Oct. 18, 1927. 1,645,730

C. VAUGHAN

METHOD OF CASTING

Original Filed Nov. 20, 1922 2 Sheets-Sheet 1

Fig. 1.

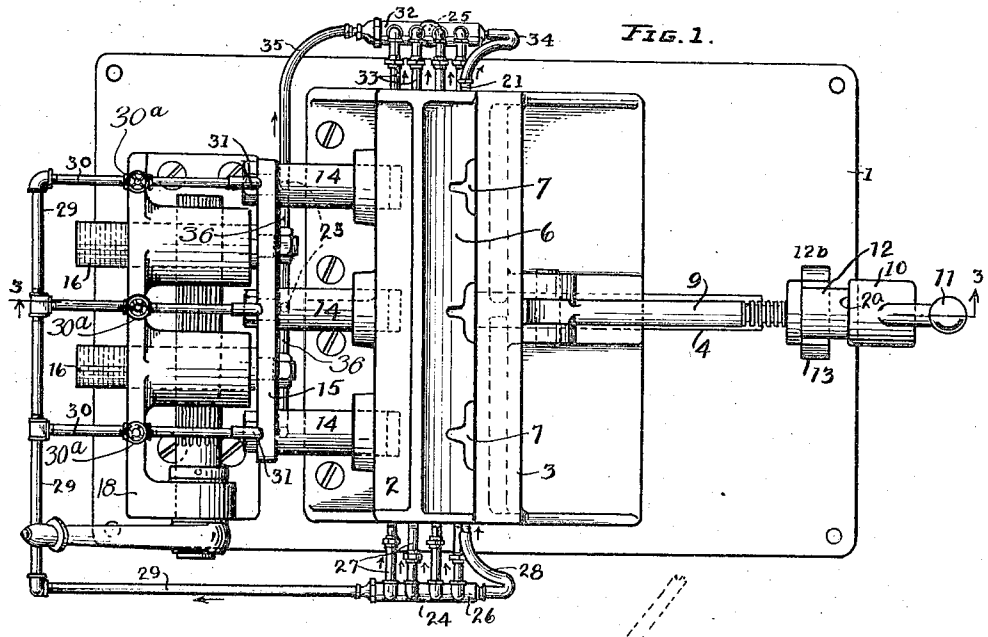
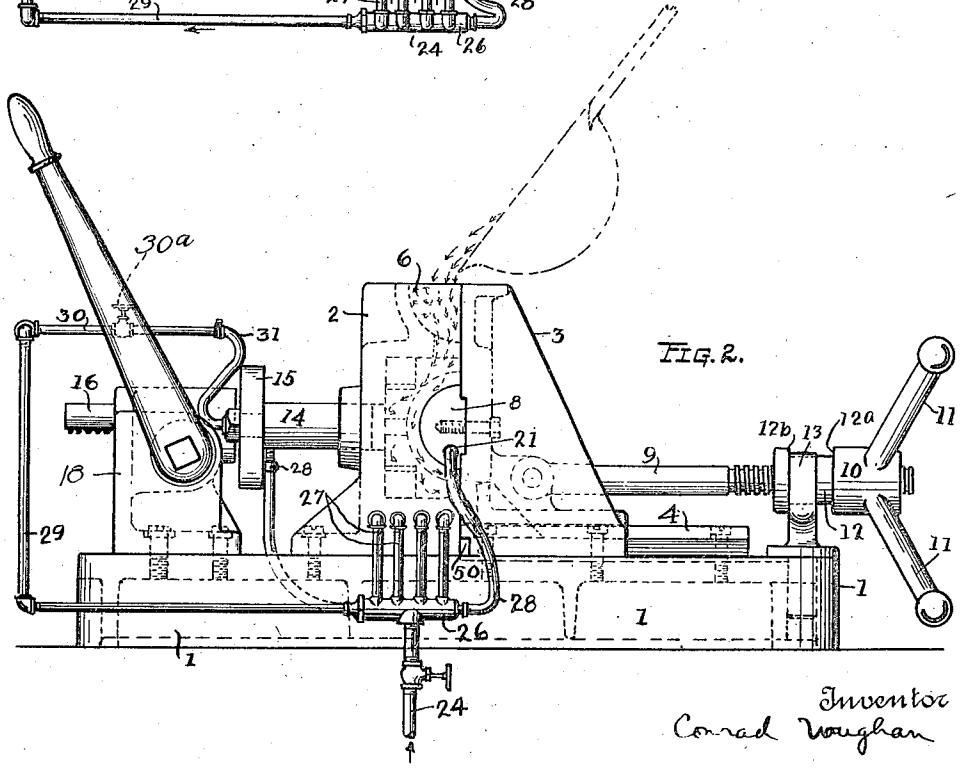


