Sept. 19, 1933. E. BAUER 1,927,384

CASTING MACHINE

Filed May 31, 1929 5 Sheets-Sheet 1

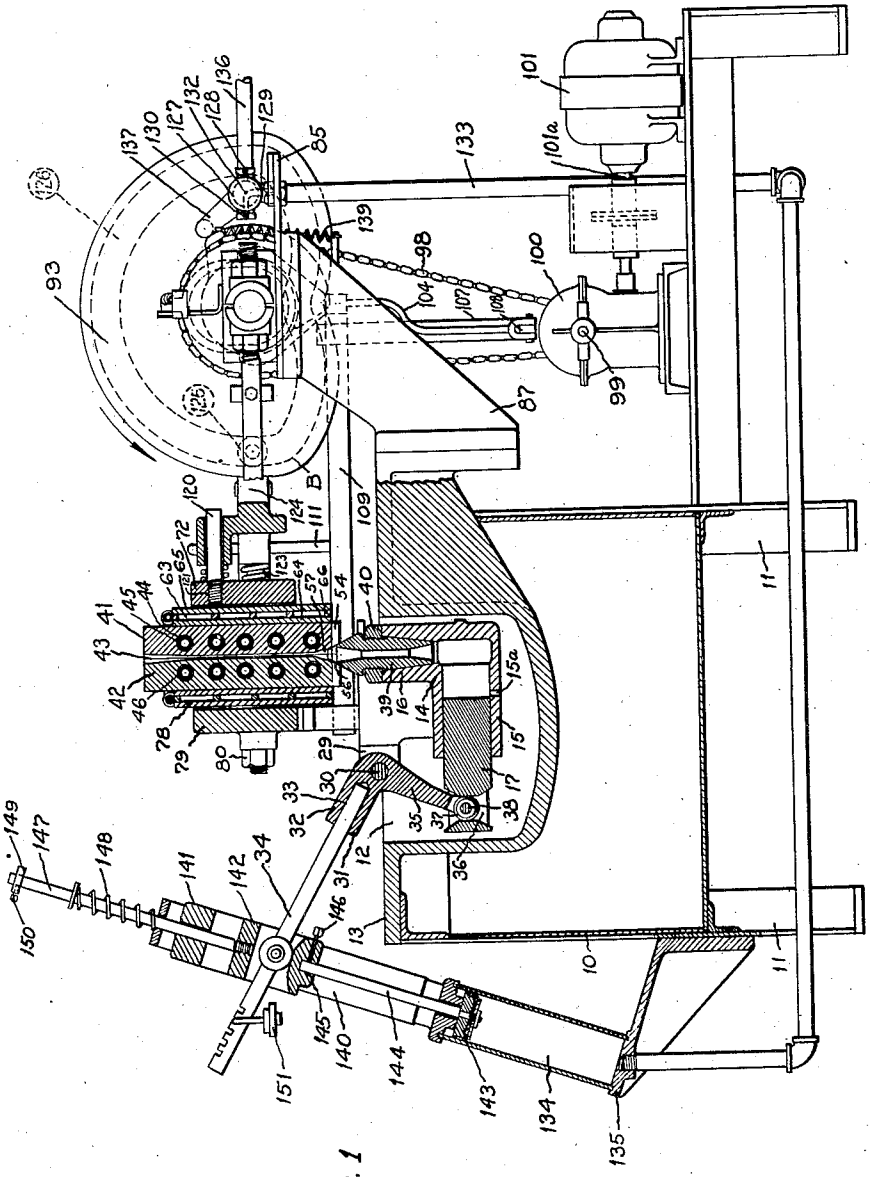


Fig. 1

INVENTOR
Ernst Bauer
BY George H. Souther
ATTORNEY

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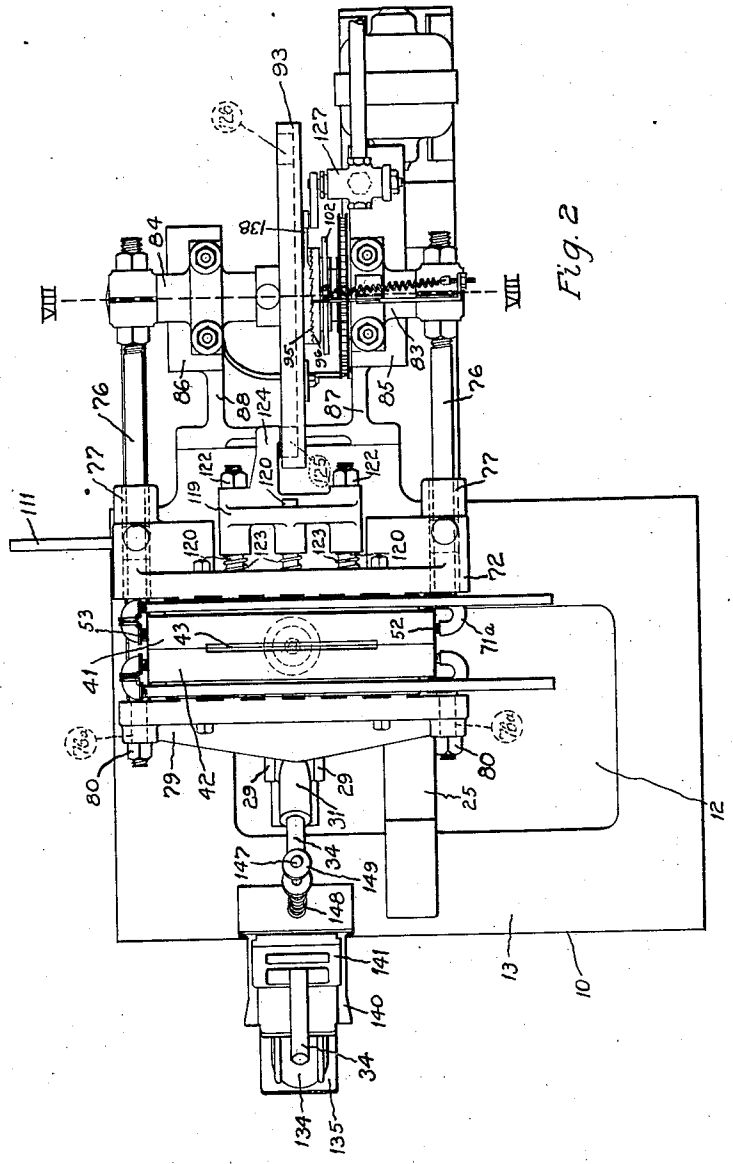



