May 9, 1939. K. A. LINDNER 2,157,550

APPARATUS FOR CASTING METALS

Filed July 19, 1935 4 Sheets-Sheet 1

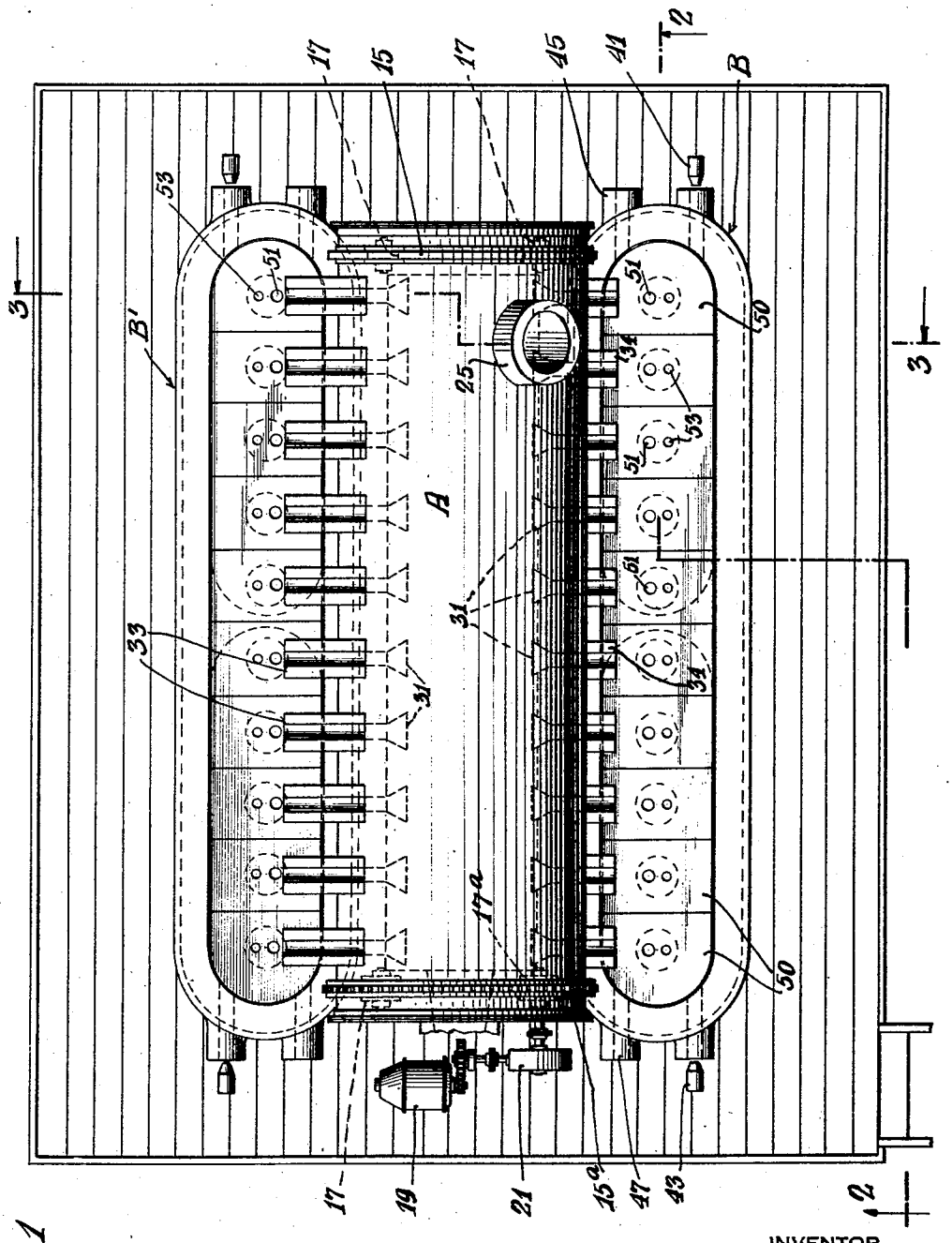


Fig. 1

INVENTOR
Karl A. Lindner
BY
James K. Kent
ATTORNEY

May 9, 1939. K. A. LINDNER 2,157,550

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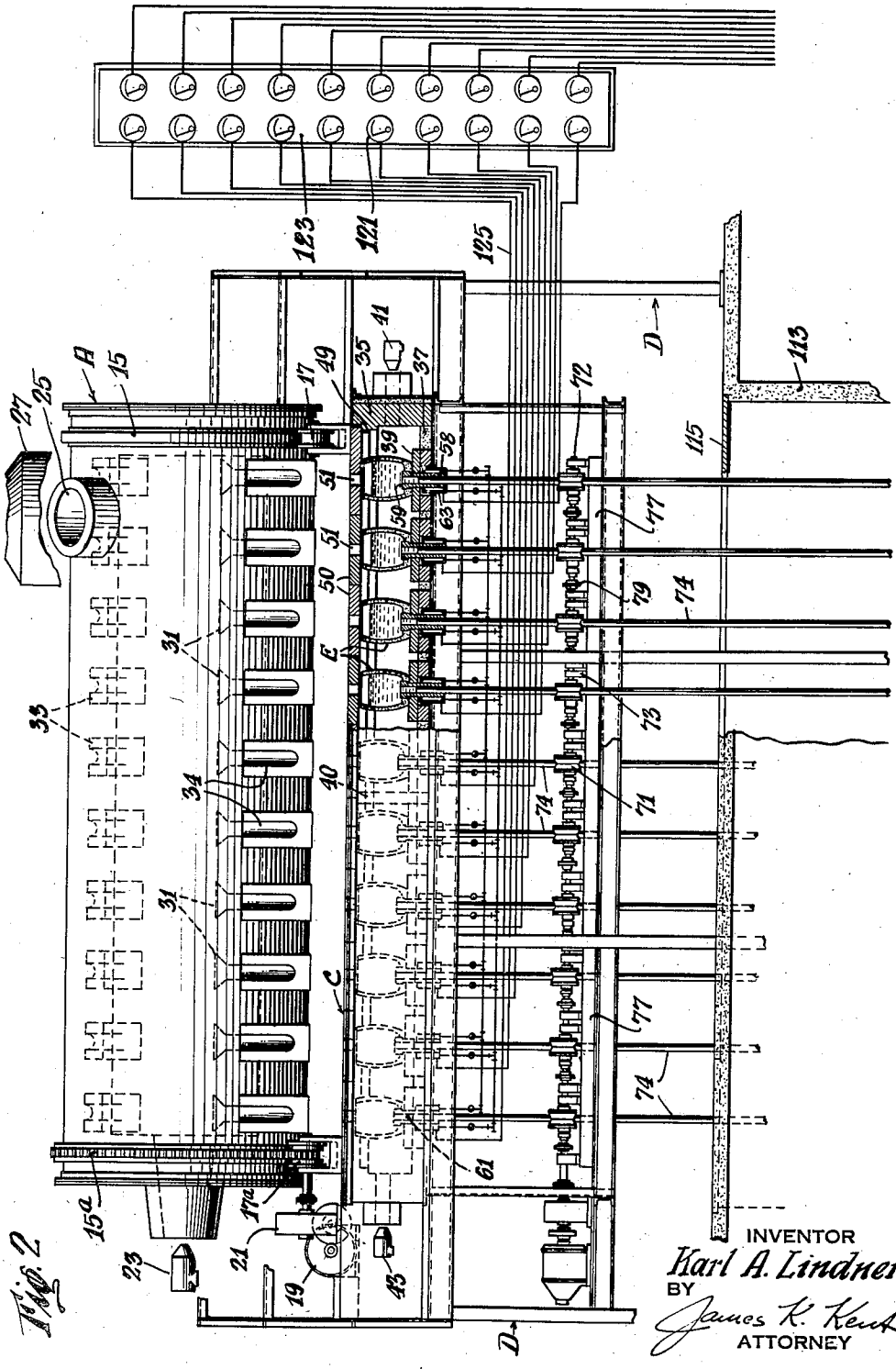