Fig. 2.



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Fig. 3.

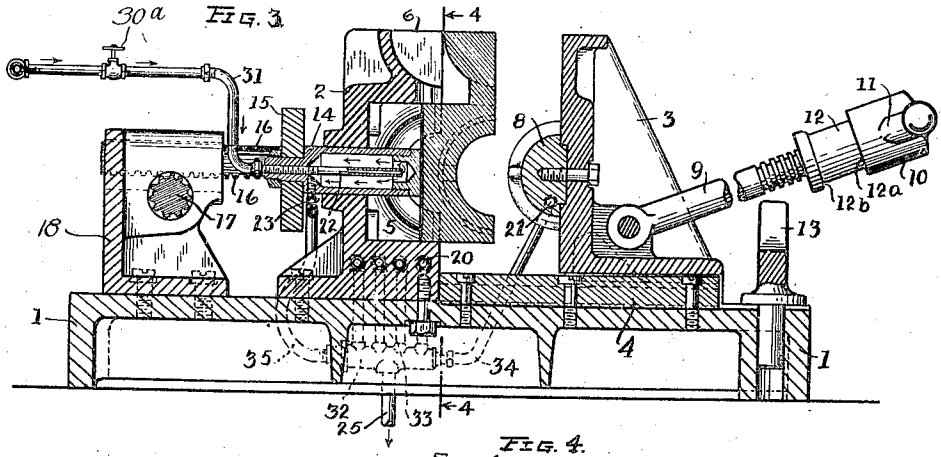


Fig. 4.

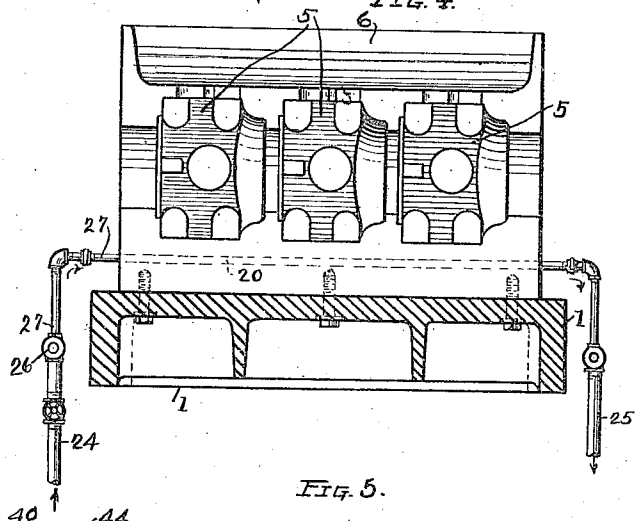
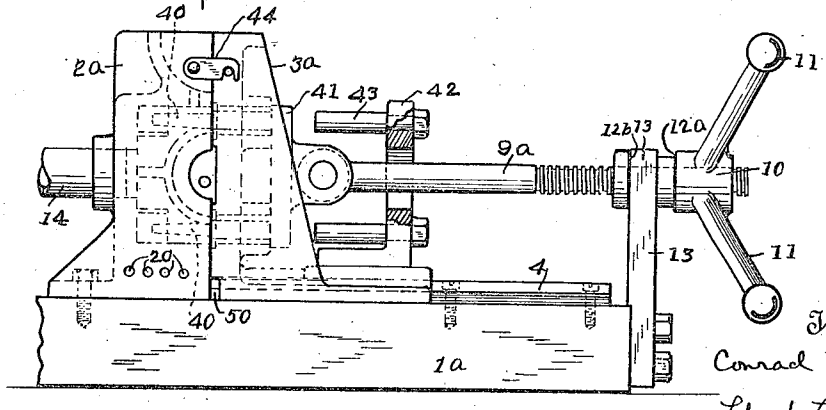


