advantages, among them being the greatly reduced cost of tooling. In addition, the relatively small units of the gang can be made with considerably more dimensional accuracy than would be possible if a single multiple-cavity mold similar to the gang were fabricated. A gang mold made according to the invention also permits experimentation with expensive alloys at a minimum of cost. Simply by changing inserts, various sample castings of such metals as gold, platinum and uranium alloys may be made for purposes of comparison and testing.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention are described with reference to the accompanying drawings, wherein:

FIG. **1** is a perspective view of a given casting to be made in a multiple fashion in the gang mold of the invention;

FIG. **2** is an elevational view, in section and taken along the line **2–2** of FIG. **3**, of a gang mold of the invention illustrating several combinations of mold units;

FIG. **3** is a section taken along the line **3–3** of FIG. **2**;

FIG. **4A** and **4B** illustrate the master dies for forming respective half-sections of the primary mold unit form;

FIGS. **4C** to **4E** are perspective views of respective inserts to be used in the master dies according to the invention;

FIGS. **5A** and **5B** illustrate the master dies for making respective half-sections of one form of unit with two of the inserts in place;

FIGS. **6A** and **6B** illustrate the master dies for making respective half-sections of another form of the unit, with yet another combination of inserts in place;

FIG. **7** is a perspective view of another combination of the composite mold units different from that of FIGS. **1** and **2**; and

17 FIG. **8** is a perspective view of a third combination of the composite mold units. Referring first to FIG. **1**, an illustrative casting **10** is shown not to represent any particular finished part but rather to emphasize the concept of the invention. Thus, it is asymmetrical and includes a rectilinear base **11** with a narrower rectilinear ridge **12** extending throughout its length from one side thereof. Reference numeral **13** indicates the stub of metal formed in the sprue passage during the casting of the part. A principal object of the casting process of the invention is to form at one time a multiplicity of parts as exemplified by casting **10** simply by pouring molten metal into the single gate of a ceramic gang mold.

One of the more developed forms of the composite mold of the invention for achieving this end is shown in FIGS. **2** and **3**. This composite mold comprises five separate forms of mold units, involving eight different forms of half-sections. In accordance with the invention this variety of parts can readily be made in one pair of master dies by the use of only three inserts, as described subsequently in relation to the remaining figures of the drawings.

Starting at the upper left of the gang mold as it appears in FIG. **2**, the first unit **15** is made up of left and right matched half-sections **15***a* and **15***b*. To the right of that in the upper tier is a unit **16** formed of left and right matched sections **16***a* and **16***b*. At the end of the upper tier is a unit **17** with its half-sections **17***a* and **17***b*. The second tier comprises a unit **18** and its half-sections **18***a* and *b*, then a unit **19** with its half-sections **19***a* and *b*, and a unit **20** with its half-sections **20***a* and **20***b*. The lower tier constitutes units **21**, **22**, and **23** made of corresponding half-sections **21***a* and *b*, **22***a* and *b*, and **23***a* and *b*.

All of these units have a certain common construction, which will be described with reference only to unit **20** on the right end of the middle tier (see FIG. **3** as well as FIG. **2**). The

unit **20** has what can be termed a "body" formed by its left and right halves **20***a* and **20***b*, and in this case the unit **20** comprises nothing more than its body; i.e. there are no extensions on it of the type described below regarding other forms of units. For this specific form of the invention, therefore, the "body" of the units is that which is identical to the whole of unit **20**. In the body of unit **20** is a sprue passage **24** extending completely therethrough, with side branches communicating with two part-forming cavities **25** and **25'** in the left section **20***a* and another pair of part-forming cavities **26** and **26'** in the right half-section **20***b*. Cavities **25** and **26** form the base **11** and ridge **12** respectively of one casting and cavities **25'** and **26'** do the same for another casting. The upper and lower surfaces of the unit **20** constitute "juncture surfaces" **27** and **28** which are of identical configuration.

