May 20, 1941. B. E. ELDRED 2,242,350

CONTINUOUS CASTING OF METAL SHAPES

Filed Oct. 6, 1938

Fig. 1.

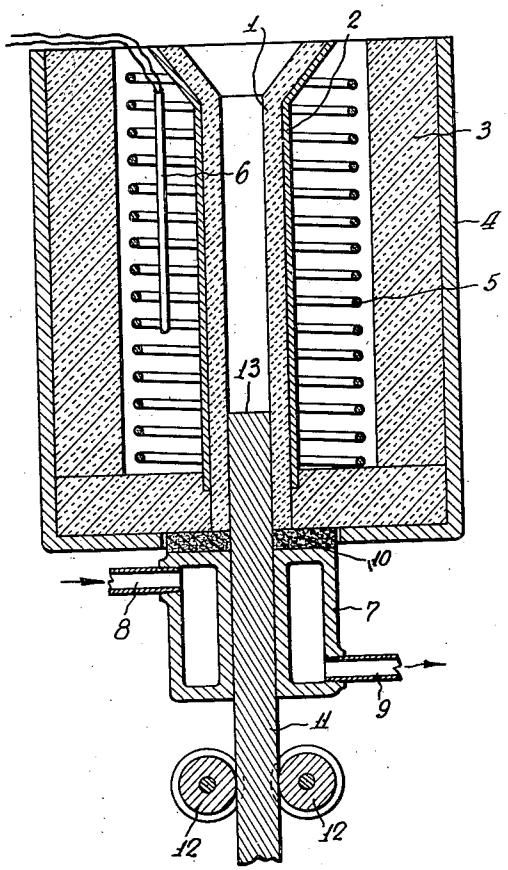
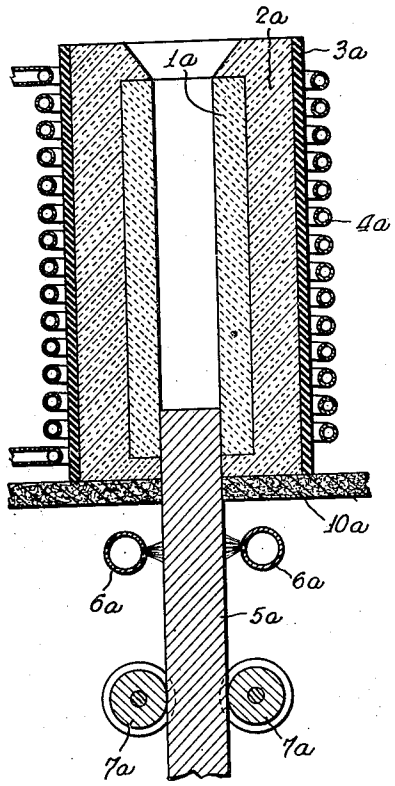


Fig. 2.



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CONTINUOUS CASTING OF METAL SHAPES

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3 Claims. (Cl. 22—200.1)

This invention relates to the continuous casting of metals, where fluid metal is supplied to one end of an open ended mold, progressively chilled therein, and withdrawn from the opposite end of the mold as a congealed shape.

The present application is a continuation in part of my co-pending application Ser. No. 46,884, filed October 26, 1935, which describes the method of casting in an open ended mold wherein the fluid metal as it is advanced through the mold, is caused to progressivly lose substantially all of its superheat and then its latent heat in separate paths of heat flow.

Metal will not freeze until its superheat has been dissipated; and the main object of the present invention is to so control the removal of superheat from the fluid metal as it advances in the mold, that a constant supply of metal substantially free of superheat shall be presented to the zone in the mold where latent heat is developed and removed, thus causing the metal to freeze continuously under maintained conditions of heat removal.

Another object is to control the rate of superheat removal in point of time, so that for any predetermined speed of travel of the metal in the mold, the superheat only shall be dissipated from the metal in advance of the maintained freezing zone.

The freezing characteristics of different metals and metal mixtures vary greatly and generally speaking the quantity of superheat is small as compared with the latent heat to be removed in the casting operation.

For example, in the case of the single metal copper, 40° F. superheat represents roughly 4 B. t. u. per pound to be removed to prepare the metal to freeze, whereas the latent heat for freezing represents 90 B. t. u. The problem thus presented is the progressive removal of but 4 B. t. u.'s in advance of the freezing zone, while 90 B. t. u.'s are being removed, in timed relationship, from a like quantity of metal, to maintain continuous freezing.

The fluid metal in the mold must, therefore, be prepared to freeze by very slow chilling or removal of its superheat, or when such superheat is dissipated further heat loss must be prevented until it progresses to the freezing zone where heat removal must proceed at a high rate, depending upon the rate of casting maintained.

The present invention includes regulating and restricting the outward flow of superheat from the fluid metal, by means of a novel heat-flow valve arrangement. This consists of heating means interposed between the mold member and any natural or suitably disposed fixed temperature outer heat dissipating terminal. This heating means is regulated to supply all or any desired part of the normal radiation loss from the mold containing the liquid metal. The heating means is preferably an electric heater; and this, when controlled thermostatically, or otherwise supplied with current input to balance and regulate radiation loss from the mold for any set of established conditions of temperature and quantity of metal supply, provides an exceedingly close regulation and permits of casting speeds not heretofore possible in draw casting, having regard for the quality of the metal cast.

