Aug. 16, 1938. A. J. PHILLIPS 2,126,808

APPARATUS FOR CASTING METAL

Original Filed April 24, 1935

Fig. 1

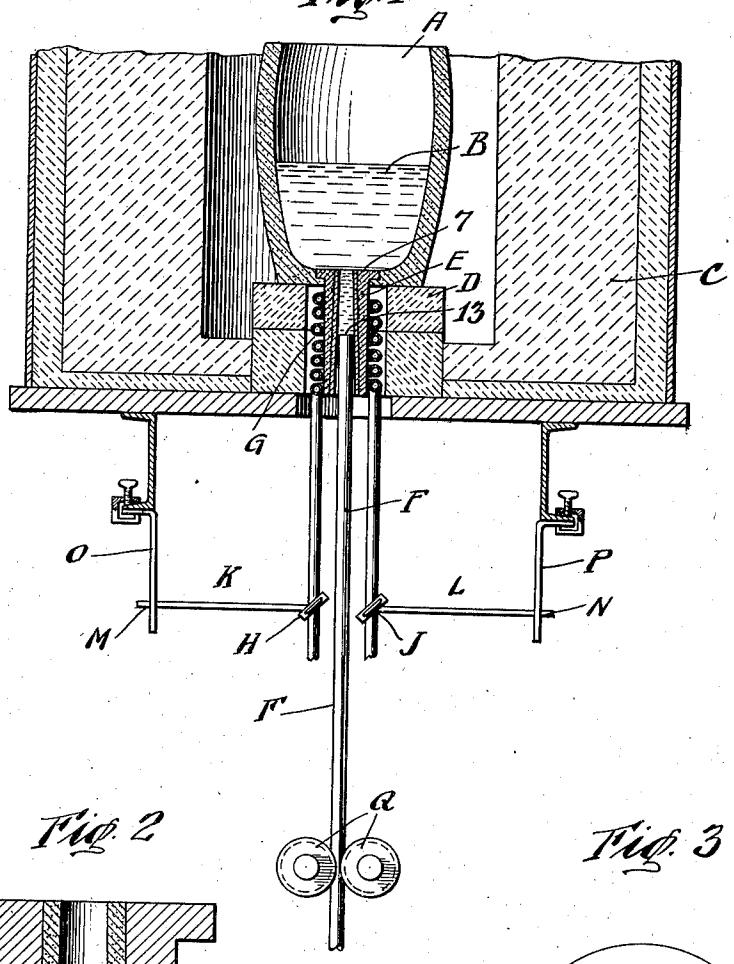


Fig. 2

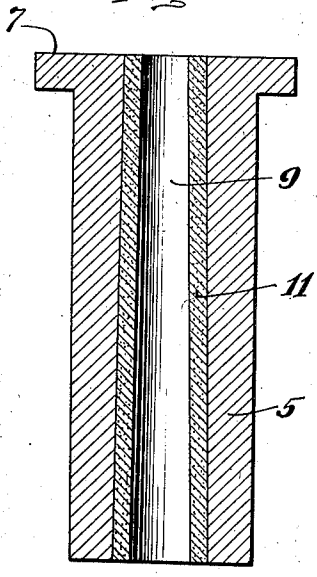
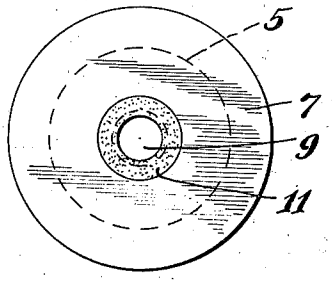


Fig. 3



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APPARATUS FOR CASTING METAL

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10 Claims. (Cl. 22—57.2)

This invention relates to the so-called "continuous casting" of metals.

It is known that metal shapes may be cast in a substantially continuous manner by leading molten metal, for instance copper, from a suitable supply thereof into a mold or die, defining a forming chamber, having congealed metal in one end to serve as starting metal and acting as a plug for the mold or die, so that the adjacent molten metal becomes welded to the congealed starting metal, and in turn becomes congealed in the die or mold, as the starting metal is withdrawn therefrom. When the rate of such removal is substantially equal to the rate of congelation of the molten metal in the die, there is produced a continuous formation of the metal shapes.

The operation, however, is attended with certain difficulties which act to cause fractures in the metal shapes, or imperfections in the surface of the metal. These difficulties apparently have their origin largely within the die, arising from the condition of the surface of the die engaged by the metal, the friction of the metal in the die, the degree of wetting of the die by the metal, and other factors.