Fig. 2

INVENTOR
Ernst Bauer
BY George H. Souther
ATTORNEY

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CASTING MACHINE

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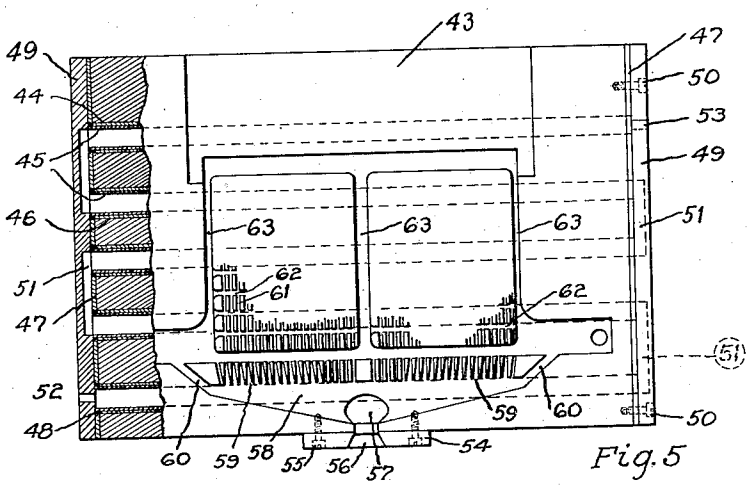