Referring to the drawing:

Fig. 1 is a schematic axial sectional view of a mold with an electrical resistance, suitable for casting copper, aluminum and their alloys;

Fig. 2 is a similar view showing a mold arrangement for higher melting metals and metal mixtures.

For the purposes of the claims, metals whose melting points are at least substantially equal to the melting point of aluminum are designated as high-melting-point metals.

Fig. 1 shows a mold 1 of graphite, or other refractory, suitable for the metal to be cast. This has a chrome steel casing 2 surrounding the mold as a protection against possible breaking of the mold, and to otherwise protect and sustain it. This is surrounded by the usual heat insulating material 3, in outer shell 4. A heating element 5 is located in the intervening cylindrical space. A thermocouple 6 operates through well known control means to regulate the current input to the heating element 5, thus maintaining the temperature surrounding the mold at a constant level; and, with a sufficiently long die, this temperature may be at the melting point of the metal to be cast. Thus the natural radiation from the mold to the air which surrounds insulating shell 3, is accurately controlled. Chilling means for freezing the metal, may be a cooling chamber 7 with inlet 8 and outlet 9 for the flow of any desired chilling fluid. The chilling means 7 is insulated from the lower end of mold 1 by a plate 10 of cement-asbestos material, preferably "transite." 11 indicates the formed casting, and 12 a pair of pull-out rolls therefor.

The above arrangement may be used as shown, by pouring metal into mold 1, or it may be directly connected to a furnace chamber containing a reserve of metal. The axis of the mold may be vertical, horizontal, or at any desired inclination.

An arbitrary boundary line between fluid and solid metal is shown at 13; but this freezing zone will vary in position according to speed of withdrawal of the casting. It should be borne in mind that the speed of withdrawal provides for superheat entering the mold by convection, and likewise for the removal of heat by convection, at the opposite end of the mold.

With suitably maintained conditions, and a sufficiently long mold, the freezing will take place well in advance of the chilling member 7 and the casting, if of a suitable metal or metal mixture, will be comprised of long macro crystals orientated longitudinally of the casting. With a short die the crystallization will proceed necessarily in a more or less radial direction.

Fig. 2 is another mold arrangement wherein the mold 1*a* is surrounded with a suitable heat insulation 2*a* which in turn is surrounded by electrical insulation 3*a*. A water cooled coil 4*a* serves the dual purpose of a conductor for a high frequency electrical current which maintains the mold wall or the metal therein at the desired temperature by induced current therein; and likewise serves as a fixed temperature outer terminal for accumulating and dissipating heat from within its confines. 5*a* illustrates the issuing casting cooled by any suitable means, a water spray 6*a* being here shown as a means readily adapted to a horizontal die arrangement of the mold. A pair of pull-out rolls 7*a*, 7*a* advance the casting and fluid metal in the mold.

The terms superheat and latent heat are used herein in their broad accepted sense. Superheat as used signifies the heat content of any metal or metal mixture contained to raise its temperature after it is completely molten and latent heat is that heat evolved by the metal congealing during its change in state from liquid to solid.

I claim:

1. A method of regulating the rate of chilling of a body of molten high-melting-point metal in motion in a mold which is in outward heat flow relation with a lower-temperature heat-dissipating terminal, which method includes interposing heat in the path of said normal outward flow of heat from the metal, and regulating the amount of said interposed heat to decrease the outward flow of heat from the metal sufficiently to maintain any desired length of said molten metal substantially at congealing temperature, ready for solidifying substantially without change of temperature.

2. A method of continuously casting a body of high-melting-point metal in a heat-conducting mold which has an inlet end and an outlet end, which includes advancing said high-melting-point metal in said mold towards said outlet end while said metal is in molten condition, diminishing the outflow of heat from said mold and from said metal therein to a lower-temperature heat-dissipating zone which is outwardly spaced from said mold so that said outflow of heat is less than the outflow of heat through the atmosphere, also supplying heat in the path of said outflow of heat from said metal in the mold to said outwardly spaced heat-dissipating zone, and regulating the amount of such interposed supplied heat so as to maintain a desired length of said molten metal at or close to the congealing temperature.

3. In the art of continuously casting high-melting-point metal in a heat-conducting mold which has an inlet end and an outlet end and while congealing the metal before it leaves the outlet end of said mold in a congealing zone which is adjacent said outlet end, those steps which consist in advancing superheated and molten high-melting-point metal in said mold towards said outlet end, dissipating the superheat of said superheated molten metal through the wall of said mold, controlling the rate of heat removal of said superheat by supplying regulated heat in the path of flow of heat of said superheated molten metal out of the mold so as to withdraw substantially all of the superheat through the wall of the mold, and removing the latent heat of said molten metal so as to congeal the same in said congealing zone, by removing said latent heat through the surface of the last congealed metal which is in contact with said molten metal.

BYRON E. ELDRED.