W. S. POTTER.

PRODUCTION OF CASTINGS.

APPLICATION FILED DEC. 17, 1909.

967,830. Patented Aug. 16, 1910.

2 SHEETS—SHEET 1.

Fig. 1,

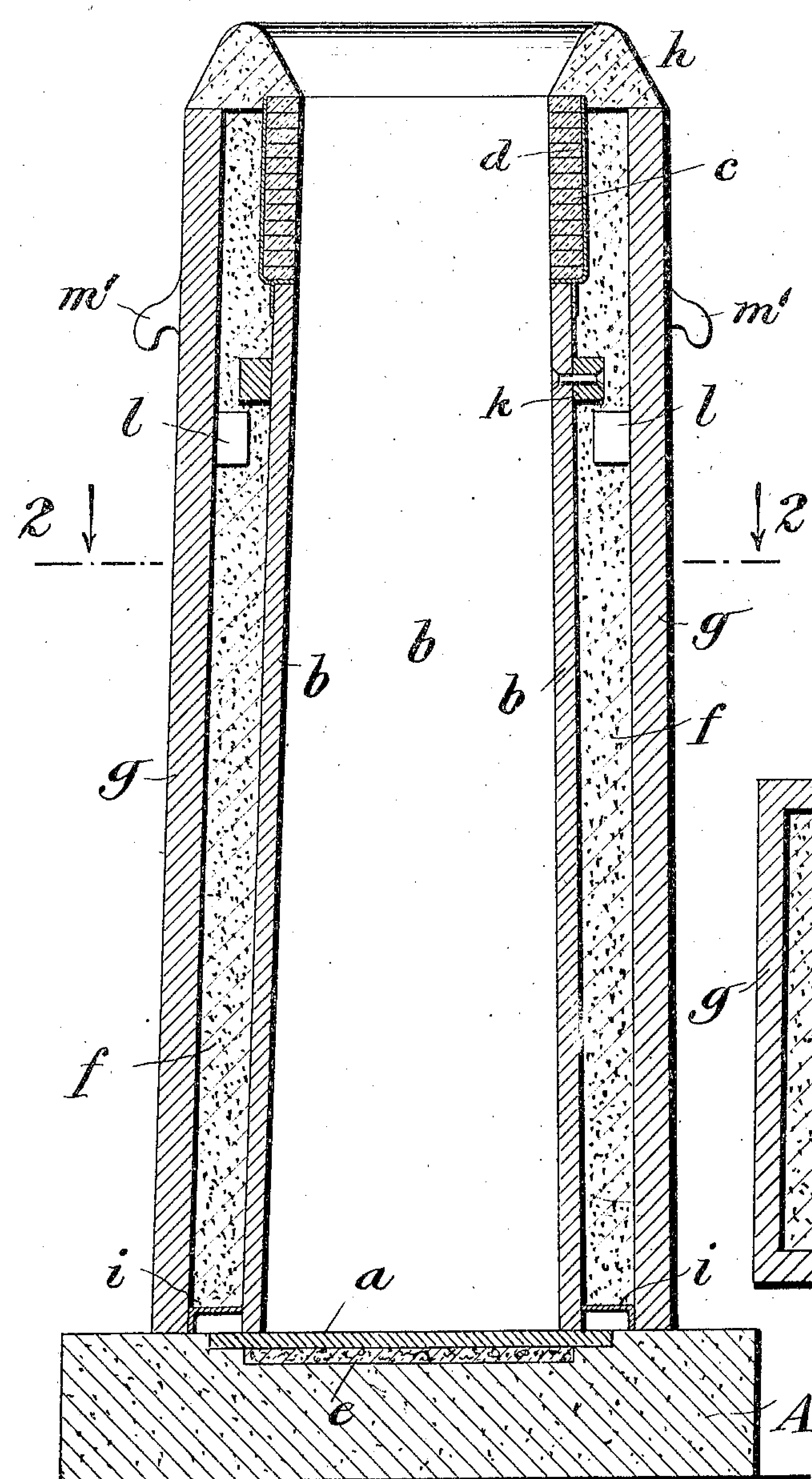
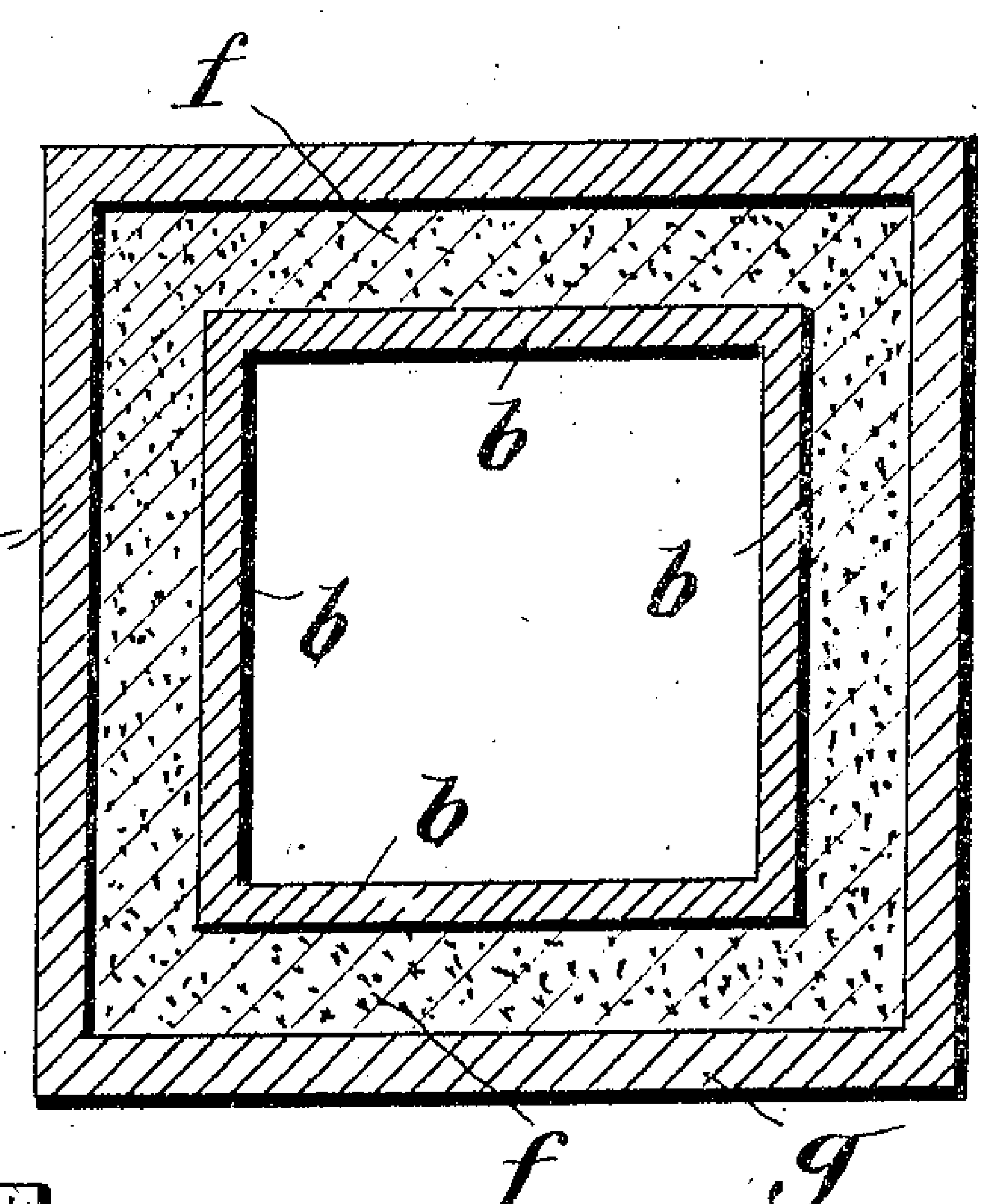