Fig. 5

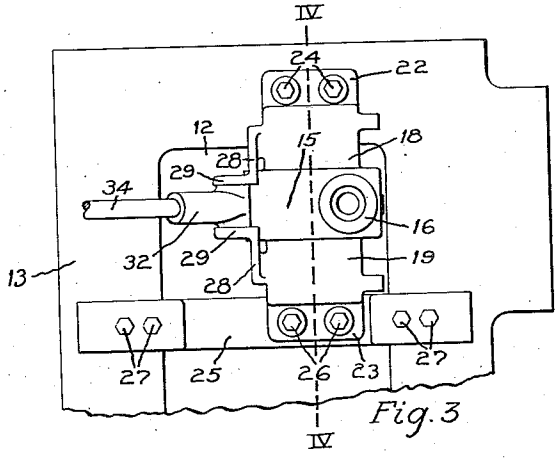



Fig. 3

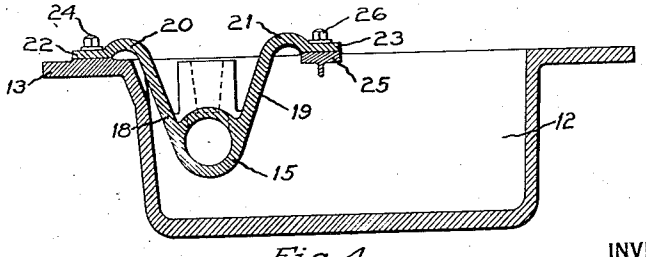



Fig. 4

INVENTOR
Ernst Bauer
BY George H. Pointer
ATTORNEY

Sept. 19, 1933. E. BAUER 1,927,384

CASTING MACHINE

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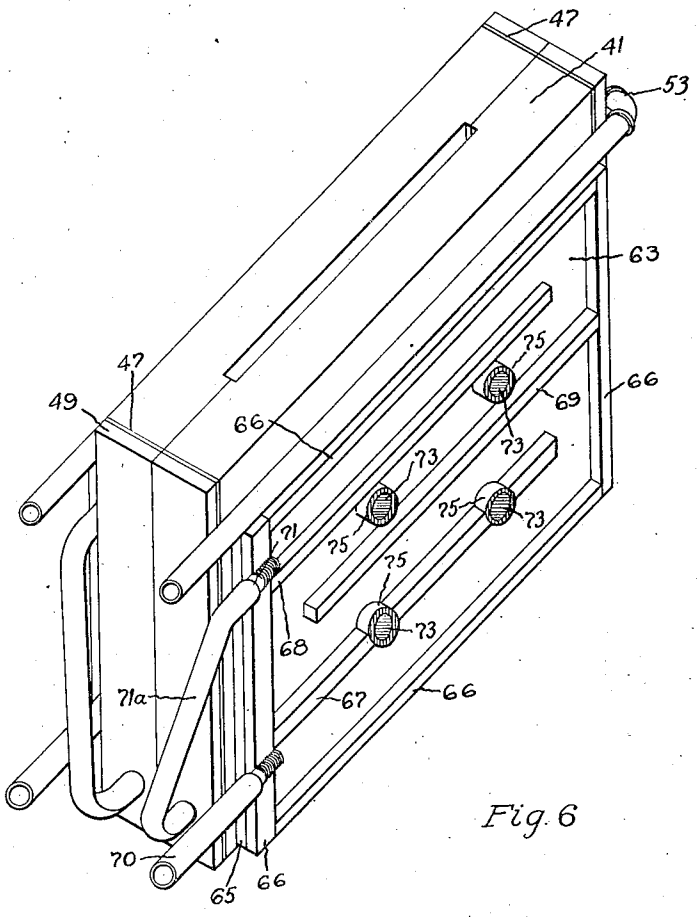