Only a pair of castings is formed in one unit in this example, though more may be formed with a suitable network of sprue passages. The respective sections of the unit **20** may be cast from a pourable slurry or transfer molded, which is to say the binders for the refractory materials may be either fluid and chemically set or may be resinous and softened by heat. Typical refractory materials for this purpose are alumina, zirconia, zircon, mullite, refractory clay, graphite, alpha-quartz, fused silica, high melting glass and various fused refractories, iron chromite, chromic oxide, titanium carbide, titanium beryllide, silicon carbide, and other suitable carbides, beryllides and borides.

All of the units **15** to **23** have a body, a sprue passage and part-forming cavities identical to those of unit **20**. This is the standardized structure, varied in other units by the presence or absence of extensions, which permits assembly of all the units into an improved gang mold.

The first form of units to be noted in the embodiment of FIGS. **2** and **3** is the form of the unit **20**, and the units **18** and **19** are identical. Half-sections **18***a*, **19***a* and **20***a* are of the same form, and half-sections **18***b*, **19***b* and **20***b* are likewise of the same form.

The second form of units is that of units **21**, **22** and **23**. These are identical to the first form except that their half-sections include respective lower extensions which when matched define what can be designated as "sprue-closure portions." The sprue-closure portion of unit **23** is indicated as **29**, and it is simply all of the lower part of unit **23** extending beyond the body thereof (the "body" of unit **23**, as explained above, is that portion of its configuration duplicating the unit **20**). This sprue-closure portion **29** includes a short closed sprue passage which registers with the sprue passage of the unit **20**. A juncture surface **30** is defined at the top of the unit **23** and, since it is a surface of the body, it is identical to the juncture surfaces **27** and **28** of the unit **20**.

The three units **15**, **16** and **17** of the upper tier constitute three additional forms of units, though each has a body and lower juncture surface identical to that of the unit **20**. They differ in their upper extension or "gate-forming" portion, all of which have a short portion of sprue passage which aligns with that of the units beneath. The half-section **15***a* provides a left end gate-forming portion **31** and the half-section **15***b* provides a right intermediate gate-forming portion **32**. The half-section **16***a* and **16***b* provide left and right intermediate gate-forming portions **33** and **34**. The half-section **17***a* provides a left intermediate gate-forming portion **35** and the half-section **17***b* provides a right intermediate gate-forming portion **36**. The cojoined areas of the half-sections **15***b* and **16***a*, and also of **16***b* and **17***a*, are identical.

Together, the gate-forming portions **31** to **36** define a single gate into which metal can be poured during use for direct access to the three sprue systems extending into units **15-18-21**, **16-19-22** and **17-20-23**. It is to be understood that for purposes of clarity no mention is made of risers or other components which may also be included in this composite mold during actual practice.

Each half-section of every mold in the structure shown in FIGS. **2** and **3** is molded of ceramic material in master dies. Only two such master dies are necessary for all the variations and they are shown in FIGS. **4A** and **4B**. FIG. **4A** shows a die block **40** and a mating die block **41** which together permit the molding of all left half-sections in the gang which form the base **11** of the desired finished part. Die blocks **42** and **43** of FIG. **4B** likewise serve to make all of the right half-sections used in every unit for defining that side of the finished part which includes the ridge **12**. By the proper use of inserts **44**, **45** and **46** shown in FIGS. **4C**, **4D** and **4E** respectively, every particular form of mold unit can be made in the pairs of die blocks shown in FIGS. **4A** and **4B**. This is illustrated with reference to FIGS. **5A** and **5B** and FIGS. **6A** and **6B**, and is a consequence of the fact that the inserts bear a relation to the extensions on the bodies of the units discussed previously. Thus insert **46** has the same shape as the sprue-closure portions of the half-sections of units **21** to **23**. Insert **45** is shaped the same as the gate-forming portions of the half-sections **31** and **36**, and insert **44** has the shape of the insert **45** minus the gate-forming portions of the half-sections **15***b*, **16***a*, **16***b* and **17***a*.

By placing inserts **44** and **46** in the die blocks **40** and **41**, as shown in FIG. **5A**, a ceramic half-section can be molded to serve as left half-sections **15***b* and **16***b*. By removing the insert **44** and leaving insert **46** in place, half-section **15***a* can be made. Then insert **45** can be put in place as shown in FIG. **5B** and half-sections **18***a*, **19***a* and **20***a* can be made. Next insert **46** can be removed and half-sections **21***a*, **22***a* and **23***a* made.