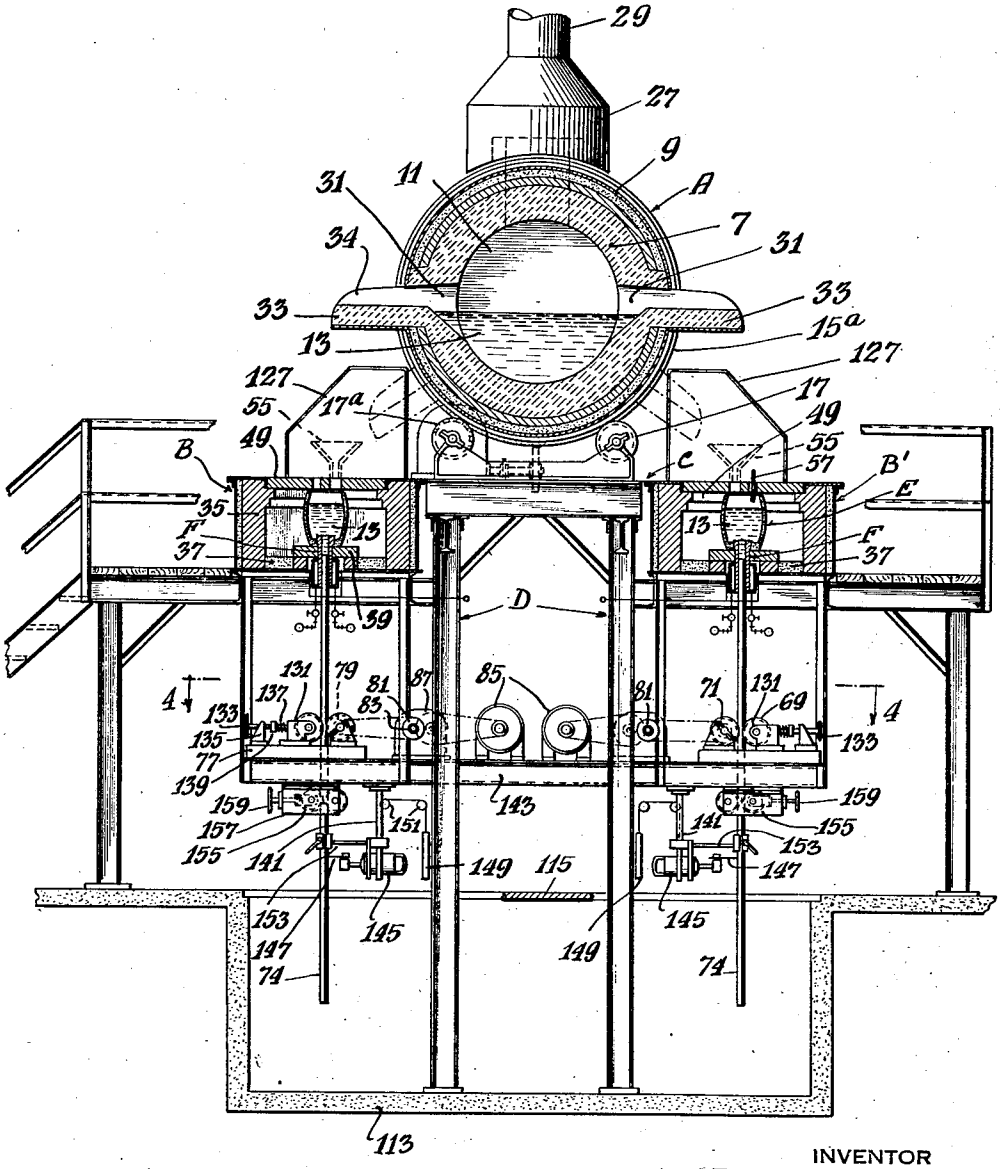
Fig. 2

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Fig. 3



INVENTOR
Karl A. Lindner
BY
James K. Kent
ATTORNEY

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APPARATUS FOR CASTING METALS

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Fig. 4

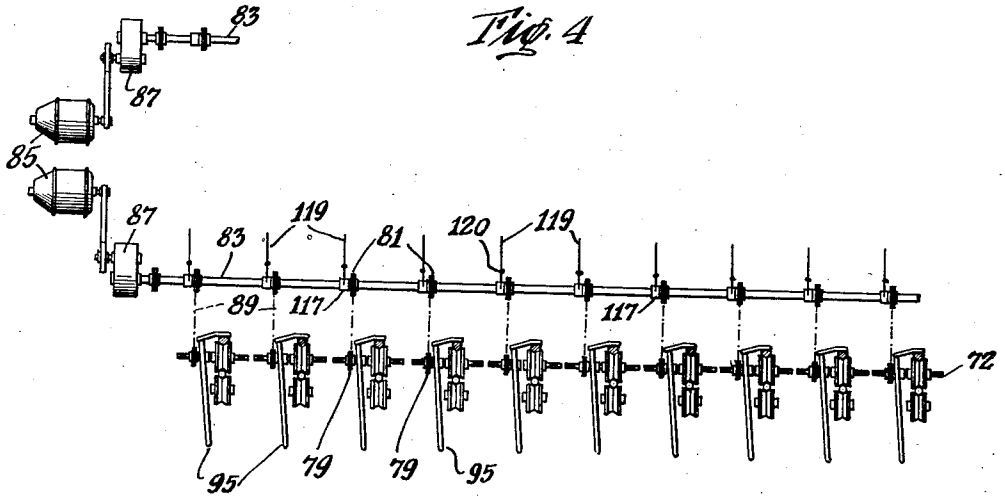


Fig. 5

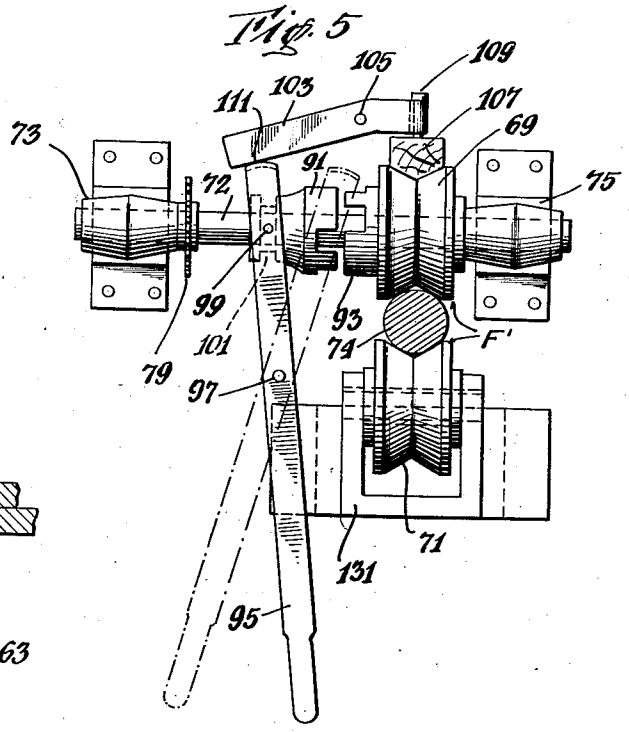
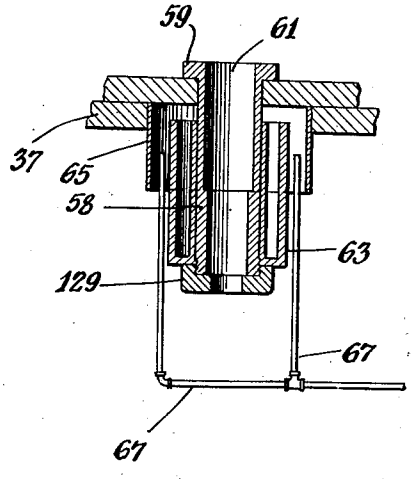


Fig. 6



INVENTOR
Karl A. Lindner
BY
James K. Kent
ATTORNEY

Patented May 9, 1939 2,157,550

UNITED STATES PATENT OFFICE

2,157,550

APPARATUS FOR CASTING METALS

Karl A. Lindner, Rahway, N. J.

Application July 19, 1935, Serial No. 32,212

11 Claims. (Cl. 22—57.2)

The present invention provides an improved process and apparatus for producing, in a continuous manner, cast shapes of metal such as copper and copper-base alloys, in which shapes the copper is characterized by its high density, freedom from porosity, included oxide and gases.