Fig. 2,



WITNESSES:

L. B. Penfield

L. H. Barlow

INVENTOR:

Winfield S. Potter,

BY

Hume & Goldsborough,

ATTORNEYS.

W. S. POTTER.
PRODUCTION OF CASTINGS.
APPLICATION FILED DEC. 17, 1909.

967,830. Patented Aug. 16, 1910.

2 SHEETS—SHEET 2.

Fig. 3.

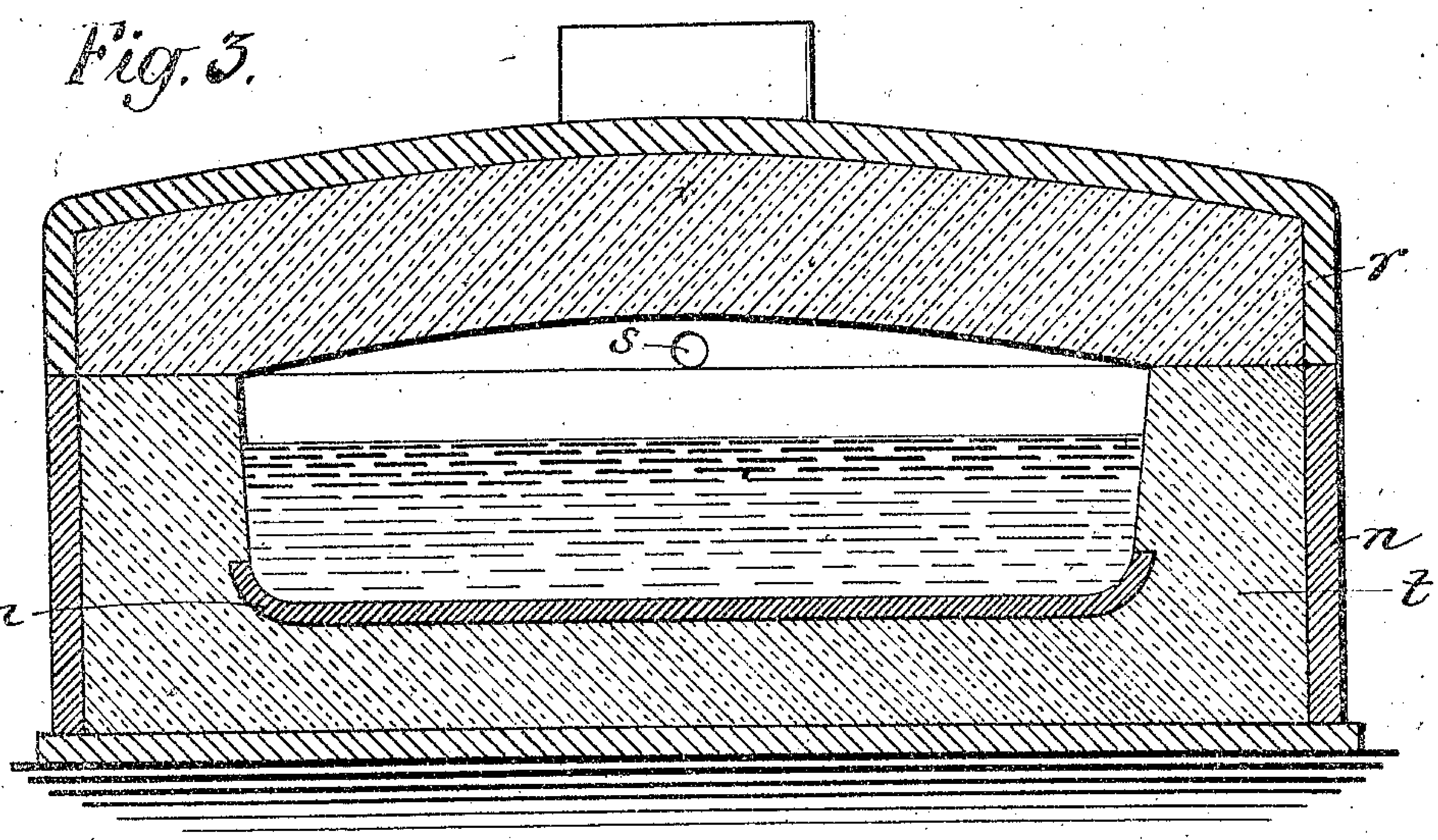
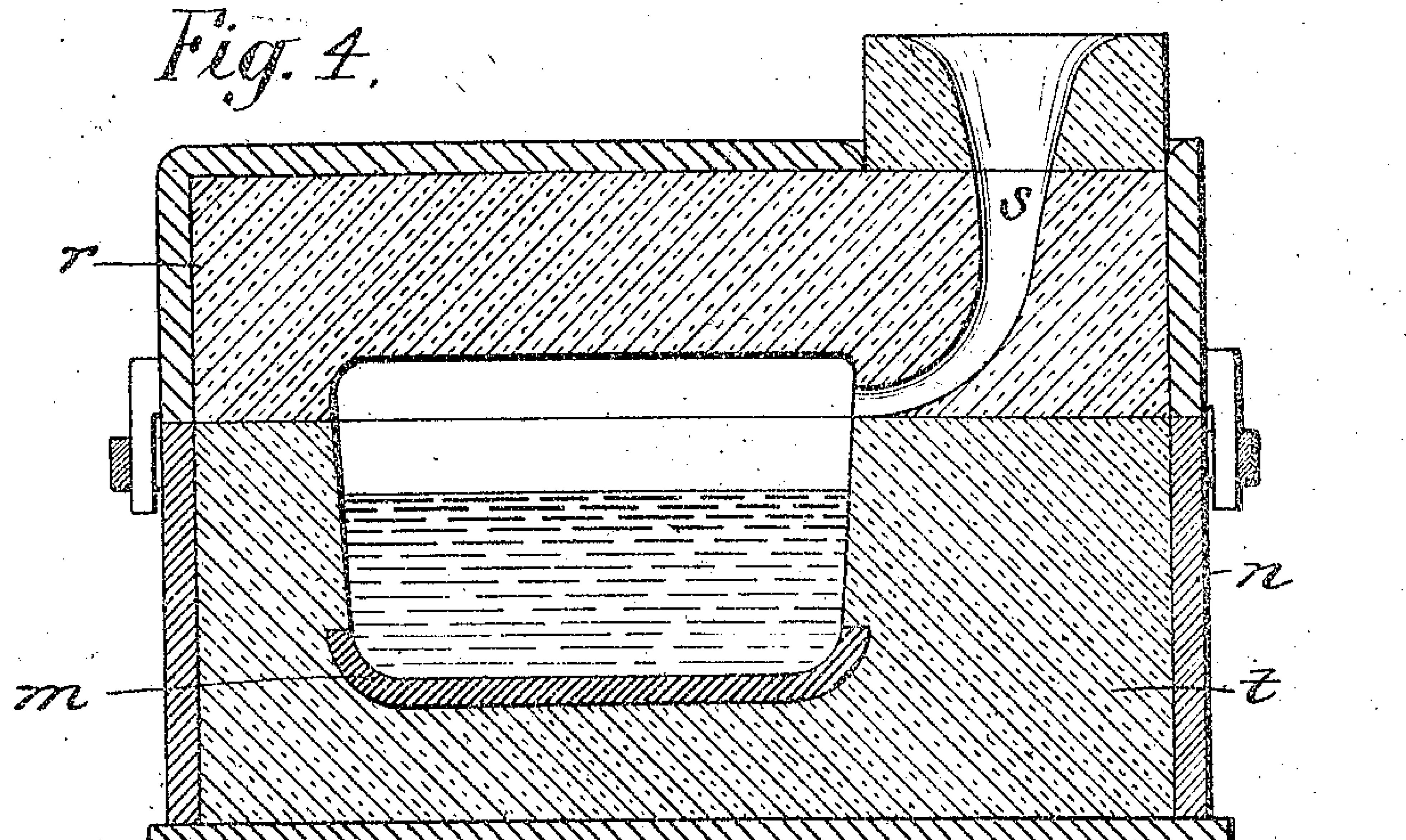