Fig. 5.



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UNITED STATES PATENT OFFICE.

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METHOD OF CASTING.

Original application filed November 20, 1922, Serial No. 602,269. Divided and this application filed December 26, 1924. Serial No. 758,115.

This invention relates to a method of casting metals in permanent metal molds.

While the invention is obviously of more general application in many of its aspects, it has been developed in connection with the casting of articles from aluminum or its alloys, but is equally adaptable to any alloys having relatively high crystallization shrinkage and relatively low fusing point.

This application is a division of my prior application Serial No. 602,269, filed November 20, 1922, for molds and method of casting.

The general object of the invention is to provide a method for casting such alloys to yield castings in which porosity due to crystallization shrinkage or contraction and too rapid pouring is eliminated.

A further object is to provide a process of casting suited to making castings having flanges or projections or having sudden variations in the cross-sectional dimensions.

A further object of the invention is to considerably shorten the time required for the casting operation, which not only gives a bigger production yield per mold per day, but also produces castings in which the physical structure of the metal is of relatively fine grain and relatively uniform throughout.

Another object of the invention is to cause the metal to flow at a suitable rate into the mold cavity, and to accompany this by simultaneously cooling the molten metal remote from the gate or that in heavy or thick sections of the casting. Thus the freezing of the metal takes place progressively toward the gate and the metal in the mold cavity remains liquid between the point where solidification is taking place and the gate. The new metal coming through the gate comes at such a rate into the mold cavity that it will not be filled so rapidly that the metal in the gate or in any thin parts of the casting near the gate will be frozen before the metal solidifies in the more remote or thicker parts of the mold cavity, and thus prevent feeding of the metal through the gate when solidification shrinkage is taking place in the metal in the mold cavity. This overcomes the objection sometimes encountered in other molds where the metal of the thin part solidifies before the metal in the thicker part of the casting and thus prevents proper feeding of the metal in the thicker part upon solidification and contraction. Without such feeding, the contraction causes a drawing away from the already solid metal of the thin part, resulting in cracking of the casting or uneven shrinking of the casting from the mold walls causing depressions in the casting, or both.

While it is an object of this invention to provide a relatively small gate to control the rate of flow into the casting cavity, it is also an object of this invention to provide a gate which, due to its shape, will prevent piping and will improve the physical characteristics of the metal in the casting adjacent the gate.

Another object of the invention is to provide a mold in which the amount of molten metal required in the sprue is greatly reduced as a considerable cooling of the metal in the mold cavity is accomplished before the hot molten metal fills the sprue cavity. A relatively smaller amount of metal is therefore needed in the sprue cavity to feed the casting on account of the fact that there has been considerable cooling in the mold cavity and part of the shrinkage has already taken place in the mold cavity before the sprue cavity is filled, and also because the freezing of the metal in the mold cavity is controlled so that it is progressive toward the gate, so that fluid communication is maintained between the sprue cavity and the unfrozen parts of the casting in the mold cavity.

Another object of the invention is to provide a relatively simple method of cooling the portions of the mold distant from the gate to facilitate freezing.

Other objects will be apparent from the following description and annexed drawings.

Reference should be had to the accompanying drawings forming a part of this specification in which

Figure 1 is a top plan view of the casting apparatus.

Fig. 2 is a side elevation of the apparatus.

Fig. 3 is a section on line 3—3 of Fig. 1.