Fig. 6

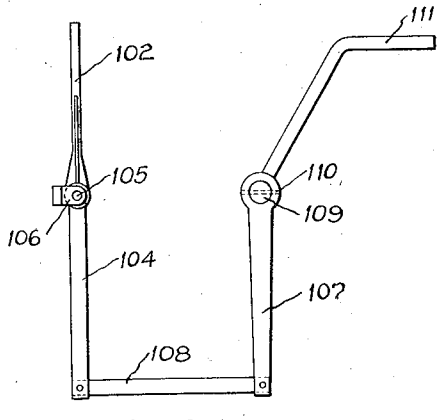



Fig. 9

INVENTOR
Ernst Bauer
BY George H. Souther
ATTORNEY

Sept. 19, 1933. E. BAUER 1,927,384

CASTING MACHINE

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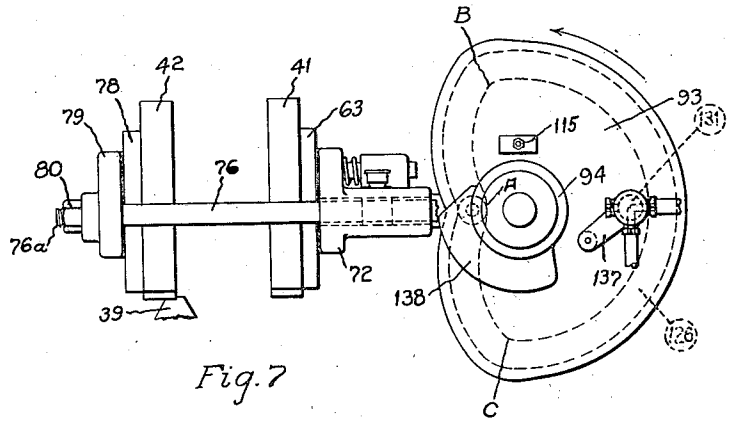



Fig. 7

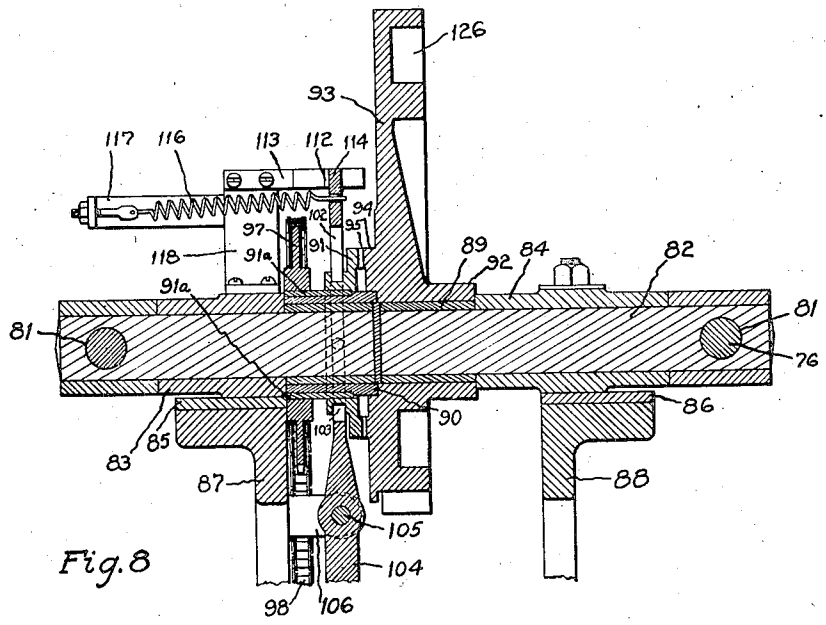



Fig. 8

INVENTOR
Ernst Bauer
BY George H. Souther
ATTORNEY

Patented Sept. 19, 1933 1,927,384

# UNITED STATES PATENT OFFICE

1,927,384

## CASTING MACHINE

Ernst Bauer, Niagara Falls, N. Y., assignor to U S L Battery Corporation, Niagara Falls, N. Y., a corporation of New York

Application May 31, 1929. Serial No. 367,437

21 Claims. (Cl. 22—57)

My present invention relates to casting machines and more particularly to automatic machines for casting storage battery grids.

I am aware that various types of automatic or semi-automatic grid casting machines have been heretofore proposed, but, so far as I am aware, none of the proposed machines have been capable of successful operation. This has been due chiefly to failure to recognize and give sufficient consideration to the various physical conditions encountered in the manufacture of a grid, and which render the ordinary die-casting machines and processes inapplicable to the above-mentioned art.