In the production of such shapes, the operation may be carried out by providing a container or reservoir for the metal, which container is adapted to be maintained at temperatures at or above the melting point of the copper or other metal being cast. This container is provided with a tubular forming mold or die which communicates with the reservoir for receiving molten metal therefrom, forming a congealing chamber in which the molten metal is solidified, so that a supply of molten metal may be fed continuously to one end of the mold without interrupting the continuity of the ingot during the entire process, thereby enabling ingots of indefinite length to be cast.

In order to proceed in this manner, the die or mold is constructed so as to comprise, preferably, a cylindrical tube having its interior surface smoothly polished to facilitate withdrawal of the ingot into the channel of which tube the molten metal passes for solidification, a suitable solid plug of metal having been inserted in this channel before the metal is introduced into the reservoir, so that the molten metal cannot run out through the die, but will weld to the plug and will unite therewith, thereby enabling the withdrawing of the solidified metal from the die to be started; and, as solid metal is withdrawn, fresh quantities of molten metal flow into the die and solidify, so that cast metal may be withdrawn from the die in a continuous manner.

It has been the recognized practice to maintain the molten metal and the die defining the congealing chamber at the same temperature, so that there will be no heat interchange between the metal and the die; and also the conditions of operation are maintained so that there is no temperature gradient between the die and the solidified portions of the metal, solidification of the metal being obtained by withdrawing substantially all of the heat from the metal through the solidified portions thereof.

The present invention modifies the above procedure by bringing a cooling medium of suitably sufficient intensity into thermal contact with the walls of the die so as to abstract the heat from the metal mainly through the walls of the die rather than mainly along the metal as has been taught by the prior art, the lateral abstraction of heat from the metal through the walls of the die coupled with suitable adjustment of the rate of withdrawal of the metal from the die being found to produce an inherently different type of crystal structure in the metal from that obtained by abstracting the heat principally along the rod, this latter producing a columnar crystal structure in the metal, while withdrawing the heat from the metal principally through the die with suitable adjustment of the rate of withdrawal of the metal from the die produces substantially radial crystals or crystals inclined but decidedly tending towards radial.

The present invention embraces the further object of providing an apparatus whereby any desired number of continuous casting operations may be carried out simultaneously, the apparatus including the above-mentioned features as well as other new and desirable embodiments which make for improved operation and increased efficiency.

Other objects and advantages of the present invention will become apparent as the description proceeds, and the features of novelty will be set forth clearly and in detail in the appended claims.

Before proceeding with the description of the details of this invention, the following considerations may be noted:

In the continuous casting of copper or other metals a die or mold is used within which the copper solidifies, the die being cooled drastically by the application thereto of a cooling coil or water jacket through which cold water is maintained in continuous circulation, thereby abstracting heat from the metal mainly laterally through the die walls rather than through the rod. The solidified copper in the form of rod or ingot is removed continuously from one end of this water-cooled die or mold, whereas the liquid copper flows continuously into the other end of the die from the reservoir or supply of molten copper.

In order to permit the extraction of the solidified rod, the surface of the die or mold must be very smooth, so that friction between the die and the rather fragile, newly solidified copper will be at the minimum; and since, in accordance with the present invention, heat is extracted through the die or mold itself, it is necessary that the die be made of heat conducting material which is interiorly polished to a mirror surface and which is at least sufficiently non-porous so as to prevent absorption of molten metal into the die. Dies made from graphite of low

porosity, or from boron carbide, have given in practice the best results, the latter material producing a die that is extremely hard, and entirely non-porous, while possessing the requisite amount of heat conductivity for effective extraction of heat through the walls of the die.

In accordance with the present invention there is provided an apparatus whereby a plurality of rods or ingots of metal, such as copper, may be cast continuously, the apparatus including means whereby any predetermined number of such rods or ingots, less than the full capacity of the apparatus, may be cast in a continuous manner.

The apparatus in general embraces what may be referred to as a casting furnace which is heated by a suitable oil or gas burner to temperatures above the melting point of the copper or other metal to be cast. This furnace is built to contain a plurality of containers of suitable capacity for receiving the molten metal to be cast, these containers being positioned directly beneath openings or ports in the cover of the furnace.

For supplying metal to these containers there is provided a tilting melting furnace for melting the metal, this furnace being of relatively large capacity and being provided with discharge ports and lips for discharging molten metal directly into the casting furnace through the ports in the top thereof, and thence into the receptacles positioned in the melting furnace beneath these ports. In order to guide the metal into the receptacles from the melting furnace, suitable funnels in the ports of the casting furnace may be provided.

The said receptacles are received in openings provided in the bottom of the casting furnace, these receptacles being provided in each case with a die which extends through the said openings, in which dies the molten metal from the receptacles solidifies, as above described. Power operated pulling rolls are provided for withdrawing the solidified metal from each die and desirably brake mechanism may be provided for each set of rolls so that any desired set of rolls and the die corresponding thereto may be withdrawn from service.

It may be mentioned at this point that it has been found by many tests and experiments, that, in order to permit the successful withdrawal of the solidified rod, the surface of the channel of the die must be very smooth so that friction between the die and metal will be absolutely minimized. It is to be borne in mind that the die, in order to be satisfactory from the standpoints of operative life and the permitting of facile withdrawal of the rod, must fulfill certain definite requirements.

Thus, it has been found, definitely, that the inner surface of the die must be very smooth, i. e., free from irregularities and imperfections of all kinds; it must be highly polished, a mirror surface giving the best results; it must be sufficiently hard to withstand the movement of the metal within it without excessive wear; it must be sufficiently refractory to withstand without deformation or excessive burning, the high temperatures to which it is subjected in service; it should be as nearly non-porous as it is possible to obtain; the pore spaces present in the material must be as small as possible; the die must be of a material which will not combine or alloy with the metal being cast.

