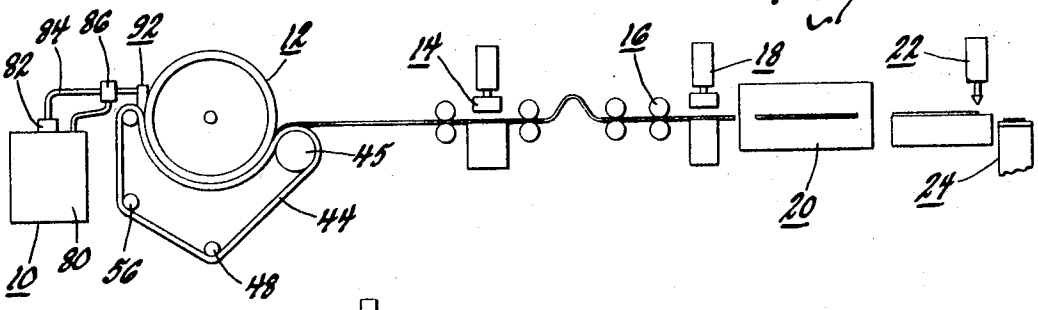
July 15, 1969 C. A. NICHOLS ETAL 3,455,371

BATTERY GRID CASTING METHOD AND MACHINE

Original Filed Aug. 14, 1964 4 Sheets-Sheet 1

Fig. 1



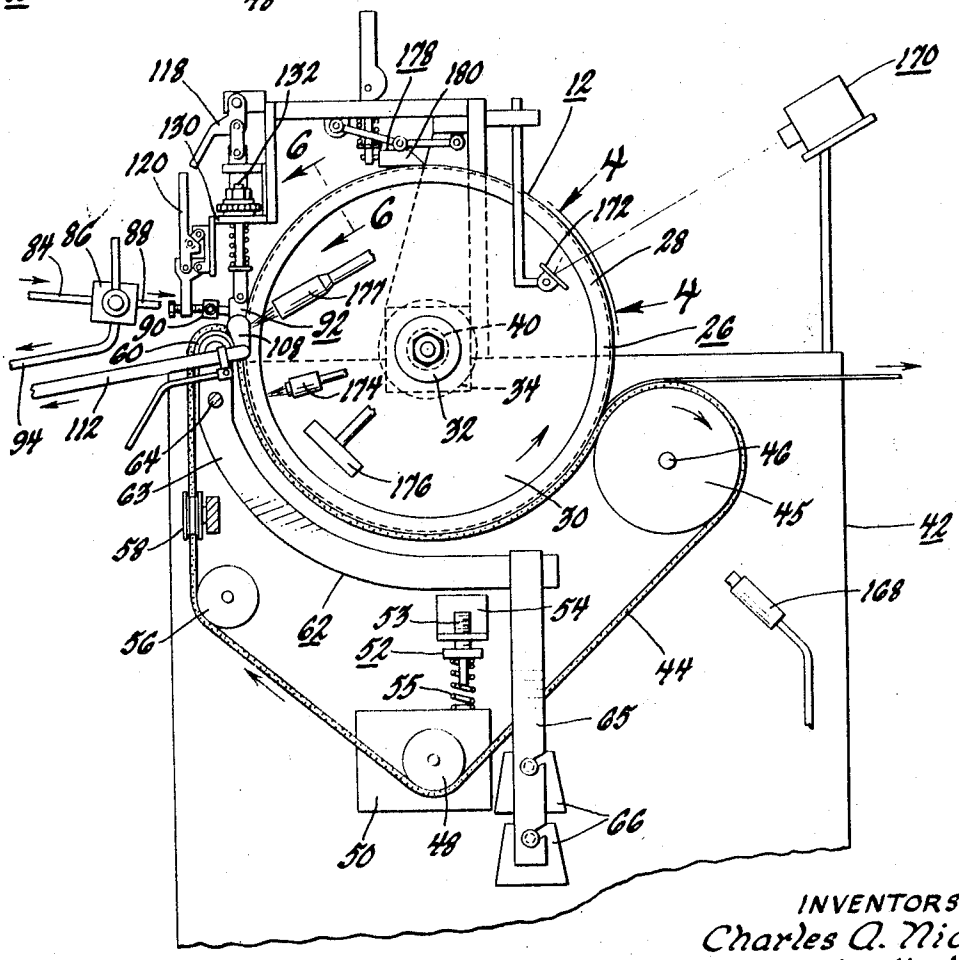


Fig. 2

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BATTERY GRID CASTING METHOD AND MACHINE