The ordinary storage battery grid comprises a large number of fine wires supported by somewhat heavier cross-bars, the wires and cross-bars being surrounded by a still heavier frame. The grid is usually cast from an alloy of lead and antimony, the latter being present in small quantities to lend mechanical strength to the lead. The specific heat of such an alloy is very low and consequently, when the molten lead comes into contact with the relatively cool surfaces of the mold, particularly in the smaller grooves thereof, solidification occurs very rapidly. In order to prevent the occurance of any premature solidification, it is essential that the said grooves be filled with molten metal within a minimum period of time. This must be accomplished, however, without placing the molten metal under high pressure to avoid segregation. It is equally essential that the formation of air pockets within the mold be prevented, as any air trapped within the mold will obstruct the flow of molten metal to all of the mold passages and there will result a porous and fragmentary grid. In the larger grooves, in which those parts of the grid constituting the frame are formed, however, the action is entirely different. Here, because of the larger cross-sectional area of the grooves, a longer period of time is required for the metal therein contained to solidify completely. The relatively cool metal of the mold coming in contact with the molten metal entering the said grooves, will form an outer crust. If the action of the pump is cut off the instant that the mold is filled with metal and before the frame portions of the grid have completely solidified, the molten metal will run out of the mold, leaving such portions hollow. I have found that very satisfactory results may be obtained by continuing the feeding stroke of the pump piston in the manner described below, until all of the metal contained in the mold cavity is solidified.

According to my invention, the molten metal is fed to the mold at a variable rate, being initially relatively high in order to completely fill all of the mold grooves substantially instantaneously, and sloping off to a very slow rate for retaining the molten metal within the mold cavity until solidification has occurred and assuring that the larger grooves thereof are completely filled with metal. The mold is so designed that the air will be expelled therefrom by the molten metal as it enters, thereby effectively preventing the formation of air pockets within the mold.

An object of my invention is to provide a machine for casting storage battery grids which, with the exception of the removal of the grid from the mold, is entirely automatic in its operation.

A further object of my invention is to provide an automatic grid-casting machine wherein the molten metal is fed to the mold at a variable rate.

A further object of my invention is to provide a novel form of mold for casting storage battery grids.

A further object of my invention is to provide a novel method for manufacturing storage battery grids.

Other objects and advantages will become apparent as the description proceeds.

A clearer understanding of my invention may be had by reference to the accompanying drawings wherein:

Figure 1 is a side elevational view thereof, certain parts being shown in section.

Figure 2 is a top plan view.

Figure 3 is a top plan view of the pump showing the manner of mounting same.

Figure 4 is a sectional view taken on the line IV—IV of Figure 3.

Figure 5 is a front elevational view of one of the mold sections, a portion thereof being shown in section.

Figure 6 is an isometric view of the mold sections and cooling chamber.

Figure 7 is a side elevational view of the mold and operating means.

Figure 8 is a sectional view taken on the line VIII—VIII of Figure 2, and

Figure 9 is an end elevational view of the manually operated lever and connected parts.

In the form of my invention illustrated, reference numeral 10 designates a furnace which may be of any suitable type and which is supported by legs 11. The furnace may be heated by combustion or electrically. A melting pot 12 is formed

integrally with the furnace top 13 and extends downwardly into furnace 10. During the operation of the machine, the melting pot is substantially filled with molten metal. Arranged therewithin, so as to be submerged in the molten metal, is a pump 14 comprising a horizontal cylinder 15 having one end open, and having a vertical cylinder 16 rising from the opposite end thereof. A piston 17 extends through the open end of cylinder 15 and is adapted for reciprocal motion therein. A port 15*a* extends through the wall of the cylinder 15 at the under side thereof for admitting molten metal to the said cylinder. With the piston 17 in its extreme left-hand position (Fig. 1) the port 15*a* is uncovered. As the piston starts to move toward the right, it covers the said port 15*a* and prevents the admission of more metal trapping within cylinder 15 the metal already admitted thereto. By this construction the volume of metal admitted to the pump cylinder for each stroke of the piston, may be pre-determined and will remain constant throughout the operation of the machine.