Fig. 4.



WITNESSES:
L. B. Benfield
L. H. Barlow

INVENTOR:
Winfield S. Potter
BY
Pennie & Goldsborough
ATTORNEYS

UNITED STATES PATENT OFFICE.

WINFIELD S. POTTER, OF NEW YORK, N. Y.

PRODUCTION OF CASTINGS.

967,830. Specification of Letters Patent. Patented Aug. 16, 1910.

Application filed December 17, 1909. Serial No. 533,569.

To all whom it may concern:

Be it known that I, Winfield S. Potter, a citizen of the United States, residing in the borough of Manhattan, city, county, and State of New York, have invented certain new and useful Improvements in the Production of Castings; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to the production of ingots, blanks and irregular shapes of metal by a casting operation of such a character that when the casting is removed from the mold in which it is formed it will possess the physical characteristics suitable for permitting it to be rolled, forged, hammered, pressed or otherwise formed to the desired finished shape without the necessity of a reheating operation. In realizing this purpose, the method of casting employed is of such a character as to substantially avoid irregularities of physical structure throughout the ingot, blank or irregular shape, especially in the outer portions thereof where they are otherwise liable to develop, and which are prejudicial to the subsequent forming or shaping operations, and also to substantially prevent segregation throughout the ingot, blank or irregular shape, thereby preserving corresponding homogeneity of composition and distribution of the constituent elements of the metal in the cast product.