Fig. 4 is a section on line 4—4 of Fig. 3.

Fig. 5 is a side elevation of a slightly modified form of the invention.

Referring to the annexed drawings, the mold and actuating members for the mold parts are mounted upon a base member or bed plate 1. The mold may be made of any suitable material and consists of a fixed section 2, secured to the bed plate, and a movable section 3, slidable in a guideway 4 on the base member 1. Such guideway may be of the usual T-section to rigidly hold the slidable section 3 from tipping. The fixed section 2 has the face thereof, which is presented to the movable section, recessed to provide the casting cavities 5 and a sprue cavity 6 and T-shaped feed openings or gates 7 leading from the sprue cavity to the casting cavity. The movable section 3 has a flat face on the side thereof toward the fixed section which fits against the recessed face of the fixed section. A core 8 may be attached to the face of the movable section 3 to project into the casting recesses 5. A threaded bar 9 is pivoted to the outer side of the movable mold section 3, adjacent the base thereof, and carries a nut 10 upon its outer end, which has handles 11 fixed thereto and is formed with a wide bearing groove 12 having side walls or opposing shoulders 12^a and 12^b. An open yoke 13 is fixed to the end of the base member 1 and is adapted to receive the grooved portion 12 of the nut 10. When the nut 10 is seated in the yoke 13, the yoke forms a thrust bearing for the nut so that by turning the nut in one direction the shoulder 12^b bears against the yoke and forces the bar 9 to move the section 3 until it is clamped tightly against the fixed section 2. After a casting has been made, the nut 10 can be turned in the opposite direction by means of the handles 11, so that the shoulder 12^a bears against the yoke and pulls the mold section 3 away from the section 2, freeing it of the casting. The nut may then be rotated or the section 3 moved so that the screw 9 may be lifted free of the yoke 13 in order that the movable section 3 can be quickly pulled entirely away from the fixed section 2.

The fixed section 2 is provided with an ejecting mechanism consisting of a series of plungers 14 slidably fitted in the rear wall thereof and at the back of each casting recess 5. During the operation of casting, these plungers are in withdrawn position so that their ends are flush with the wall of the recess and form a part thereof. The plungers 14 in the present disclosure are rigidly secured to a cross bar 15 which carries a pair of rearwardly extending rack bars 16. These are engaged by an elongated pinion 17 journaled in a suitable bracket 18 at the rear end of the base member. A suitable operating lever is connected to one end of the pinion to actuate the same. By swinging the lever forwardly after the movable mold section 3 has been moved away from the fixed section, the plungers 14 are caused to move in the same direction and eject the castings from the mold. In case there be the same number of plungers desired as rack bars, the plungers themselves may be formed with rack teeth in them to be directly engaged by a pinion and thus do away with the connecting bar or plate 15. In the mold herein disclosed by way of example, the movable section 3 is the one shown with a flat face as a matter of convenience, whereas it is obvious that either of the mold sections may be movable but preferably the one is stationary which will retain the casting until it is ejected by the ejector mechanism herein described.

An important feature of the invention is the chilling of certain portions of the mold. While this may be accomplished in various ways, circulation of any suitable fluid, but preferably a liquid such as water or oil, through the portions of the mold which are to be chilled has been found to give excellent results. By such chilling the rate of cooling of the metal of the thick parts of the casting is increased to such an extent that the freezing if such thick parts may be made to occur sooner than the freezing of the thinner metal parts between such thick parts and the gate. By the use of such chilling the metal in the thick parts of the casting or in those parts having sudden variations in cross-sectional dimensions is cooled so as to prevent cracking during freezing.