Original Filed Aug. 14, 1964 4 Sheets-Sheet 2

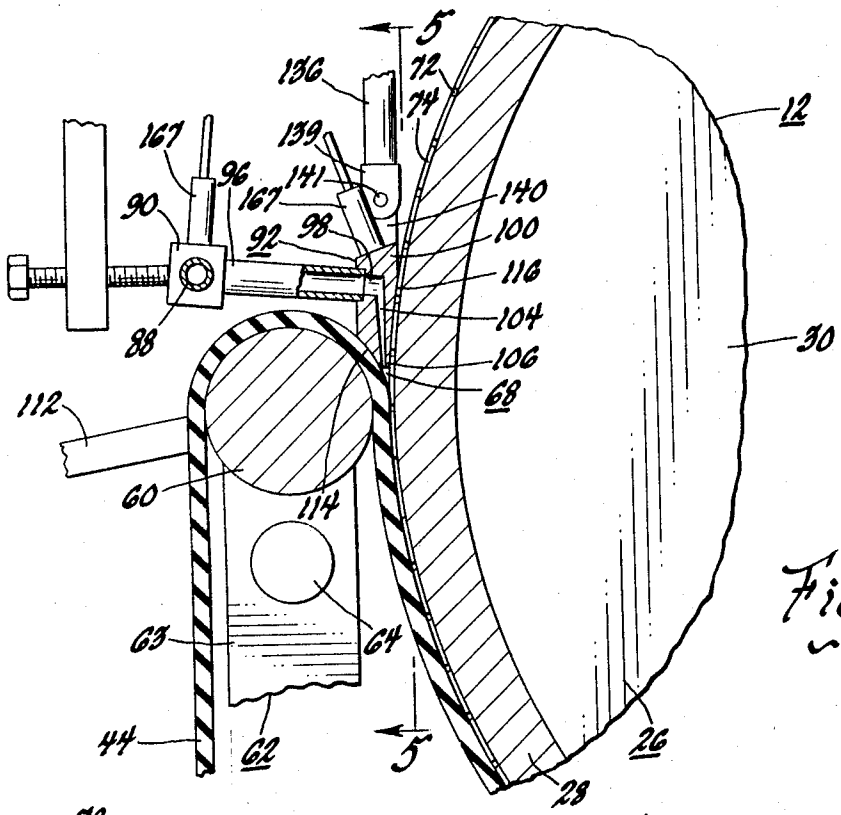


Fig. 3

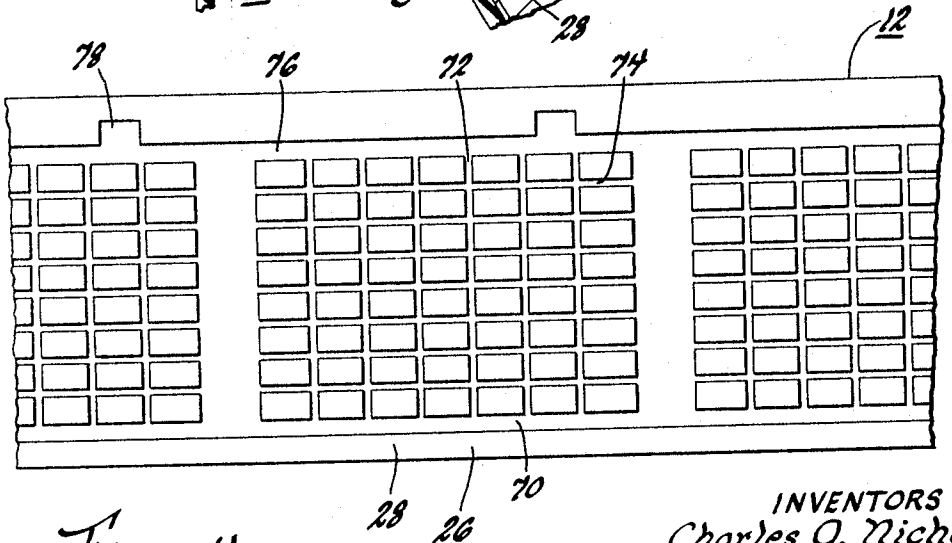


Fig. 4

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BATTERY GRID CASTING METHOD AND MACHINE