Thus it has been found that the surface of the die contacted by the metal should be highly polished, perfectly smooth, and non-porous; that the area of contact between the congealed metal and the die should be maintained at the minimum; that the die material must have sufficient heat conductivity to assure sufficient cooling of the metal within the die limits to effect congelation of the metal in the die; that the die does not bind the metal to it; that the die possess sufficient refractoriness to resist entirely deformation at the temperatures and loads employed during operation.

Summarizing above considerations, it will be understood generally that in the continuous casting of metal, e. g. copper, a die or mold is used within which the metal solidifies. The solidified copper, or other metal, is removed continuously from the bottom or end of this die or mold, the liquid copper continuously flowing into the top or inlet end of the mold. In order to permit the extraction of the solidified metal, the surface of the die or mold must be very smooth so that friction of the rather fragile newly solidified metal will be at the minimum. However, in order to permit the solidification of the copper at a reasonably rapid rate, it is essential that the heat be extracted at the point of solidification. Consequently, it is essential that heat be extracted through the die or mold and that the die or mold be so constructed as to permit this heat extraction. Such materials as graphite or carborundum are satisfactory in permitting a rapid heat extraction but it is difficult to prepare such materials with a surface sufficiently smooth and durable to permit the removal of the metal in a satisfactory manner, especially with regard to the length of life of the die.

On the other hand, materials such as fused quartz can be prepared with a satisfactory surface more readily than can graphite, which tends to rather rapidly wear away in service, or carborundum which is difficult to machine and polish to the required degree of smoothness; but on the other hand, quartz does not possess sufficient thermal conductivity to permit satisfactory extraction of heat.

The present invention provides a die which will combine the above indicated advantage while eliminating the disadvantages.

In accordance with the present invention, there is provided a die of a black body thermal conducting member such as carborundum or graphite a smooth surfaced inner member, such as clear fused quartz, which is transparent to heat waves, this providing a smooth surface within which the copper or other metal solidifies. The use of the clear fused quartz in contact with the copper permits the hot copper to radiate heat at a rapid rate to the black body member which completely surrounds the quartz sleeve. This radiated heat is absorbed by the black body member which converts it to sensible heat in which form it is removed by any suitable means, such as water-cooling.

Instead of quartz, a heat conducting glaze baked on the inner surface of the carborundum or graphite die may be used.

In the accompanying drawing,

Fig. 1 represents a general sectional elevation of one form of apparatus used for the continuous casting of metals, the view incorporating a die of the general construction of the improved die.

Fig. 2 is a vertical sectional view of the improved die, illustrating details of construction thereof.

Fig. 3 is a plan view of the die of Fig. 2.

Referring more particularly to the drawing, A indicates a suitable container for a supply of molten metal B, such as copper, the container or reservoir A being shown positioned in a heating chamber or furnace C, which is heated in any convenient manner to a temperature sufficient

to maintain the body of metal B thoroughly molten.

The reservoir A is shown in Fig. 1 as being mounted on refractory tiling D, the reservoir A being shown as provided with a die or mold E into which molten metal is led from the reservoir A, and wherein the metal solidifies and from which the cast metal is withdrawn, as indicated at F. In order to assure satisfactory solidification of the metal B in the die E, the die is surrounded by a cooling coil G, which is adjustably held in position by clamps H and J, secured to rods K and L, which are adjustably secured, at M and N to rods O and P, which in turn are secured to the supporting frame for the furnace.

The present invention is concerned principally with the construction of the die E, and reference may be had to Figs. 2 and 3 for the detailed showing of this construction.

As mentioned above, the die of the present invention comprises a black body of heat conducting material such as graphite or carborundum, this black body being provided with a bore defining a congealing chamber for the molten metal. This bore is surrounded by a smooth-surfaced lining, which is transparent to heat waves, and which allows the same to pass from the molten metal being congealed into the black body, in which they are absorbed, and from which the heat is extracted by the cooling coil G which is in heat interchange relation with the black body of the die.

This construction will be clear from Fig. 2, wherein the black body of graphite or carborundum, making up the die E, is designated at 5. At one end of the die is the collar 7, this collar forming the inlet end by which the die is mounted and held in the reservoir A. The die is bored axially as indicated at 9, this bore being tapered from the inlet end sufficiently to maintain the minimum contact with the congealed metal, as will be explained more fully hereinafter.

Surrounding the bore 9 is the lining 11 of clear fused quartz, which lining is produced by lining the bore 9 with pure silica and fusing the same until a uniform layer of the quartz is produced. This layer is reamed with emery powder until it becomes perfectly smooth and polished and the bore 9 becomes of the desired size and taper.

The resulting die presents a perfectly smooth, non-porous surface to the metal being cast, and enables the rapid withdrawal of heat from the metal. Further, the character of the quartz or glaze lining is such that it will enable the congealed metal to be withdrawn readily from the die, the hardness of this lining, coupled with its smoothness of surface, substantially prolonging the life of the die.