The pump 14 is supported by a pair of arms 18 and 19 which are formed integrally with the cylinder 15, and which extend upwardly and outwardly therefrom, the outer ends being bent back upon themselves to form curved portions 20 and 21, and flat portions 22 and 23, respectively. The curved portions 20 and 21 are positioned a short distance above the furnace top 13. In the form shown, the flat portion 22 of arm 18 is bolted to furnace top 13 by means of bolts 24, and the corresponding portion 23 of arm 19 is bolted to a strap 25 by bolts 26. Strap 25 extends across melting pot 12 and is secured to the top 13 at either side thereof by bolts 27. The central portion of the strap is depressed a distance equal to its thickness in order that the upper or supporting surface thereof will lie in the plane of the upper surface of top 13. It sometimes becomes necessary to remove the pump cylinder 15 for cleaning or for repairing purposes. With the arrangement shown, this may be accomplished within a minimum period of time with the pump in the hot condition, by removing bolts 24 and 26 and inserting lifting tools under curved portions 20 and 21 of arms 18 and 19 respectively.

Extending laterally from the upper portion of each of the arms 18 and 19 is a bracket arm 28 having an ear 29 at the free end thereof, said ears being perforated to accommodate a pivot pin 30 upon which is pivoted a bell crank lever 31. Arm 32 of lever 31 is bored longitudinally for a portion of its length to provide a recess 33 adapted to receive one end of a rod 34. The free end of arm 35 of lever 31 extends into a recess 36 formed in the pump piston 17, and is bifurcated to accommodate a roller 37 supported between the forked ends of said arm by a pin 38, which extends through said roller and said forked ends. Roller 37 reduces friction between lever 31 and pump piston 17. Recess 36 is flared to allow limited movement therein of arm 35.

Extending through the upper open end of cylinder 16 is a nozzle 39, the lower end of which is tapered to correspond with the tapered surface of the inner wall of cylinder 16. As will be hereinafter described more in detail, nozzle 39 acts as a point of support for the mold assembly located directly thereover. The weight of the said assembly acting downwardly upon the nozzle, causes the latter to become tightly wedged within the cylinder 16 and assured a tight fit therebetween. The nozzle may be easily removed from cylinder 16 by means of a nut 40, screw-threaded on the portion of said nozzle extending above said cylinder. Turning the nut down against the top of said cylinder will lift the nozzle therefrom. The inner surface of the nozzle is slightly flared toward either end for a purpose to be hereinafter described.

The mold is located directly over the nozzle 39 and comprises two parts 41 and 42, arranged vertically and containing the mold cavity 43, the latter being open to the atmosphere through the top of the mold. A series of parallel passages 44 extend laterally through each of the mold sections 41 and 42 and in each said passageway is a tube 45 of slightly smaller diameter. The spaces between the outsides of the tubes 45 and the walls of passageways 44 are filled with solder 46 to insure intimate contact therebetween. A thin plate 47 fits against each end of each mold section, as best shown in Figure 5. Tubes 45 extend through plates 47, the ends thereof being flush with the outer surfaces of said plates. The portions of plates 47 immediately surrounding the ends of said tubes are cut away to provide recesses 48 which are filled with solder to provide tight joints. An end plate 49 fits against each plate 47, and bolts 50 which extend through plates 47 and 49 and into the end of the mold, secure the said plates thereto. The surfaces of plates 49 which contact with plates 47 are provided with grooves 51, sufficiently long to extend over the ends of two tubes 45 and so arranged that there is formed a continuous passageway from an inlet perforation 52 in one of the said plates 49, to an outlet perforation 53 in the plate 49 at the opposite end of the mold section. The temperature of the mold is controlled by cooling water which enters through inlet 52 and which flows through tube 45 and connecting grooves 51, being ultimately discharged through outlet 53.

A plate 54 is secured to each mold section at the central portion of the lower edge thereof by means of screws 55. A portion of each plate 54 is cut away, as indicated at 56, whereby, when the mold is in the closed position, recesses 56 form a conical perforation into which the upper end of nozzle 39 extends.