Original Filed Aug. 14, 1964 4 Sheets-Sheet 3

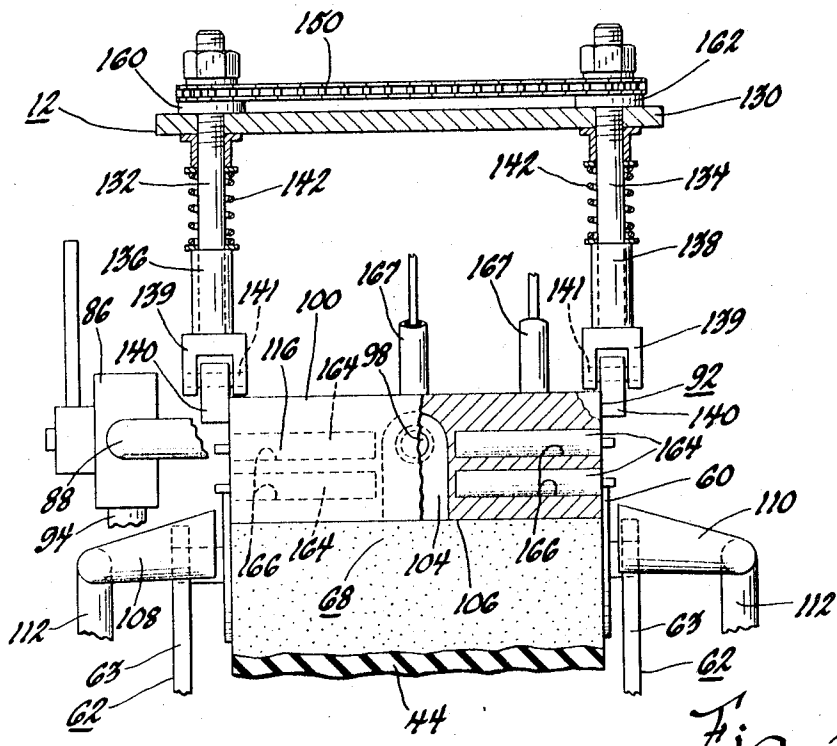


Fig. 5

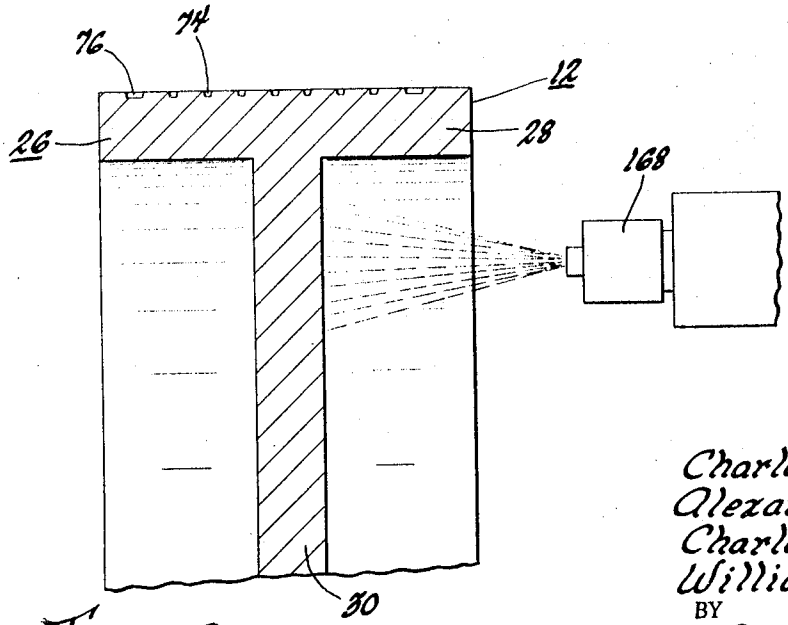


Fig. 6

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BATTERY GRID CASTING METHOD AND MACHINE

Original Filed Aug. 14, 1964 4 Sheets-Sheet 4

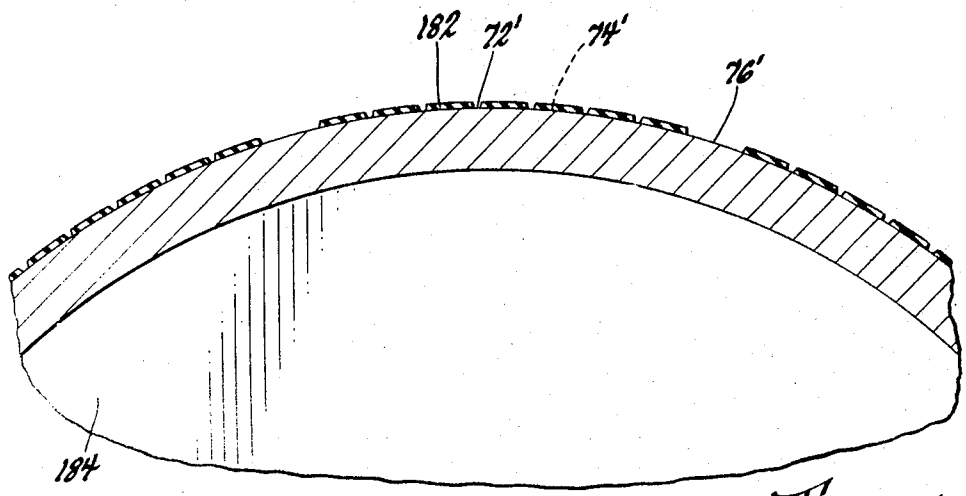


Fig. 7

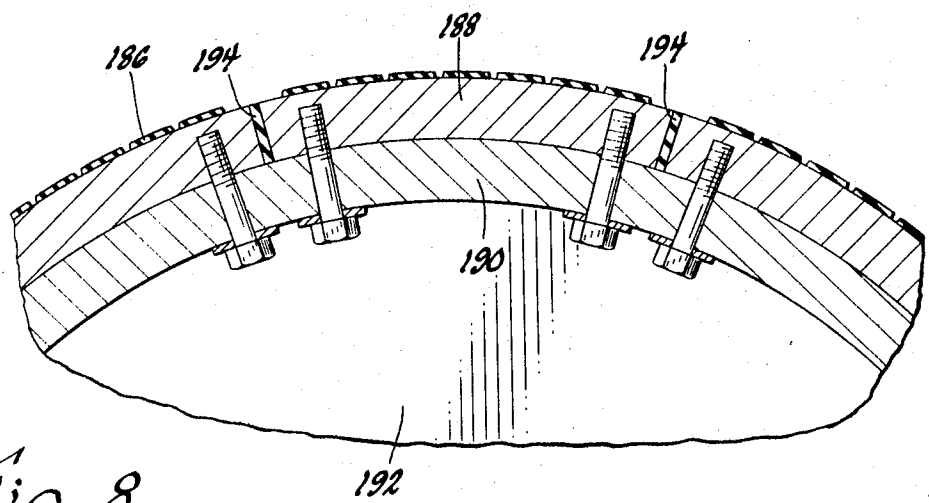


Fig. 8

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3,455,371

BATTERY GRID CASTING METHOD AND MACHINE

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Original application Aug. 14, 1964, Ser. No. 389,564. Divided and this application Oct. 21, 1966, Ser. No. 598,572