In the practice of my invention, the casting metal is poured into the mold at a temperature but slightly above the freezing or setting point of the metal, in order that the freezing or setting of the metal may take place rapidly. Moreover, as the metal is poured into the mold, it comes in contact with mold surfaces of such a character as to exercise a chilling effect upon the exterior of the casting. The rapid freezing or setting of the metal, due to the relatively low temperature at which it enters the mold and due to the action of the chills is the feature upon which I rely to prevent segregation throughout the casting, as, for instance, when the metal poured is steel containing phosphorus and carbon, to avoid the segregation of those elements and to maintain them in the casting in substantially the distribution which they had in the molten metal as it enters the mold.

In realizing the advantage due to the substantial prevention of segregation in the casting, there is developed, by the action of the chills, a tendency to the formation, in the exterior portions of the casting and in proximity to its outer skin, of columnar or dendritic structures, which tendency, if not counteracted, would result in a cast product unsuitable, without reheating, for subsequent shaping and forming.

It is, therefore, a main characteristic feature of my invention to counteract the formation of these columnar or dendritic structures and to eliminate any which may have been temporarily formed, by permitting the casting to remain in the mold until the temperatures have been so redistributed throughout its mass that the conditions for the formation of such columnar or dendritic structures, or for their persistence in the casting, are removed. To this end, the high temperature prevailing in the interior of the casting, after the metal has frozen or set are gradually transmitted to the chilled portions to an extent sufficient for the purpose intended.

In practice, the redistribution of temperatures for the purpose intended may, in some instances, raise the temperature of the exterior portions of the casting to even a higher degree than is absolutely required for the elimination of columns or dendrites, but this will usually be found of advantage for the reason that frequently the exigencies of the mill require that the castings be held temporarily in reserve before they can be subjected to the shaping or forming operations and the extra heat of the castings can, therefore, be made available to keep them at the forming and shaping temperature during brief periods of delay. If particular circumstances involve such delay as would result in a drop in the temperature of the casting below the temperature necessary for the forming or shaping operation contemplated, they may be kept in storage or reserve in a soaking pit or the like so that they may not materially lose their casting heat. It will also be understood that if, at the temperature of issuance from the mold, the castings are too hot, for the forming or shaping operation intended, they may be cooled or permitted to cool until they shall have reached the desired shaping or forming heat.

In order that the conditions for the presence of the columnar or dendritic structures in the casting as it is delivered from the mold shall not exist, I further provide that the metal surfaces originally serving as chills shall likewise be raised in temperature while the casting is still in the mold until they are of substantially the same temperature as that which prevails, in the redistribution, in the portions of the casting where the columns or dendrites would otherwise develop; and, in order that this result may be effectively secured, I provide means for correspondingly limiting radiation from the metal chills outwardly.

It will be noted, therefore, that the underlying features of my invention embody (1) the avoidance of segregation in the casting, by the expedient of pouring the metal at a temperature but slightly above its freezing point and by causing it to set rapidly through the intermediacy of chills, and (2) the avoidance of columns or dendrites, by leaving the casting in the mold, until the high temperature prevailing in its interior shall have appropriately acted upon the outer zone in which the columns or dendrites would otherwise tend to develop, and until the chills themselves have been raised to the temperature necessary to permit this action and also by the high temperature of the chills, arresting or avoiding any further formation of irregular structures in the outer portions of the casting; with the final result that the casting, when removed from the mold, will have its temperatures so redistributed that the casting may be rolled, forged, hammered, pressed, or otherwise shaped, as desired, and without the necessity of any reheating operation whatsoever.

In the redistribution of temperatures contemplated by my invention in order to avoid the appearance, in the cast product, of columns or dendrites, a sufficient rise of temperature in the exterior portions of the casting is attained by maintaining such a ratio between the mass of the chills and the mass of the casting that the chills themselves will be brought to a temperature somewhat above that which is necessary for the avoidance of the columns or dendrites. In fact, as hereinbefore indicated, the redistribution of the temperatures may, in some instances, bring the exterior of the casting to a temperature higher than is suitable for the immediate action of the forming or shaping apparatus. In other words, in attaining the temperature necessary to avoid the presence of columns or dendrites in the product as it is delivered from the mold, the exterior portion of the casting may reach a higher heat, without disadvantage. In all cases, nevertheless, when the hot casting is to be subjected to the forming or shaping operation intended, precaution must be taken to correspondingly cool it if its temperature is too high.