In accordance with the present invention, the matter of porosity of the die is an important factor, as well as the resistance of the die to abrasion. It has been found in the case of copper, that the surface tension of the molten copper is extremely low, and that where the die material is of a porous character it has been found that the copper tends to pass into the pores in much the same way that water is absorbed by blotting paper; and this is also noted in the event of cracks or the like being present in the die surface.

The die therefore becomes impregnated with the metal at least around the inner surface of the die, so that upon congelation and withdrawal of the metal, the impregnation causes a tearing and abrading action between the metal and the die. Again referring specifically to copper, the tensile strength of the congealed copper at temperatures just below its freezing point is very low, so that the newly solidified metal is fragile in character. The tearing and abrading action just referred to tends to fracture this newly-solidified metal and to tear out the surface of the die, thereby destroying the efficiency of the operation.

Another requirement which the die must fulfill, as has been mentioned above, is that of heat conductivity, it being found in practice that the best metal is made by producing solidification of the metal in the die by enclosing the die in a water jacket through which water is maintained in circulation, thereby extracting the heat from the metal through the walls of the die, and reducing friction between the die and metal by chilling the die substantially along its entire length thereby promoting shrinkage of the metal from the die.

Experiments have demonstrated conclusively that graphite is a satisfactory die material from the standpoint of the quality of the metal produced, especially from dies composed of specially prepared graphite in which the porosity does not greatly exceed 20% and the size of the pore spaces does not run substantially over 40 microns.

In instances where the inherent softness of graphite is wished to be avoided, the dies may be provided with a liner composed of boron carbide, which, when cast from its molten condition, is characterized by its hardness, being non-abradant by the metal being cast; by its total absence of porosity; by its refractoriness and resistance to deformation and oxidation; and by its heat conductivity; and the quality of the metal produced is good.

The invention of the present application may be more readily understood by reference to the accompanying drawings, which illustrate one form of a complete plant installation for carrying out the production of rods and billets.

In the accompanying drawings

Fig. 1 is a plan view of the apparatus.

Fig. 2 is a side elevation of the apparatus of Fig. 1, the melting furnace being shown as tilted to one of its discharging positions for enabling metal melted therein to pour directly into the containers therefor in the casting furnace, the casting furnace being shown partially in section which is taken along the line 2—2 of Fig. 1. Fig. 2 shows also, diagrammatically, temperature indicating apparatus applied to the installation for indicating continuously the temperatures of the cooling water being circulated around each die.

Fig. 3 is a transverse sectional elevation of the apparatus, the view being taken on the line 3—3 of Fig. 1.

Fig. 4 is a plan view of the assembly of mechanism which is provided for controlling the operation of the individual pairs of pulling rollers by which the operation of any individual pair of rollers may be stopped whenever desired, the view being taken generally along the line 4—4 of Fig. 3.

Fig. 5 is an enlarged view of one of the units of the assembly of Fig. 4.

Fig. 6 is an enlarged sectional elevation of one of the dies showing certain details of the mounting thereof.

Referring more particularly to the drawings it will be seen that the apparatus comprises a rotary tilting melting furnace A which is adapted to discharge molten metal directly into a casting furnace B or B¹, the respective furnaces being heated by suitable heating instrumentalities, such as oil or gas burners, to temperatures substantially above the melting point of copper, or other metal, being cast.

The furnaces A, B and B¹ are mounted on a suitable working platform C, supported on framework D.

The casting furnaces B, B¹ are provided with suitable receptacles E for containing the metal to be cast, each of the receptacles having a die F, defining a forming chamber in which the metal solidifies, as described previously herein. Mounted on suitable supporting platforms, are a plurality of pairs of pulling rolls for withdrawing cast metal from the dies, there being one pair of these rolls for each die, as will be described in more detail hereinafter.

As will be seen from the drawings, the melting furnace A comprises a highly refractory body 7 provided with a metal shell 9, the refractory body 7 defining a melting chamber 11, in which metal 13 is melted and maintained above its melting point.

Adjacent to each end of the melting furnace A is an annular track 15, 15a which engage rollers 17, 17a for enabling the furnace to turn by means of suitable driving mechanism which will be described hereinafter.

It will be seen from the drawings that the so-called "track" 15a is in reality an annular gear and that roller 17a is a driving pinion meshing with this gear. The pinion 17a is operated by a reversible motor 19 and standard type of speed reducer 21. A burner 23 heats the furnace A, the furnace being provided with a flue outlet 25 for escape of combustion gases which are led away through hook 27 and flue 29, there being sufficient clearance between the outlet 25 and hood 27 to allow the furnace to turn.

The furnace A is provided with a multiplicity of ports 31 through which ports the molten metal 13 is adapted to be discharged into the receptacles E. The ports 31 are placed in alignment, and with reference to the transverse section of the furnace, they are diametrically opposed. For guiding the metal into the receptacles E, discharge lips each having a guide channel 34, are provided. In the illustrated installation, there are shown ten of such discharge ports 31 on each side of the melting furnace A, although it will be understood that this number may be different in any given installation, and any suitable means may be provided for stopping off any ports which it is not desired to use. The furnace is provided with a suitable charging opening, not shown, which is located in any convenient place, such as, for example, in the end of the furnace opposite to the burner 23. Suitable instrumentalities are provided, of course, for covering or closing the charging opening.