Int. Cl. B22d 11/06

U.S. Cl. 164—87 7 Claims

ABSTRACT OF THE DISCLOSURE

In a preferred form, a method for continuously casting battery grids by rotating a drum mold with respect to a continuous belt pulley system. An open-ended throat region is formed in cooperation with a dispenser head and the periphery of the rotary drum mold when it first meets the continuous belt. The method includes the circulation of molten metal into the throat region at a rate in excess of the volume of the mold cavities exposed to the throat region so as to maintain a flow velocity in the throat region across the mold cavities to prevent premature metal solidification. The belt is uniformly pressed against the outer periphery of the mold to wipe less than the full amount of the flow into the throat region into the mold cavities and the excess flows out the open ends of the throat region. A layer of low heat diffusivity material is maintained at the surface of the mold to further prevent premature solidification of the molten metal as it flows into the mold cavities.

This application is a division of application Ser. No. 389,564, filed Aug. 14, 1964, now U.S. Patent No. 3,300,-821, issued Jan. 31, 1967.

This invention relates to an improved machine and method for continuously casting strips of battery grids from molten material.

While machines for continuously manufacturing strips of material or castings from a molten mass are known, none of these machines or methods has been completely suitable for casting articles having close tolerance components or small dimension, for example, a battery grid having grid wires directed between crossbars enclosed by a rim or peripheral bead on the outer periphery of the grid. In casting articles of this type by a continuous process, it has been found that presently known machines are unable to completely assure good reproduction of the mold configuration because of problems in completely filling the mold and extracting the casting therefrom.

Accordingly, an object of the present invention is to provide an improved method for manufacturing continuous strip castings including a "high-low principle" of molding wherein a first portion of the mold is made of a material having a low diffusivity factor for preventing solidification of molten material before the mold has been completely filled and a second portion of a high diffusivity factor for reducing the surface tension of the molten material to assure accurate reproduction of the mold contour in the fine detailed portions thereof.

A further object of the present invention is to improve machines for continuously manufacturing castings as a continuous strip from a mass of molten material of the type including a rotary drum mold, a dispenser, and a belt by the provision of improved means for locating the dispenser in close tolerance relationship with the mold and a floating roll that compensates for drum eccentricity to

maintain a substantially constant geometry between roll and mold as molten material flows from the dispenser into the juncture between the mold and roll whereby an even distribution of molten material into the mold is obtained while preventing flashing across the mold face to assure complete reproduction of the mold contour.

A further object of the present invention is to improve the manufacture of battery grids or the like in machines of the above-described type by an improved continuously flowing stream of molten material to and from a pool for filling a continuously advancing mold surface.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein preferred embodiments of the present invention are clearly shown.

In the drawings:

FIGURE 1 is a diagrammatic view of a process line including the continuous casting machine and method of the present invention;

FIGURE 2 is a view in side elevation of the present invention;

FIGURE 3 is a fragmentary view partially in side elevation and in section showing the dispenser, floating roll, drum mold and belt relationship in the improved machine;

FIGURE 4 is a plan view looking in the direction of arrows 4—4 in FIGURE 2;

FIGURE 5 is a reduced view in vertical section taken substantially along the line 5—5 of FIGURE 3 including a showing of means for raising and lowering the dispenser;

FIGURE 6 is a fragmentary, enlarged view in vertical section taken along the line 6—6 of FIGURE 2;

FIGURE 7 is an enlarged, fragmentary view in vertical section of a further embodiment of a drum mold surface; and

FIGURE 8 is an enlarged, fragmentary view in vertical section of another embodiment of a mold of the present invention.

Referring now to FIGURE 1 of the present invention, a process line for continuously manufacturing strip castings, for example, castings of battery grids or the like, is illustrated as comprising a melting system **10** for directing molten material, for example, an antimony lead alloy to a casting machine **12** and thence through a trim station **14** for trimming the casting and thence through a paste station **16** for filling the voids in the battery grid castings with a suitable electrochemically active material, and thence through a shear station **18** for separating the continuous strip of battery grids into individual units. These units are then passed through a suitable oven **20** for curing the active material in the grid framework and thence to a secondary shear station **22** for further separating the finally cured battery grids into battery size units which are then carried to a suitable assembling station by means of a conveyor belt **24**.