In operating, the die is mounted in position in the reservoir A so that the end of the die preferably is substantially flush with the inside surface of the reservoir. The cooling coil G is adjusted into position around the die, and a starting rod is inserted in the die as far as is desired for the position of the congelation level of the metal. The starting rod is positioned also between the rolls Q, which are driven from any suitable source of power, not shown, and which control the withdrawal of the metal from the die.

The reservoir A is brought up to a temperature sufficient to assure that the metal being cast, for example, copper, is maintained molten and sufficiently hot so that the abstraction of heat through the die by the action of the cooling coil will not cause freezing of the metal in the reservoir above the die, which would prevent withdrawal of the metal from the die, as will be obvious; and also, so that the position of congelation of the metal in the die will be within the limits of the die enclosed by the cooling coil, thereby abstracting heat mainly through the die instead of mainly through the cast metal, and maintaining a sharp freezing line, as indicated at 13, in Fig. 1. The taper of the bore 9 is such that virtually the only contact between the solidified metal and the quartz lining 11 is at the line of freezing 13. Therefore, the friction between the die E and the solidified metal being withdrawn is reduced to the lowest possible level.

The term "black body" and "dark body" as used in the description and the claims refers to the absorption and non-transmittal or reflection of heat in a manner similar to the absorption of the major portion of all light waves by a "dark" or "black" body, the more complete the absorption the "blacker" the body. In the present instance, the sleeve of dark or black material, for example, graphite, rapidly absorbs heat, while the clear or transparent lining rapidly transmits heat. This arrangement results in the removal of the heat from the metal being cast rapidly through the die itself, the dark graphite sleeve very rapidly absorbing the heat from the transparent lining, and the water jacket surrounding the graphite sleeve extracting the heat rapidly from the dark lining. The high heat capacity of the graphite sleeve causes the heat to travel directly through the die, rather than through the cast metal, with the result that there is rapid cooling of the metal in the die by the transmission of heat therefrom through the die itself.

What is claimed is:

1. A die for casting metals, which comprises a dark body having a bore therethrough, and a lining of material transparent to heat waves, surrounding the bore, whereby heat from molten metal in the die is rapidly transferred to the dark body to produce congelation of the molten metal in the die.

2. A die for casting metals, which comprises a dark body having a bore therethrough and a lining of fused clear quartz enclosing the bore, whereby heat from molten metal in the die is rapidly transferred to the dark body to produce congelation of the molten metal in the die, the said bore being tapered uniformly sufficiently to prevent substantial contact of congealed metal therewith other than at the position of solidification of the molten metal.

3. A die for casting metals which comprises a graphite body having a bore therethrough, and a lining of fused quartz enclosing the bore and adapted to be contacted with metal in the bore.

4. A die for casting metals which comprises a graphite body having a bore therethrough and a lining of fused glaze surrounding the bore, the said glaze being transparent to heat waves for effecting rapid transfer of heat to the graphite body.

5. A die for casting metals which comprises a carborundum body having a bore extending axially therethrough, and a lining of fused quartz surrounding the bore for transferring heat from metal engaging the lining to the carborundum body.

6. A die for casting metals which comprises a dark refractory body, such as graphite or carborundum, having a bore extending therethrough, and a lining of fused quartz for the said dark

refractory body, the said lining enclosing the bore and having its surface highly smoothed and polished and free from irregularities, the said bore being uniformly tapered throughout its length.

7. Apparatus for casting metals which comprises in combination, a die comprising a dark refractory body, such as graphite or carborundum, having a bore extending therethrough, and a lining of fused quartz for the said dark, refractory body, the said lining enclosing the bore and having its surface highly smoothed and polished and free from irregularities, the said bore being uniformly tapered throughout its length, and means for cooling the die, the said means being in heat exchange position relative to the dark body.

8. Apparatus for casting metals which comprises, in combination, a die comprising a dark refractory body having a bore extending therethrough defining a congealing chamber for molten metal, the said bore being enclosed in a layer of fused clear quartz forming a lining for the dark body, a cooling coil surrounding the dark body in heat exchange position relative thereto, and means for adjusting the cooling coil relatively to the said dark body.

9. Apparatus for casting metals, comprising the combination with a reservoir for containing molten metal, of a die associated with the reservoir and adapted to receive molten metal therefrom, the said die comprising a dark refractory body having a liner therefor transparent to the passage of heat waves, and cooling means enclosing the die for effecting solidification of molten metal in the die.

10. Apparatus for casting metals comprising the combination with a reservoir for containing molten metal, of a die associated with the reservoir and adapted to receive molten metal therefrom, the said die comprising a graphite body having a liner therefor of fused quartz, and cooling means enclosing the die for effecting solidification of molten metal in the die.

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