It has been pointed out that the ports 31 are adapted to discharge molten metal directly into the casting furnaces B or B¹, depending in which direction the melting furnace A is turned. Since the casting furnaces B and B¹ are duplicate in construction, only one of them needs to be described.

The casting furnaces B, B¹ extend along the melting furnace A, being substantially coextensive in length therewith. Each of the casting furnaces comprises a continuous refractory wall 35, and a bottom 37. The bottom 37 is provided with a number of aligned holes for receiving the dies F with which the receptacles E are provided. Therefore, there are as many of these aligned holes as there are discharge ports in the melting furnace A. The receptacles E are shown as being mounted on refractory tiles 39, if such be required. Internally the casting furnace B or B¹ is divided into two compartments by a partition 40, each compartment being heated by a separate burner 41, 43 and is provided with a separate outlet 45, 47 for products of combustion. A shoulder 49 extends around the top of the wall 35 for receiving individual blocks or tiles 50, the aggregate of which forms a complete cover for the casting furnace, the tiles 50, however, being individually removable. Each of the tiles 50 is placed over an individual receptacle E, and is provided with two holes 51 and 53, the former receiving refractory funnels or the like 55, and the latter being adapted to receive thermocouples 57. The holes 51 and 53 also serve as means enabling the insertion of lifting tools for removing the tiles 50 if desired.

The receptacles E are refractory pots or crucibles of desired capacity, each holding for example from 800 to 1000 lbs. of copper. Each of these is provided with a die F, each of which dies is provided with an elongated body 58 having a collar 59 adjacent to the inlet end of the channel 61 which defines the forming chamber. The body 58 extends through the bottom 37 of the furnace B, and is substantially enclosed by a water jacket 63 which cools the walls of the die and effects solidification of the metal in the channel 61. The collar 59 provides a ready means for securing the dies in position in the bottom of the receptacles E.

Where the dies F are made of graphite or other oxidizable material, it is found to be highly desirable to surround the dies with a non-oxidizing atmosphere. To this end, exposed portions of the die surface are enclosed in a steel hood 65, the interior of which is maintained flooded with an inert or reducing gas supplied through lines 67 from any convenient source. Water gas or illuminating gas are suitable for maintaining a protective atmosphere about the die.

Beneath each of the dies F is located a pair of pulling rolls 69, 71 so arranged that they will receive a cast rod or billet 74 therebetween in axial alignment with the channel 61 in the die. Rolls 69 are the driving rolls, each of these being loosely mounted on a shaft 72, which is rotatably mounted in bearings 73, 75. These bearings are bolted to a platform 77 which extends below each of the casting furnaces. Each of the shafts 72 is provided with a sprocket 79 for driving the shaft 72 from corresponding sprockets 81 on shaft 83, the latter being driven at variable predetermined speeds by a variable speed motor 85 operating through a standard speed reducer 87 geared to

the shaft 83. Sprocket chains 89 connect the sprockets 81 and 79.

Each of the shafts 71 therefore is driven continuously, and mechanism thereon is provided for controlling the operation of the rolls 69 and 71. This mechanism includes a clutch device for each of the pulling rolls 69, the clutch device comprising the rotating clutch member 91 connected to the shaft 72 by a usual key and slot connection, the fixed clutch element 93 being mounted on the roll 69. Movement of the clutch member 91 into and away from engagement with the clutch member 93 is effected by a lever 95 which is fulcrumed at 97 on a bolt passing through platform 77, a pin 99 transmitting motion from the lever 95 to the clutch member 91, the pin 99 being received in an annular recess 101 in the clutch member 91.

In order to hold the billet 74 in position between the rolls 69 and 71 when the rolls are inoperative, a brake device is arranged for operation simultaneously with the operation of the clutch members 91 and 93. For this purpose, there is provided a lever 103 which is fulcrumed on a bolt 105 passing through the platform 77, one end of the lever 103 having a brake shoe 107 secured thereto by a bolt or the like 109. The other end of the lever 103 is engaged by the end 111 of the lever 95, this end 111 being cam-shaped, so that when the lever 95 is operated to retract the clutch member 91 from engagement with the clutch member 93, the lever 103 is engaged by the cam end 111 of the lever 95 for pressing the brake shoe 107 against the roll 69, thereby securing the roll 69, and also roll 71, from rotation, thereby frictionally holding the billet 74 and preventing its dropping out of position when the rolls are stopped, thereby positively assuring that the molten copper will not run out from the superposed receptacle E. The billets 74 may project into a casting pit 113, which may be provided with a suitable removable cover 115.

It will be noted that the operation of each sprocket 81 on the shafts 83, 83 is controlled by a clutch 117, which is similar to the clutch mechanism described above, each of the clutches 117 being operated by a lever 119 mounted similarly to the levers 95, levers 119 being fulcrumed at 120.

Water is maintained continuously circulating through the water jackets 63, and the heat abstracted from the copper by the circulating water obviously heats this water substantially above the room, or atmospheric, temperature. It has been discovered in practice that the temperature of the water circulating through the water jackets remains approximately constant so long as the casting conditions remain constant; but if the casting conditions become changed as, for instance if the billets or rods being cast become fractured, or the surface thereof becomes checked or imperfect, the temperature of the water will drop very quickly responsive to such changes, and the constancy of the water temperature affords, therefore, a check on the condition of the rod or billet before changes therein become visible. In order to render the water temperature continuously visible, recording thermometers of standard type are put in circuit with the water in the water jackets, as designated diagrammatically at 121 there being such a thermometer for each die, 123 representing a bank of such thermometers which may be mounted in any convenient location. Electrical connections with the respective water jackets are indicated by the circuits 125.