The fixed section of the mold is provided beneath the casting recesses 5 with a series of passages 20 extending lengthwise thereof, the core 8 has a passage 21 adjacent its bottom extending lengthwise thereof, and the plungers 14 are hollow, and have axially disposed inlet pipes 22 extending from the rear end thereof to the front end or face engaging the casting. An outlet nipple 23 is located adjacent the rear end. Liquid is circulated through the fixed mold section, core and ejectors by means of feed and discharge pipes 24 and 25 on opposite sides of the machine. The feed pipe 24 has a connection 26 at its upper end from which short pipe sections 27 extend to the passages 20 in the base portion of the fixed section. A flexible conduit 28 connects one end of the connection 26 with the passage 21 in the core 8, and a branch conduit 29 extends rearwardly and across the rear end of the machine. Branch pipes 30 with valves 30^a therein for regulating the flow are in line with each of the ejector plungers 14, extending from the pipe 29 to a point over the rear ends of the plungers 14 and are connected to the inlet pipes 22 of the plungers by means of flexible hose sections 31. The discharge pipe 25 is connected at its upper end with a connection 32 similar to the connection 26, from which short pipe sections 33 extend to the outlet ends of the

passages 20 in the base of the fixed mold section 2. A flexible hose section 34 connects one end of the connection 32 with the outlet end of the passage 21 in the core 8, and a flexible conduit 35 extends rearwardly from the opposite end of the connection 32 and connects with a cross pipe 36, connected to the discharge nipples 23 of the plungers 14.

By means of the liquid circulating system above described the parts of the mold adjacent the lower portions of the casting cavities 5 are chilled so that metal in the casting cavities is frozen progressively toward the gate and before the metal freezes in the gates 7. The gates are of relatively smaller cross-sectional area than in molds heretofore used, so that the flow of metal continues while a relatively larger portion of the casting is cooled or frozen, and so that the metal does not freeze in the gates 7 until after all the metal necessary to replace the crystallization shrinkage of the casting is fed to the mold cavity.

In addition to being of relatively smaller cross-sectional area, the gate has a large periphery with respect to its cross-sectional area, that is instead of being circular or elliptical, as is common practice, I have found that it is beneficial to form the gate of a cross-sectional shape such that all parts of the gate are relatively narrow and that there are no wide or heavy sections of metal in the gate. I have found that for this purpose a gate of T-shape is advantageous. With a gate of such shape the tendency to form pipes extending down into the casting is prevented and it is not necessary to extend the gate upwardly a considerable distance to provide a large sprue cavity to furnish sufficient head to prevent the piping formed upon solidification from extending down into the casting. Moreover, with a gate of T or similar cross-sectional shape, namely, a gate having a relatively long and narrow cross-sectional portion and having a laterally extending cross-sectional portion communicating with said long and narrow portion, depressions in the surface of the casting may in many cases be substantially eliminated, as previously mentioned, such advantageous results being probably due in part to escape of air from within the mold being more readily facilitated by gates of such shape, as the flow of part of the molten metal is directed away from the parting line of the mold.

It will be understood furthermore that my improved gate construction permits feeding of molten metal therethrough for a longer time than is obtainable from a gate having merely a long and narrow portion. Thus, in the gate illustrated at 7, the metal of the mold bordering both the relatively long and narrow gate portion and the lateral gate portion adjacent their intersection receives heat from the molten casting metal disposed within both gate portions, which heat as a result of the cross sectional shape of the gate, is not readily dissipated from said bordering mold metal. The said mold metal therefore exerts less chilling action on the molten casting metal than the mold metal adjacent the other portions of the gate. As a result, the casting metal disposed adjacent the intersection of the gate portions remains molten longer than the remainder of the casting metal in the gate, thereby increasing the time of feeding of molten metal through the gate to the casting cavity adjacent said intersection.

Heretofore it has usually been considered necessary to apply heat to portions of the mold to prevent freezing in the gate, or to use metallic inserts of high heat conductivity to chill the thicker parts of the casting. The heating of the mold is expensive and I have found that it is not necessary and in fact slows down the casting operation. It is advantageous to avoid the use of such metallic inserts because they are not so efficient for chilling the mold and because, without such inserts, the mold surfaces can be made of the same metal, or metal having substantially the same properties, such as heat conductivity, so that the casting will not contact with metals of varying properties.