With reference to FIG. **6A**, inserts **44** and **46** can be placed in die blocks **42** and **43** and half-sections **15***b* and **16***b* can be made. By removing insert **44** and leaving insert **46** in place, half-section **36** can be made. Then insert **45** can be put in place as shown in FIG. **6B** and half-sections **18***b*, **19***b* and **20***b* can be made. Finally insert **46** can be removed and half-sections **21***b*, **22***b* and **23***b* can be made.

Thus all of the half-sections of the entire gang are completed by the use of the two die blocks and the three inserts. The half-sections are cemented together either with organic or ceramic cements and joined in a similar manner to the other units of the gang. The assembly is then fired to eliminate the organic material or volatile chemical components and it is ready to receive molten metal during casting. Suitable locating means should be provided between the various units of the assembly to lend support in the course of the casting process, and for this same reason appropriate reinforcing ribs may be provided on the exterior of the mold units to prevent warpage and increase strength without unduly thickening the walls of the mold. Instead of cojoining the various junctures both horizontally and vertically as shown in FIGS. **2** and **3**, suitable half-sections could be made so that they are joined only vertically as shown in FIG. **7**. Alternatively a horizontal composite gang may be formed as shown in FIG. **8** without any vertical extensions.

The central concept of the method is that the inserts **44** to **46** used in the master dies **40** to **43** conform to the shape of and fill corresponding portions of the cavity and hence by their presence or absence in various combinations can be used to make as many as eight different forms of half-sections. All such forms have the same body configuration since the inserts never affect that part of the master dies. This standardization of the body permits the various forms to be assembled at identical juncture surfaces to develop a wide variety of different gangs. All such gangs have in common the fact that there is only one gate into which the molten metal need be poured during use.

We claim:

1. A ceramic gang mold for casting a plurality of parts simultaneously comprising:

a. a plurality of mold units of a plurality of forms, all of the forms including:

i. a body of identical shape defining one or more part-forming cavities and a sprue passage extending into the cavities and through the body, and

ii. at least one juncture surface, each juncture surface on each unit being identical to at least one other juncture surface on at least one other unit;

b. at least one of said forms of mold units further including:

i. a gate-defining portion extending from the body with access therethrough to the sprue passage in the body but no sprue-defining portion;

c. at least one of said forms of mold units further including:

i. a sprue-closure portion extending from the body and closing the sprue passage in the body but no gate defining portion;

d. said mold units being cojoined at said identical juncture surfaces to form a gang mold with a single gate communicating with all part-forming cavities through the sprue passages which are all closed remote from the gate.

2. A gang mold according to claim 1 wherein the identical bodies of all forms of the mold units each defines a plurality of part-forming cavities.

3. A gang mold according to claim 1 wherein each mold unit is formed of cojoined complementary half-sections.

4. A gang mold according to claim 1 wherein a plurality of said forms of mold units include said gate-defining portions, at least some of said cojoined juncture surfaces are located on the gate-defining portions, and the single gate is formed by all of the gate-defining portions and opens directly into a plurality of said sprue passages.

5. A gang mold according to claim 1 wherein at least one of the mold units with said gate-defining portion includes a juncture surface on its body but no sprue-closure portion, at least one other of said mold units with said sprue-closure portions includes a juncture surface on its body but no gate-defining portion, and at least one other of said mold units includes two juncture surfaces on its body but neither a gate-defining portion nor a sprue-closure portion, said units being cojoined at said juncture surfaces on the respective bodies with the unit with two such surfaces interconnecting the other two units.

6. A gang mold according to claim 5 wherein at least one of the mold units with said gate-defining portion and a juncture surface on its body includes a further juncture surface on its gate-defining portion, and an additional mold unit with a gate-defining portion is cojoined at said further juncture surface, the single gate being formed by a plurality of gate-defining portions and opening directly into a plurality of said sprue passages.