A guard or hood 127 may be placed over the funnels 55 as a protection against splashing and a guide collar 129 may be provided for each of the dies in order to assure a true axial withdrawal of the rod.

It is thought that the operation of the mechanism will be apparent from the foregoing considerations, but it may be briefly reviewed for clarifying all details, it being assumed for purposes of illustration that copper is the metal being cast.

To start the operation, copper rods of appropriate size and shape are passed into the channels 61 of the dies 57, the protruding rod being gripped by the drawing rolls 69 and 71. These latter rolls are adjustable relatively to the rod, the brackets 131 in which the rolls 71 are mounted being movably mounted on the platform 77 so that the bracket and roll will be movable towards and away from the rods 74 responsive to corresponding turning movements of screws 133, which operate through blocks 135 rigidly secured to the platform 77. The screws 133 operate to adjust the amount of pressure exerted by springs 137 which are mounted on studs 139 on the brackets 131, so that as the screws 133 are advanced, the brackets 131 will be forced towards the rods 74 and the rolls 71 will be brought into close frictional engagement with the rods 74.

Cathode copper is melted in the melting furnace A, and blown with air until desulphurized, the slag formed during the blowing operation being skimmed off as it is produced. A thick layer of carbon is distributed over the molten bath, which is poled with green wood to tough pitch. The carbon used is preferably low sulphur petroleum coke, the layer being sufficiently thick so that there will be no direct interstices between the combustion gases in the furnace and the metal bath. The carbonaceous material substantially completes the deoxidation, which is entirely completed by placing phosphorus in the receptacles E, and a carbonaceous layer may also be placed in the receptacles E; or the copper may be poled as above, and then completely deoxided by blowing with gases inert to copper such as with carbon monoxide and nitrogen, the hoods 127 being filled with the inert atmosphere, as well as the casting furnaces B, B^1.

Having prepared the metal and inserted the starting rods, and the casting furnaces B, B^1 having been brought to substantially the same temperature as the melting furnace, the melting furnace A is tilted until the molten copper flows from it through the ports 31 and fills the receptacles E. Should any of the receptacles be out of service, the corresponding ports in the melting furnace are closed. When the receptacles E in one of the casting furnaces are filled to the desired height with molten metal, the furnace A is turned in the opposite direction and the receptacles E in the other casting furnace are filled in like manner.

As the copper fills the receptacles E it passes into the channels 61 of the dies F and fuses to the rod previously inserted therein. The motors 85, 85 are started and the shaft 83, 83 are driven, thereby operating sprockets 81 and 79, so that when the clutch elements 91 and 93 of the drawing rolls 69 and 71 are engaged, the rolls are operated to withdraw the rods or billets 74. Heat from the molten copper in the dies F is withdrawn through the dies by the water jackets 63 so that the copper solidifies in the channels 61 as the rods or billets are withdrawn. The longitudinal move-

ment of the rods or billets and the supply of molten metal to the dies are made to correspond with each other and both are regulated to correspond with the cooling of the metal in the dies, so that when the movement of the billets and the feeding of the fresh metal have thus been adjusted, the continuous formation of the billets in the molds becomes automatic.

Adjacent to each rod or billet there is provided sawing mechanism for cutting the castings into desired lengths. This sawing mechanism includes, in each instance, a support 141 welded to a platform beam 143 and carrying a motor 145, which motor operates a disc saw blade 147. The weight of the motor 145 may be counterbalanced by a counterweight 149 suspended over pulleys 151. The rods or billets 74 are guided to the saw by a guide bracket 153 and guide rolls 155, adjustably mounted in blocks 157. Adjustment of the rollers 155 is accomplished by means of a screw 159 similarly as described above in connection with the pulling rolls.

The temperature of the metal 13 and the rate of withdrawal of the rods or billets 74 are so adjusted that the rods or billets emerge from the dies while at high temperatures, i. e., approximately 1500° F., this being found in practice to produce a desirable crystal structure in the metal, in that the crystals extend radially in the metal. While the apparatus has been described in connection with the continuous casting of copper, it is apparent that ingots of copper alloys of different predetermined compositions may be produced in a similar manner by the apparatus as described, as will become obvious. For such purpose, the receptacles E are used for producing the desired alloys, the alloying components being commingled therein in the proper desired proportions; and the resulting ingots will be formed and continuously withdrawn in the manner as already described.

Furthermore, the channels 61 of the respective dies may be made of different diameters, if desired, and since the pulling rolls 69 and 71 are adjustable relatively to each other, it becomes apparent that the apparatus may be employed for producing continuously ingots of different predetermined diameters, so that a plurality of ingots of indeterminate length and of different diameters and compositions may be produced from the same apparatus at the same time, thereby affording a high degree of flexibility in the operation of the apparatus.

The use of a tilting furnace for melting the metal possesses decided advantages, in that there is provided continuously a large supply of molten metal which may be supplied to the casting furnace under carefully controlled amounts and conditions as may be required, and additionally, by the use of a tilting furnace, the discharge ports 31 are conveniently accessible at all times for controlling the flow of metal through any individual port or ports as may be required by the conditions of operation.

What is claimed is:

1. Apparatus for casting metals comprising the combination with a supporting platform, of a melting furnace and a casting furnace on the said platform, the said casting furnace being located adjacent to the melting furnace for directly receiving molten metal flowing from the melting furnace, a plurality of discharge ports in the melting furnace, means in the casting furnace adjacent to each of the discharge ports in the melting furnace for receiving metal issuing from the discharge ports, means for substantially preventing access of air to the metal as it pours from the melting furnace into the casting furnace, and mechanism for continuously withdrawing cast metal from the casting furnace.