The continuous grid casting machine **12** is best illustrated in FIGURE 2 as comprising a large diameter mold drum **26** having an outer peripheral flange portion **28** supported by a radially inwardly directed web or disc **30** supportingly received on a drum adapter unit or element **32** having a plate portion **34** secured to the web **30** by suitable fastening means, such as a key. In the illustrated embodiment, a key element (not shown) is located in engagement between the web **30** and plate **34** to prevent relative movement between the drum **26** and the adapter unit. A shaft **40** secured to the adapter is rotatably supported upon suitable fixed framework **42** whereby the mold drum **26** is rotated about the axis of shaft **40** by suitable drive means (not shown) acting through shaft **40**. The outer periphery of the mold drum **26** will thus

drivingly engage a continuous belt 44 that passes about a pulley 45 rotatably supported on the fixed support 42 by means of a shaft 46 and thence across a belt tension roller 48 rotatably supported on a movable plate 50 that is biased so as to produce a predetermined pressure between roller 48 and belt 44 by a spring loading device 52 including a threaded stud 53 received by a fixed bracket 54 for adjusted movement therein so as to vary the spring force of a coil spring 55 in surrounding relationship with one end of stud 53. Following passage over the belt tension roller 48, belt 44 passes over spaced rollers 56, 58 located thereabove to guide the belt 44 in a substantially vertical direction prior to its passage over an equalizing roller 60. As best seen in FIGURES 2 and 5 the roller 60 is supported at each of its ends on one end of each of a pair of equalizing arms 62 each having a downwardly curving upper portion 63 thereof pivotally supported on a pin 64 supported by the fixed support 42. The opposite end or offset portion 65 on each arm 62 depends substantially in a vertical plane and supports suitable counterweights 66 that tend to pivot the roller 60 about the axis of pin 64 toward the outer periphery of the drum 26 where the belt 44 cooperates with drum 26 to form a throat region 68 therebetween as it passes from the roller 60 onto the drum 26.

The continuous belt 44 then passes about the drum 26 through less than 180° of the outer circumference thereof to return to the idler pulley 45 from whence the continuously cast grid strip is directed to a further processing step, for example, to the trip stage 14 illustrated in FIGURE 1. In order to produce the continuous strip of casting from a source of molten material, the belt 44 is preferably constructed of a high temperature resistant material of substantial flexibility, for example, a special silicone rubber, 4-ply belt with a No. 8025 fabric material as manufactured by Goodyear Tire and Rubber Company. This material was used on one working emodiment of the machine and in addition to having desired thermal durability, it had an outer surface of approximately sixty durometers in order to produce castings of good quality.

Previous to the present invention, it was recognized that continuous strips might be continuously cast from a mass of molten material; however, previous machines are limited to casting articles wherein the component parts thereof have substantial dimensions without close tolerances. When the mold configurations of previous machines are modified to include small dimensional characteristics and fine detailed portions that must be continuously manufactured to very close tolerances, it has been found that portions of the mold fail to fill and, hence, there is not a reliable continuous reproducibility of mold configurations and/or there is an overfilling of the mold with a considerable flashing of excess material across the mold surface that renders the finished casting completely unsuitable for its intended purpose.

In the illustrated embodiment of the invention, a molten material is fed into the throat region 68 between belt 44 and drum 26 in a manner and under a temperature control that assures that a continuous strip of substantially identical castings of desirable tolerance will be directed from the drum 26.

In accordance with certain of the principles of the present invention, improved means are included in the illustrated casting machine 12 to uniformly direct a predetermined amount of molten material at a desired fluidity into a mold cavity on the drum 26 that is representatively illustrated in FIGURE 4 as including a battery grid 70 having small cross-sectioned grid wire depressions 72 extending between larger cross-sectioned cross-arm depressions 74 each being connected at the outer ends thereof to a relatively large cross-section rim depression 76 having a tab portion 78 integrally formed therewith.

More particularly, in the illustrated embodiment of the present invention, as best seen in FIGURE 3, the equalizing roller 60 cooperates with the belt 44 in the vicinity of the throat region 68 to fulfill three important functions in maintaining a throat region of constant geometry. One of these functions is that the two independent pivoted equalizing arms 62 and self-aligning bearings at the ends of the shaft or roller 60 allow the equalizing roller 60 to shift relative to the outer periphery of the drum 26 to compensate for eccentricity or wobble therein.

Furthermore, by adjusting the counterweights 66, it is possible to apply equal force to each end of the equalizing roller 60 whereby a uniform contact pressure between the belt 44 and the drum 26 is attained across the entire width of the throat region 68. By virtue of the equalizing roller system, any variation in the diameter of the drum due to thermal expansion is compensated for by pivotal movement of the roller 60 around the pin 64 by an amount equivalent to the thermal expansion in drum 26 whereby the contact pressure between the belt 44 and drum 26 is maintained substantially constant.

By virtue of the above-described characteristics of the equalizing roller system, the throat region 68 is maintained substantially geometrically constant and, accordingly, molten material directed therein can be controlled to produce a closely controlled filling of the continuous mold on the outer periphery of drum 26. In the illustrated embodiment of the invention, as best seen in FIGURES 1–3, molten material is fed into the throat region 68 from the source 10 of molten material that is representatively illustrated as including a lead pot 80 having a predetermined charge of molten material therein that is circulated by a pump 82 through a discharge conduit 84 connected to a three-way control valve 86 that directs the molten material through a conduit 88 connected thereto that has one end thereof connected to a fitting 90 serving as a support for a thermocouple unit in a thermowell 167 thereon. From valve 86 a recirculating conduit 94 directs fluid from discharge conduit 84 in by-passed relationship to the dispenser assembly 92 during certain phases of the operation of the illustrated casting machine 12.