In the case of steels, the temperature for the forming and shaping operations will vary within considerable limits; for instance, in the case of a manganese steel having say 12% of manganese and 1% of carbon, the shaping or forming temperature suitable for the outer portions of the casting will usually lie somewhere between 1100° C. and 1200° C. When the desired redistribution of temperatures has taken place throughout the casting, and when, therefore, the exterior portion has been brought to the condition contemplated for the avoidance of columns or dendrites, the casting, in its hot state, is removed from the mold and is either immediately or after suitable cooling, subjected to the forming or shaping operations intended, or, if it is necessary to hold the casting in reserve, it may be maintained in the heated condition for a shorter or longer period of time, as circumstances may require, in a suitable soaking pit or the like.

It will be understood that the conditions for successful rolling, forging, pressing or the like, do not require a homogeneous or uniform distribution of the heat throughout the ingot. On the contrary, the interior portions of the ingot, when removed from the mold, will usually be at temperatures only so far removed from the melting point of the metal as to provide the necessary cohesion to resist crushing during the shaping or forming operation, while the exterior portions will be at varyingly lower temperatures than the interior. The main considerations are the substantial avoidan[illegible] segregation and the practical absence of columns and dendrites; the absorption of a portion of the interior heat of the casting by the chilled outer portions, and the like absorption of a portion of such internal heat by the chills themselves sufficing to bring about all of the redistribution of heat that is required.

It will be understood that while my invention is particularly applicable to the making of castings from steels having high percentages of carbon, manganese, tungsten, nickel or the like, it is of general application to the making of castings from other metals, such as aluminum and its alloys, alloys of copper, etc., which are subject to segregation and to the formation of irregular feebly bonded structures of such a character as to require the casting to be reheated before subsequent working. In this connection, it may be appropriate to point out that where reheating is required to adapt the casting to a subsequent forming operation, the reheating is almost invariably accompanied by the formation of cracks or fissures in the dendritic structures and internal oxidation along the surfaces of such cracks or fissures. With some metals, the walls of the fissures are readily welded together during the subsequent working operations, while with other metals this is either impossible or only possible to a limited degree. In the practice of my invention, on the other hand, whatever the metal employed, the columnar or dendritic structures have practically disappeared by the time the casting is removed from the mold. Furthermore, there is an entire absence, in the castings produced in accordance with my invention, of the separating out from the metal of certain feebly cementing compounds which are present in the columnar or dendritic structures and which occupy therein the fissures or cracks referred to. In fact, it is one of the characteristic merits of my invention that these feebly cementing compounds, ordinarily separating out in the class of ingots requiring reheating, are reabsorbed and redistributed in the metal before the casting is removed from the mold.

I wish further to emphasize the fact that my invention is not confined to the production of ordinary mill castings such as ingots and blanks generally, but is applicable with corresponding advantage to the casting of what I have hereinbefore designated as irregular shapes, as, for instance, such shapes as car wheels, beveled gears and the like, cast approximately in the shape of the finished article and which are then to be worked under a hammer or press to the desired form in the shaping die and which may finally be subjected to subsequent heat treatment for hardening, annealing, or the like, as may be found desirable.

It is characteristic of my invention and especially to be considered from the commercial standpoint, that not only is the casting as it is delivered from the mold adapted to be subjected to the subsequent forming or shaping operation desired, and that it is substantially devoid of dendrites and has set without segregation of its phosphorus, carbon or the like, and that reabsorption and redistribution of the compounds which form or tend to form in the dendritic structures, have occurred during the period of heat distribution, but also that the casting has been brought to this condition in a single heat, by redistribution of its own temperatures, and in a correspondingly short period of time, which, in many cases, will be at most but one fourth of the time necessary for the usual operations of casting and reheating. Accordingly, a mill equipped with my invention will have a correspondingly high capacity, inasmuch as the finished castings, ready for the forming or shaping operation, can be produced rapidly and in amount sufficient to insure a constant supply for a shaping and forming plant of large output.

In order to illustrate the scope and purpose of my invention by specific or typical instances of means for putting it into effect, I have shown, in the accompanying drawings, its application to the production respectively of a vertical ingot and of an ingot of a slab-like configuration. It will be understood, however, that the particular illustrations chosen are designed to serve merely as instances of many others, included within the range of the invention as has been hereinbefore indicated and as will appear further on in the specification and in the appended claims.