The present invention greatly increases the speed of operation by keeping down the temperature of the mold, thus producing a casting of better physical characteristics. In view of the greater rapidity of operation, and also in view of the shape of the gate, the sprue cavity can be relatively small and the sprue metal required is much less than heretofore, when the volume of metal in the sprue was about one half the volume of metal in the casting, which was considered good general practice. By the present method the volume of metal in the sprue need not be more than a maximum of approximately 25% of the volume of metal in the casting, which effects a considerable saving in melting costs.

The cooling of the ejector plunger causes the metal of the castings to be chilled at the points where they are engaged by the plungers, so that the relatively hot castings are not deformed by the pressure exerted thereon by the plungers.

It will be seen that any number of castings may be made in one mold, each casting cavity having a gate connecting it to the common sprue. Furthermore by having the molds designed so that the gates come on the ends of the casting, a series of castings may be easily trimmed simultaneously by sliding them on their flat faces on the table of the trimming machine. Also as the metal coming from the gate is thin in cross-sectional shape it is more easily and quickly cut

through than when a circular or elliptical gate is used.

In the modified construction shown in Fig. 5 the base 1^a and fixed and movable sections 2^a and 3^a are constructed in substantially the same manner as the corresponding parts in the modification first described. In this modification, however, the movable section 3^a has core pins 40 slidably mounted in openings therethrough and projecting into the casting recesses. The core pins 40 are for the purpose of forming apertures such as bolt holes or the like in desired portions of the casting. The pins 40 are fixed to a plate 41 which is adapted to bear against the outer face of the movable mold section 3^a. A bracket 42 is attached to the base of the movable section and has stop pins 43 detachably secured thereto and projecting toward the plate 41. A screw 9^a similar to the screw 9 above described is pivotally attached to the plate 41. The sections 2^a and 3^a are held in position after they are in close contact by suitable catches 44 pivoted to one of them. When the screw 9^a is pulled rearwardly after catches 44 are unlocked, the core pins 40 are first partially withdrawn from the casting and then when the plate 41 strikes the stop pins 43, the movable section 3^a is pulled bodily away from the fixed section 2^a.

A suitable recess 50 may be formed in the movable section 3 of the mold adjacent the base, which will prevent small pieces of scraps of metal which fall between the sections of the mold from keeping the mold sections out of close contact.

It will thus be seen that I have provided a method of casting aluminum alloys and the like whereby the freezing of irregularly shaped castings may be caused to take place progressively toward the gate.

By my method, moreover, the freezing of the casting metal may take place relatively rapidly. Thus the time required for each casting operation is materially reduced and the production of castings greatly increased.

Furthermore, by reason of the progressive and relatively rapid freezing of a casting as accomplished by my improved method, less molten metal to compensate for crystallization shrinkage of the casting metal remains to be fed from the sprue cavity through the gate to the casting cavity after the filling of the casting cavity, and hence a smaller sprue cavity may be employed with attendant advantage, including decreased cost of production.

Furthermore, it is to be understood that the particular forms of apparatus shown and described, and the particular procedure set forth, are presented for purposes of explanation and illustration and that various modifications of said apparatus and procedure can be made without departing from my invention as defined in the appended claims.

What I claim is:

1. The method of casting a metallic alloy of relatively high crystallization shrinkage and of relatively low fusing point which consists in pouring such metal into a metal mold of substantially uniform heat conductivity having a mold cavity, a relatively small sprue cavity, and a relatively narrow gate between them, controlling the flow of metal through the gate from the sprue cavity and chilling the metal in the mold cavity in such a manner that freezing is progressive toward the gate, whereby the surplus of metal in the gate and sprue cavity is maintained molten during substantially the solidification period of the metal in the mold cavity.

2. The method of casting a metallic alloy of relatively high crystallization shrinkage and low fusing point which consists in pouring molten metal into a mold of substantially uniform heat conductivity, the sprue cavity of which has a gate communicating with the casting cavity, and cooling such portions of the mold about the casting cavity which are engaged by the thick part of the casting.