The dispenser assembly 92 is connected to the fitting 90 by a line 96 through a centrally located inlet opening 98 on the rear face of a wedge-shaped head portion 100. Interiorly of the wedge-shaped head portion 100 is a centrally located downwardly directed opening 104 that directs molten fluid to a narrow tip portion 106 of head 100 that overlies the juncture between the belt 44 and mold drum 26. When the threeway valve is conditioned to direct molten fluid from the discharge conduit 84 to the fitting 90, a continuous flow of molten material is directed through the distributor opening 104 into the throat region 68 where the belt and drum serve to divide the molten stream issuing from the distributor opening 104 into substantially equal divided streams that pass transversely across the face of the continuously advancing mold 70 on the outer periphery of the drum 26 through substantially half the width of the advancing mold.

As the stream of continuous molten material passes across such equal portions on the face of the advancing mold, the belt 44 is continuously acted upon by the equalizing roller 60 to wipe a predetermined portion of the continuously circulating molten material into the cavities of the advancing mold with a continuously uniform pressure across the width of the mold sufficient to assure that the molten material will fill even relatively small dimensional portions of the mold cavity, for example, the small wire portions 72 therein. As best seen in FIGURE 5, any matter in excess of that required to fill the cavity portions of the continuously advancing mold flows exteriorly of the side edges of the outer periphery of the belt 44 and drum 26 where it is received by funnels 108, 110 located on either side thereof with each of the funnels 108, 110 communicating with a like conduit 112 serving to return

the excessive material or overflow to the lead pot **80** for recirculation back to the dispenser assembly **92**.

Another feature of the present invention is the fact that the illustrated dispenser assembly **92** serves to prevent leakage of the molten material exteriorly of the throat region **68** other than through the open sides thereof into the funnels **108**, **110**. In order to assure against leakage other than through such side openings, the wedge-shaped head **100** is carefully spotted between the continuous belt **44** and the other periphery of the drum **26** so that a rear surface **114** thereon having a curvature corresponding substantially to that of the equalizing roller **160** serves to slidably direct the belt **44** into a tangential relationship with the outer surface of drum **26** and prevent leakage rearwardly of the throat region **68**. A front surface **116** on head **100** having a curvature substantially corresponding to that of the outer periphery of drum **26** serves as a front locator against the drum and to seal between the front of dispenser assembly **92** and drum **26**. A desired location of the wedge-shaped head **100**, belt **44** and drum **26** is obtained in the illustrated embodiment of the invention by two toggle mechanisms **118**, **120** for adjusting the wedge-shaped head both vertically and horizontally with respect to the throat region **68**. The toggles **118**, **120** are each conventional arrangements that perform the dual functions of following a predetermined adjusting motion to a locked position. In the illustrated arrangement these toggles serve as a means for obtaining a rough location of head **100** with respect to drum **26** and belt **44**. Fine adjustment of head **100** is obtained by adjustment means including a flat plate portion **130** supported by suitable means on the fixed framework **42**. The plate **130** threadably supports a pair of spaced screws **132**, **134** that depend therefrom through elongated members or guide sleeves **136**, **138** respectively. Each of the screws **132**, **134** has a bifurcated end **139** thereon that is pivotally connected to a lug **140** on the side of the head **100** by a pin **141**. Each of the screws **132**, **134** also has a spring **142** located therearound held between a depending part on the plate **130** and the members **136**, **138** to bias the wedge-shaped head **100** away from the plate **130** to produce a desired vertical spacing of the tip **106** within the throat region **68**. A continuous chain **150** rides over sprockets **160**, **162** secured to the upper end of each screw **132**, **134**, respectively, whereby, upon adjustment of one of the screws, the chain **150** and sprockets **160**, **162** conjointly move and the screws **132**, **134** are closely adjusted equally in the vertical with respect to the flat plate portion **130** for changing the relationship between head **100**, belt **44** and drum **26**.

Accordingly, the dispenser head **100** can be closely adjusted to its operating position where it is spotted within the throat region **68** so that the concave rearward surface **114** and the forward surface **116** thereon will be in juxtaposition with the belt **44** and drum **26**, respectively. By virtue of the above-described adjusting mechanism, when it is desired to move the dispenser **92** exteriorly of the throat region **68**, it is merely necessary to release the toggle mechanisms **118**, **120**.

During the casting of molten material into the molds on drum **26**, temperature control of various portions of the device are fairly crictical. For example, if the temperature is too high at the dispenser, molten lead or the like may fountain up between the interface between dispenser head **100**, belt **44** and drum **26** or if the temperature is too low, the molten material may tend to solidify in the dispenser to restrict the continuous circulation of molten material transversely of the continuously advancing mold face. One representative thermal control arrangement includes thermal couple controlled cartridge heaters **164** having 400 watts at 115 volts located within openings **166** on either side of the head **100**. These heaters, under the control of thermocouples in thermowells **167**, maintain the material at approximately 600° F. when the initial temperature in the pot **80** is around 830° F. Under these circumstances, the drum **26** is preferably controlled at about 280° F. During casting of grids within the mold on the outer periphery of drum **26**, the web **30** of the drum is cooled to prevent the drum temperature from rising above the desired control range. In the illustrated embodiment of the invention, as shown in FIGURE 6, cooling is accomplished by spraying the web **30** with water from a spray gun apparatus **168**. The spray is controlled by a control pyrometer assembly **170** that measures the temperature of the inside surface of the drum through a surface mirror **172** that reflects.