In the drawings, Figure 1 represents a vertical sectional view of mold apparatus suitable for producing a vertical ingot in accordance with my invention. Fig. 2 represents a cross-sectional view thereof taken on a plane indicated by the line 2—2 of Fig. 1. Figs. 3 and 4 represent respectively vertical sections at right angles to each other of mold apparatus for casting a horizontal or slab-like ingot in accordance with my invention.

Referring to the drawings and particularly to Figs. 1 and 2 thereof, the mold proper consists of a bottom piece *a* of metal and side walls *b* likewise of metal, which side walls support an upper section or casing *c* fitted over them and which is provided with a refractory lining *d*, of fire brick or the like. The bottom *a* and side walls *b* of the mold are intended to act, in the first instance, as chills, for the purpose of causing the casting metal as it is poured into the mold to freeze or set rapidly, in such manner as to prevent segregation of the phosphorus, carbon, or like segregable elements, as the case may be. To this end, the mass of the chill bottom *a* and chill sides *b* is appropriately proportioned to the temperature of the casting metal and the volume which it occupies in the mold, and the casting metal is poured at a temperature but slightly above that of its freezing or setting point, so that the freezing or setting of the ingot will proceed with the required promptness up to the point represented by the brick-lined casing *c*, where the metal will remain temporarily liquid so that any cavities produced below by the setting operation may be fed and filled from the liquid head thus provided. In order that the casting, as it comes from the mold, shall be devoid of any of the irregular, dendritic or columnar structures hereinbefore referred to, I establish adjacent to the outer surfaces of the metal chills, as they may be called, (*i. e.*, the metal sides and the metal bottom of the mold), a body of material which is but a slow conductor of heat. Thus, for the metal bottom a I may employ a subjacent pad or filling e of dry sand or asbestos set in a recess in the foundation plate or base A of the apparatus and I may employ a like filling f, of dry sand or asbestos, in the annular space between the side walls of the mold and an outlying jacket g. The thickness and heat absorbing capacity of the walls b and of the bottom a of the mold are so established that only the proper amount of heat is abstracted during the pouring of the metal to cause the mass of casting to freeze or set promptly, leaving out of consideration the metal within the brick lined casing c which remains temporarily liquid to supply piping cavities. Radiation from the ends of the annular space between the mold proper and the jacket g may be minimized and accidental intrusion of liquid metal between the inner and outer walls of the mold may be avoided by building up an annular mound h of fire clay or the like above said annular space. The dry sand filling f rests upon a ledge i attached to the inner lower edge of the jacket g, and the mold walls b are provided with a band k with which are adapted to engage suitable lifting lugs l upon the inner surface of the jacket and the jacket is provided with bails m'. By this arrangement it is feasible to readily strip the mold from the cast ingot without losing any material part of the sand envelop f.

The chill walls b of the mold can be observed through sight tube openings provided for the purpose, at various places, or their temperature can be otherwise determined, and when that temperature has risen to the degree required, the mold is to be stripped from the ingot, which may then be formed or shaped, as desired, either immediately, or after cooling somewhat, as may be most expedient, or after being held in reserve in a soaking pit.

In Figs. 3 and 4, which illustrate the production of a flat or horizontal casting in accordance with my invention, the chill surface of metal m is contained is the main body portion n of the mold, which is provided with a cope r having a pouring gate s, through which the pouring metal enters the mold for the casting. As before, the pouring metal is preferably cast at a temperature but slightly above its freezing or setting point, and the casting sets rapidly by reason of this low temperature of the metal, together with the cooling or chilling action of the plate m. The redistribution of temperatures hereinbefore contemplated is effected while the metal is still in the mold. Radiation of heat is minimized by the nonconducting material t forming the sides of the mold cavity and underlying the chill plate m, and the latter is reheated by transmission of the temperature of the interior of the casting until it attains a heat sufficient to eliminate the dendritic or columnar structures adjacent to the outer skin of the casting; whereupon, as in the vertical casting or ingot, the horizontal or slablike ingot is ready for removal from the mold and is adapted to be subjected to the shaping or forming operation intended. It will be further noted, as characteristic of the practice of the invention, that when the ingot or other casting is ready for removal from the mold, it will have a substantially continuous grain-like structure throughout and will have a plastic interior and a strong, tough exterior. It is also a feature of the invention that it presents means for producing, without reheating, ingots or castings which are sound, inasmuch as by retaining the casting in the mold at such a temperature in its outer portion that it can be shaped or formed, and by having the upper portion at a higher temperature, any piping cavities or the like which may develop as the metal sets can be filled in with liquid metal until the upper portions themselves in which these cavities exist shall have become solid and continuous. To further this filling in operation, metal at a relatively high heat may be at hand for filling in the top of the casting, which metal may readily be brought to the desired temperature in an electric furnace, or other like furnace operating at high temperatures.