3. The process of making light alloy castings which consists in pouring molten metal into metal molds of substantially uniform heat conductivity having a mold cavity, a relatively small gate and a relatively small sprue cavity, and cooling the mold adjacent the thick parts of the casting to insure the freezing of the metal in the mold cavity and thick parts of the casting before the metal in the gate or sprue cavity is frozen.

4. The process of making castings having shapes with sudden variations in their cross sectional dimensions, from light alloys having relatively high crystallization shrinkage and relatively low fusing point which consists in introducing such metal into a metal mold of substantially uniform heat conductivity and chilling the metal in the thicker part of the casting, whereby the metal in the casting cavity is solidified progressively toward the gate and sprue cavity.

5. The method of casting which consists in introducing molten metal in metal molds having a mold cavity, a gate, and a sprue cavity, removing the heat from the heavier sections of the metal in the casting by circulating liquid through the adjacent part of the mold to insure solidification of the metal in the mold progressively toward the gate.

6. The method of casting an alloy of relatively high crystallization shrinkage and a relatively low melting point which consists in introducing molten metal of such characteristics into a permanent mold having a gate of such shape that each part of the molten metal solidifying in the gate is relatively close to the metal of the mold.

7. The method of casting an alloy of rela-

tively high crystallization shrinkage and a relatively low melting point which consists in introducing molten metal of such characteristics into a permanent mold having a gate of such shape that each part of the molten metal solidifying in the gate is relatively close to the metal of the mold, and cooling the mold adjacent the thicker or more remote parts of the casting.

8. The process of making light alloy castings in permanent molds of substantially uniform heat conductivity having a relatively small gate and sprue cavity which consists in introducing molten metal into the sprue cavity and cooling the mold at points remote from the gate, whereby substantially all of the metal in the mold cavity solidifies before the surplus metal in the sprue cavity.

9. The method of casting metals having a relatively high crystallization shrinkage and a relatively low melting point which consists in introducing molten metal into a mold of substantially uniform heat conductivity having a relatively small gate and sprue cavity and chilling portions of the mold adjacent the heavier sections of molten metal, whereby relatively rapid solidification of the casting is accomplished and such solidification is progressive toward the gate to insure the casting receiving fresh molten metal to compensate for shrinkage.

10. The method of casting, relatively rapidly, metals having a relatively high crystallization shrinkage and a relatively low melting point which consists in introducing such molten metal into a permanent mold of substantially uniform heat conductivity through a relatively small gate and cooling the portions of the mold adjacent the heavier sections of the casting, whereby a relatively smaller volume of metal is needed in the sprue cavity to furnish molten metal to compensate for shrinkage losses and a relatively quick total solidification is obtained.

11. The method of casting metal alloys having a relatively high crystallization shrinkage and a relatively low melting point which consists in introducing such metal into a permanent mold of substantially uniform heat conductivity having a mold cavity shaped to form a casting having an irregular distribution of metal, such mold having a relatively small gate, and cooling portions of the mold adjacent the heavier sections of casting metal.

12. The method of casting which consists in pouring molten metal into a permanent mold of substantially uniform heat conductivity and maintaining the fluidity of such metal through the gate into the casting cavity during the freezing of the casting by chilling only those portions of the mold adjacent the heavier sections of metal and permitting the metal in the thin sections to remain fluid between such heavy sections and the gate.

13. The method of simultaneously making a plurality of castings from metal of relatively high crystallization shrinkage and relatively low melting point which consists in introducing molten metal of such characteristics into a permanent mold of substantially uniform heat conductivity having a plurality of mold cavities with gates leading thereto from a sprue cavity and causing the solidification of the heavy sections of such castings by cooling the mold adjacent thereto, so that solidification of the metal of the castings is progressive toward the gate to insure a constant supply of fresh metal to compensate for shrinkages.

In testimony whereof, I hereunto affix my signature.

CONRAD VAUGHAN.