It has been found that in some cases when the temperature control was maintained solely on the drum **26**, the grid surface cast against the belt **44** had a course grained structure. Accordingly, in certain cases, it may be desirable to also control the temperature of the belt by means similar to that used on the drum to obtain desired grain size characteristics on the belt side of the grids.

The continuous flow of molten material through the throat region **68** desirably takes place within a throat region having a maximum volume with a minimum area of contact with the drum and belt to assure that the belt will form relatively flash-free accurate grids on the outer periphery of drum **26**. In order to obtain maximum volume with a minimum area of contact, the throat should have a cross section as close as is feasible to an equilateral triangle. In addition to the geometric configuration of the throat area, other aspects of the invention assure that lead will completely fill the mold cavities and that excess molten material will return to the melting pot for reheating. Among these additional factors are: (1) a large excess of lead is directed by the pump **82** through the throat region to produce a sufficiently high velocity to prevent the circulating stream from solidifying; (2) the belt is constructed from a low-heat conductive material to minimize the temperature drop of the lead stream in the throat region; (3) the mold drum is hard coat anodized at the outer surface or mold area in rim **28**. Such an anodized coat has a low diffusivity of heat that minimizes the temperature drop of the lead stream on initial contact with the drum. In the illustrated machine the anodized coat is a .0035–.004″ insulation layer that has been sprayed with a very thin layer of a suitable break-in compound. For purposes of this specification, diffusivity refers to thermal conductivity divided by volumetric heat capacity.

Once a portion of the fluid lead stream has been wiped into the mold cavities by the belt **44** and the excess has flowed through the side openings into funnels **108**, **110**, the belt is driven along with the drum **26** to trap the molten material in the mold cavities for a predetermined period of time that enables the drum web **30** which has a high heat diffusivity and is constructed, for example, of aluminum to quench the grids while maintaining as uniform a temperature as possible across the mold surface by controlled heating thereof through a like pair of burners **174**, **176** located in proximity to the drum **26** on either side thereof. The burners serve primarily to preheat the drum **26** to the desired drum casting temperature at which time the circulating lead stream will maintain the temperature of the drum under control of the cooling spray gun **168**. A third burner pair **177** impinges on the return lines **112** to prevent solidification of the molten material therein.

Another aspect of starting the illustrated machine is that during initial startup, there might be a tendency for excessive flash to form on the surface of the drum. Accordingly, a skiver apparatus **178** is supported over plate **130** above drum **26** so that a blade portion **180** is located tangent to the diameter of the outer drum with the leading edge thereof closely adjacent on the vertical center line of the drum. The skiver apparatus includes suitable means for adjusting the leading edge of blade **180** so that it will not cut into the surface of the drum while removing excessive flash from the outer periphery thereof.

In summary, the improved method for continuously casting strips of articles having close dimensional tolerances is made possible by passing a continuous stream of

molten material tangentially to a continuously advancing rotary mold surface while wiping a predetermined portion of the continuously circulating stream into the mold cavity without materially reducing the temperature of the molten fluid stream below a desired temperature so as to maintain a desired fluidity. One working embodiment of a machine of the type discussed above successfully continuously casts battery grids from a lead alloy containing between 4% and 7% antimonial lead where the variations in liquid temperature produced by the differences in antimony in the alloy are compensated for by suitable changes in the drum temperature and temperature of the lead supply in pot **80**.

The method also contemplates the application of a uniform pressure upon the continuously circulated stream of molten material as it is being wiped into the rotary mold. For example, in the above illustrated machine, the equalizing roller produces the desired substantially constant pressure across the mold surface for wiping the desired portion of the stream of material therein. The fact that the belt and outer surface of the drum are of low conductivity material combines with the heating of the pool within throat region **68** to maintain the desired fluidity of the material as it is initially being cast into place. The fact that an excessive amount of material is circulated aids in maintaining a desired fluidity because the fluid stream passes at a relatively high velocity across the throat region during the casting process.

Furthermore, in the illustrated machine the method of quickly quenching the mold is carried out by the fact that the drum interior serves as a substantial heat sink of high-heat conductivity material closely adjacent the low-heat conductivity mold cavities of low diffusivity. The relationship of high and low heat diffusivity regions can be referred to as a "high-low" theory of casting. By virtue of this theory, it has been found that the final castings are uniformly quenched across the mold face in a relatively short period of time. Accordingly, the belt only has to pass over a portion of the drum less than 180° and because of the reduced contact between the drum and the continuous belt, the belt has improved wear characteristics.

By virtue of the above-described apparatus the casting rate can be increased or decreased by merely varying the cooling action of spray gun **168** to take care of the variation of heat input into the drum **26** produced by the operation thereof at changing speeds. Furthermore, variations in grid thickness can be easily compensated for in the illustrated machine by increasing lead supply and water flow to the spray gun to compensate for the added heat input into the system produced by the increased grid thickness. Like reductions in lead supply and cooling water flow will occur for castings having smaller thicknesses.