2. Apparatus for casing metals comprising the combination with a supporting platform, of a melting furnace and a casting furnace on the said platform, the said casting furnace being located adjacent to the melting furnace for directly receiving molten metal flowing from the melting furnace, a plurality of discharge ports in the melting furnace, means in the casting furnace adjacent to each of the discharge ports in the melting furnace for receiving metal issuing from the discharge ports, pouring lips extending from the melting furnace adjacent to the discharge ports for guiding molten metal into the casting furnace, a hood for substantially preventing access of air to the metal as it pours from the melting furnace into the casting furnace, and mechanism for continuously withdrawing cast metal from the casting furnace.

3. Apparatus for casting metals comprising the combination with a tiltable melting furnace of casting furnaces disposed along each side of the melting furnace and adapted to receive molten metal from the melting furnace, discharge ports along each side of the melting furnace for discharging metal into the casting furnaces, casting means operatively connected with the casting furnaces, mechanism for continuously withdrawing cast metal from the casting means, and mechanism for tilting the melting furnace in clockwise and counter-clockwise directions, selectively, for discharging metal into either casting furnace as desired.

4. Apparatus for casting metals comprising, in combination, a furnace, a plurality of receptacles in the furnace for receiving molten metal from a supply thereof, each of the said receptacles being provided with a die defining a congelation chamber therein wherein molten metal solidifies, means for continuously withdrawing solidified metal from the congelation chamber as solidification of the metal proceeds, and mechanism for rendering any of the said means inoperative while applying a braking force thereto for preventing solidified metal from dropping from the die during the period of inaction of the withdrawing means.

5. Apparatus for casting metals comprising the combination with a furnace adapted to receive a supply of molten metal from a suitable source thereof, of a plurality of dies positioned in the furnace to receive molten metal therefrom, each of the said dies defining a congelation chamber in which the metal is adapted to solidify, mechanism for continuously withdrawing solidified metal from the congelation chambers, and means for rendering any of the said mechanism inoperative while applying a braking force thereto for preventing solidified metal from dropping from the die during the period of inaction of the mechanism, the said means including a clutch and brake and instrumentalities for applying the brake simultaneously with withdrawal of the clutch to inoperative position and for releasing the brake simultaneously with movement of the clutch into operative position.

6. Apparatus for casting metals comprising the combination with a furnace adapted to receive a supply of molten metal from a suitable source thereof, of casting means positioned in the furnace to receive molten metal therefrom, and

mechanism for continuously withdrawing solidified metal as continuous ingots from the casting means, the said mechanism comprising a driving shaft, a driven shaft operated from the driving shaft, pulling rolls on the driven shaft for controlling withdrawal of the solidified metal from the casting means, driving sprockets on the driving and driven shafts and clutch means for each of the sprockets for effecting maximum flexibility of control of the pulling rolls by enabling any selected set of pulling rolls to be placed out of service while maintaining operation of the remaining sets of pulling rolls.

7. Apparatus for casting metals comprising the combination with a furnace adapted to receive a supply of molten metal from a suitable source thereof, of casting means positioned in the furnace to receive molten metal therefrom, and mechanism for continuously withdrawing solidified metal as continuous ingots from the casting means, the said mechanism comprising a driving shaft, a driven shaft operated from the driving shaft, pulling rolls on the driven shaft for controlling withdrawal of solidified metal from the casting means, power-transmitting devices on the driving and driven shafts, clutch means for each of the power-transmitting devices on both of the driving and driven shafts, and brake devices for the pulling rolls operable responsively to actuation of the clutch means on the driven shaft to secure the pulling rolls when the latter are inoperative.

8. Apparatus according to claim 7, in which the brake devices comprise a brake shoe adapted to engage the pulling rolls, a lever for operating the brake-shoe, a clutch lever having one end engaging the brake-shoe lever, the said end having a cam surface for operating the brake-shoe lever responsively to actuation of the clutch lever.

9. Apparatus for casting metals comprising a furnace adapted to contain molten metal, means including a plurality of dies for withdrawing continuously solidified ingots from the furnace, mechanism for withdrawing, selectively, metal from all of the said dies simultaneously or from only selected ones of the said dies, and means for operating the said mechanism.

10. Apparatus for continuously casting metals comprising, in combination, a melting furnace, a casting furnace for receiving molten metal from the melting furnace, a plurality of metal-receiving receptacles in the casting furnace adapted to receive directly metal being poured from the melting furnace, a die for each receptacle provided with a longitudinally extending channel defining a forming chamber for the metal into which channel the metal from the receptacles is adapted to continuously flow and to solidify and from which the solidified metal is adapted to be continuously withdrawn as solidification thereof proceeds, mechanism for continuously withdrawing the metal simultaneously from the dies as ingots of indeterminate length, and means for rendering inactive a selected portion of the said withdrawing mechanism without interruption of operation of the remainder for withdrawing any desired number of selected ingots from the dies.

11. Apparatus for continuously casting metals, comprising, in combination, a tilting melting furnace, a casting furnace adapted to receive molten metal discharged from the melting furnace, heating means for the casting furnace adapted to maintain thoroughly liquid the metal therein, a plurality of casting dies in the casting furnace for receiving molten metal and for effecting solidification of metal therein, means for continuously withdrawing cast metal shapes of indeterminate lengths from the dies, the said withdrawing means including instrumentalities for withdrawing, selectively, all of the shapes together or any preselected shape, independently of the remainder, and drive mechanism common to the withdrawing means for actuation thereof.

KARL A. LINDNER.