Having thus described my invention, what I claim is:

1. The method of producing mold castings suitable, without reheating, to be subjected to shaping and forming operations, which consists in pouring the casting metal at a temperature but slightly above its freezing or setting point, chill-cooling the outer portions of the casting so as to assist in causing the casting to set rapidly, and then restricting the flow of heat from the chills until the chilled zone has been brought to a temperature necessary to remove freezing structures by the outward flow of heat from the interior of the casting; substantially as described.

2. The method of producing mold castings suitable, without reheating, to be subjected to shaping and forming operations, which consists in pouring the casting metal at a temperature slightly above its freezing or setting point, chill-cooling the outer surfaces of the casting so as to assist in causing the casting to set rapidly, then, by transmission of heat from its interior, raising the temperature of the exterior chilled zone of the casting so as to remove objectionable freezing structures and to bring the casting to a condition suitable for the shaping or forming operation intended, and simultaneously raising the temperature of the chills until their inner surfaces are likewise

brought to the degree of heat required for the reconstruction of the exterior zone of the casting; substantially as described.

3. In the production of mold castings, the method of bringing the casting to a condition suitable for shaping or forming operations, which consists in chill-cooling the outer portions of the casting so as to cause the casting to set rapidly, and restricting the flow of heat from the chills until the chilled zone has been brought to the temperature necessary to remove objectionable freezing structures by the outward flow of heat from the interior of the casting; substantially as described.

4. In the production of mold castings, the method of bringing the casting to a condition suitable for shaping or forming operations, which consists in chill-cooling the outer portions of the casting so as to cause the casting to set rapidly, and then by transmission of heat from its interior, raising the temperature of the exterior chilled zone of the casting until objectionable freezing structures are eliminated and the casting is brought to a condition suitable for the shaping or forming operation intended, and simultaneously restricting radiation from the chills until their inner surfaces are brought to the temperature desired for the surface of the casting; substantially as described.

5. In the production of mold castings and the subsequent shaping or forming thereof, the method of practically avoiding dendritic structures in the final products, which consists in so proportioning the heat absorbing capacity of the walls of the mold to the amount of heat to be abstracted from the casting, that the outward flow of heat taking place in the casting from the interior to the outer portions thereof before its removal from the mold shall substantially eliminate any dendrites which may have formed, and finally removing the casting from the mold and subjecting it to the shaping or forming operation intended, while the temperature in its outer portions is still sufficiently high to afford the desired ductility; substantially as described.

6. The method of producing mold castings of manganese steel in the condition adapting them for shaping or forming operations, which consists in pouring the metal in a mold, chill-cooling the outer portions of the casting so as to assist in causing the casting to set rapidly, and reheating the exterior chilled zone, while the casting is still in the mold, to a temperature above that at which the dendrites and other objectionable freezing structures will be eliminated; substantially as described.

7. The method of producing mold castings of manganese steel in the condition adapting them for shaping or forming operations, which consists in pouring into a mold manganese steel containing about 12 per cent. of manganese and about 1.10 per cent. of carbon, chill-cooling the outer portions of the casting so as to assist in causing the casting to set rapidly, and reheating the exterior chilled zone, while the casting is still in the mold, to a temperature above that at which the dendrites and other objectionable freezing structures will be eliminated; substantially as described.

8. The method of producing mold castings of manganese steel in a condition adapting them for shaping or forming operations, which consist in pouring the metal in a mold, chill-cooling the outer surfaces of the casting so as to assist in causing the casting to set rapidly and so proportioning the heat absorbing capacity of the walls of the mold to the amount of heat to be abstracted from the casting, that the outward flow of heat taking place in the casting from the interior to the outer portions thereof, before its removal from the mold, shall substantially eliminate any dendrites which may have formed, and finally removing the casting from the mold and subjecting it to the shaping or forming operation intended, while the temperature in its outer portions is still sufficiently high to afford the ductility necessary for shaping or forming; substantially as described.

In testimony whereof I affix my signature, in presence of two witnesses.

WINFIELD S. POTTER.

Witnesses:
JOHN C. PENNIE,
LAURA B. PENFIELD.