In accordance with other concepts of the present invention, in certain cases the mold shape might be such that it is difficult to overcome the surface tension of the molten material being wiped therein by belt **44**. In this case, the mold cavity has been modified to the form best illustrated in FIGURE 7 to have a layer **182** of low-thermal conductivity material that is substantially greater in thickness than the anodized surface discussed above but still of low diffusivity. Furthermore, the low-conductivity surface does not overlie all portions of the grid mold cavity. For example, in FIGURE 7, the low-conductivity material is such that the material being wiped from the throat area **68** into the outer periphery of the drum **26** is chilled at the base of depressions **72'**, **74'** and **76'** corresponding to like depressions in FIGURE 4. The drum **184** in this embodiment is of a high-conductivity material such as aluminum having high diffusivity that will rapidly chill the molten material in the bottom of the mold depressions while the remainder of the casting configuration is maintained at a higher temperature because of the low-heat diffusivity properties of the insulating layer **182**. Because of this modified high-low principle of casting, it has been found that the surface tension of the molten material is substantially overcome so that the molten material will substantially completely fill all portions of the grooves of the mold to assure accurate mold reproduction. The small area of the mold that has the high-heat conductivity characteristics will not substantially raise the overall heat transfer from the pool in the vicinity of throat **68** sufficiently to make material solidification a problem prior to complete filling of the mold. This high-low principle of casting has been carried out by using a rubber insulating coat with it being understood that other suitable insulators, for example, synthetics such as epoxy resins and the like would be equally suited for practicing this aspect of the invention.

In the embodiment of FIGURE 8, the high-low principle is carried out by forming an insulating layer **186** on the outer surface of a lug **188** that is bolted to the outer rim **190** of a rotary drum **192**. In this embodiment depressions like those in FIGURES 2–6 and FIGURE 7 are formed in the layer **186** and each lug is sealed at its end by a seal insert **194** that extends transversely across the full width of the rim **190**.

While the embodiments of the apparatus of the present invention as herein disclosed constitute preferred forms, it is to be understood that other forms might be adopted and furthermore, it is understood that the method may be practiced by apparatus other than that illustrated.

What is claimed is as follows:

1. A continuous casting method comprising the steps of, forming an open ended throat region between a rotary drum having cavities in its face and a continuous belt for closing the cavities, continuously exposing a limited extent of the cavities to the throat region by rotating the drum, pumping a predetermined amount of molten material into the throat region in excess of the volume of the cavities exposed to the throat region, wiping a part of the predetermined amount of molten material into the cavities in the face of the rotary drum, diverting the excess molten material through the throat region end openings to maintain a flow velocity throughout the throat region to prevent metal solidification in the throat region, trapping the molten material wiped into the mold cavities for a predetermined period of time until the material solidifies therein, and removing the solidified material from the mold cavities.

2. In the method of claim **1**, said pumping of molten material into the throat region including directing the molten material into a central part of the throat region to cause velocity flow transversely of the face of the rotary mold in substantially equal divided quantities from the central part of the throat region to the throat end openings throughout the width of the face of the drum.

3. In the method of claim **1**, said wiping including application of a uniform and constant pressure against the belt along an axis across the width of the belt by pivotally supporting the belt at its contact with the drum surface for free pivotal movement toward and away from the rotary drum.

4. The combination of claim **1**, including the further step of controlling the drum temperature by sensing the inside surface temperature of the drum and spraying the drum with cooling water in accordance with the sensed temperature.

5. A method for continuously casting battery grids in mold cavities on a rotary drum comprising the steps of engaging a continuous belt with a segment of the rotating drum through less than 180° of the outer circumference of the drum, locating a dispensing head immediately above the initial point of engagement between the belt and drum to form an open-ended throat region for the flow of molten metal into the mold cavities and for the escape of excessive molten metal from the sides of the dispensing head, directing molten metal at a predeter-

mined flow rate into the throat region to cause filling of the mold cavities and flow through the open ends of the throat region, applying a continuously uniform pressure across the width of the belt to cause the belt to uniformly press the molten metal in the throat region into the mold cavities, and conjointly controlling heat input to the metal in the throat region and heat loss from the drum to prevent the molten material from escaping at interfaces between the dispensing head and the rotary drum while preventing solidification of the molten material prior to filling the mold cavities.

6. In the method of claim 5, said conjoint controlling including sensing the temperature of the metal in the throat region and directing heat energy to the dispenser for heating molten metal as it enters the throat region, said conjoint controlling further including sensing the inside surface temperature of the drum and spraying the drum with cooling water in accordance with the sensed temperature.

7. In the method of claim 5, limiting thermal heat transfer from the throat region by providing a layer of low heat diffusivity on the drum to reduce heat flow from the cavities therein while the cavities pass through the throat region.

References Cited

UNITED STATES PATENTS

521,791	6/1894	Griscom	164—276
883,312	3/1908	Holley	164—278
1,220,211	3/1917	Feldcamp et al.	164—278
1,612,737	12/1926	Lane	164—278
1,651,678	12/1927	Davis	164—278
2,206,930	7/1940	Webster	164—278 X

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