The mold which I prefer to use is of the interlocking double type, that is, it is so designed as to cast two grids as a unit. Each mold face is provided with a relatively deep cavity 57, and a shallow cavity 58, which, with the mold in the closed position, form a lead-receiving chamber located directly over nozzle 39, and to which molten lead is fed by pump 14. Extending substantially vertically from each depression 58 are a plurality of small grooves or feeders 59 of approximately the same cross-sectional area as said grooves and through which molten metal for forming the grid proper passes. A larger passageway 60 extends from each end of the chamber formed by depressions 58, for supplying lead to form the grid frame. The fine wires of the grid are formed in vertical grooves 61 cut in the mold face, and said wires are held in position by cross-bars formed in the larger horizontal grooves 62. It should be noted that a feeder 59 is arranged directly below each vertical groove 61. The grid frame is formed in large grooves 63. With this construction the metal flowing from the chamber 58 into the mold cavity is broken up into a plurality of separate streams of small diameter except for that portion which passes through large grooves 60. Each groove

61 is supplied by a separate stream and the entire mold cavity is entirely filled with metal substantially instantaneously.

It will be noted that the walls of the feeders 59, with the exception of those located in proximity to chamber 57, converge. The purpose of this is to impart to the metal flowing through said feeders under the action of pump 14, a relatively high velocity to entirely fill the mold cavity with molten metal with a minimum period of time.

I have found that the temperature of the mold may be more evenly and satisfactorily controlled by arranging a cooling chamber 63 in contact with the rear surface of each mold section through which the mold cooling water may flow before entering the mold. The chamber is formed by a pair of parallel plates 64 and 65, separated by spacing bars 66, which are welded to the plates adjacent their edges and which form four sides of the chamber. In Figure 6 I have shown the interior of the chamber 63 secured to mold section 41. Bars 67 and 68 extend from one side thereof, terminating adjacent the opposite side, and a bar 69 extends from the said opposite side between and parallel to bars 67 and 68. Bars 67, 68 and 69 act as baffles, causing the cooling water which enters chamber 63 from a source of supply through inlet 70, to flow back and forth in a horizontal direction from said inlet to an outlet 71 provided in the upper portion thereof. A short pipe 71*a* connects outlet 71 with the inlet 52 of the mold.

The cooling chamber 63 and mold section 41 are mounted on a mounting block or plate 72 by bolts 73 which extend through said block and chamber and into threaded recesses 74 formed in the rear surface of the mold. To prevent leakage of water from chamber 63, bolts 73 may extend through bushings 75 which extend laterally through the chamber. Mounting plate 72 is supported upon guide rods 76 by means of bearings 77, one of which is provided at each side of said plate. Stationary mold section 42 is provided with a cooling chamber 78 similar to chamber 63 and which need not be described here in detail.

Chambers 62 and 78, in addition to serving as cooling chambers, lend rigidity to the mold proper. During the operation of the machine, hot metal comes in contact with the inner surface of each mold section. The outer surfaces thereof being relatively cool the mold sections tend to warp. A very slight warping of either section is sufficient to render the mold useless as it permits the formation of flash by the metal which is thus permitted to escape from the mold passages. It is therefore essential that some type of reinforcing means be employed to prevent the occurrence of such warping. Chambers 62 and 78 perform this function in addition to that above described.

Chamber 78 and mold section 42 are mounted upon a mounting plate 79 in the same manner as section 41 and chamber 63. The reduced ends 76*a* of guide rods 76 extend through apertures provided at either side of the mounting plate 79 and nuts 80 hold the plate rigidly against the shoulders formed on the guide rods by reducing the ends thereof. The opposite ends of guide rods 76 extend through apertures 81 formed adjacent either end of a horizontal stationary shaft 82. It should be noted that the major portion of the weight of the mold assembly, including guide rods 76, is borne by nozzle 39, the only other points of support of the said assembly being where the said guide rods pass through shaft 82. Shaft 82 also supports the operating mechanism for opening and closing the mold, and for controlling the action of the lead pump, and which will now be described in detail.

Shaft 82 is mounted by means of bushings 83 and 84 which are bolted to horizontal plates 85 and 86 respectively. Brackets 87 and 88, which are secured to the side of furnace 10, support the plates 85 and 86 respectively. Bushings 83 and 84 are located on either side of the center of shaft 82 and a stationary bushing 89 extends therebetween. Mounted upon the portion of bushing 89 nearer bushing 83, is a rotatable bushing 90. A clutch member 91 is keyed to bushing 90 by means of keys 91*a*, so as to rotate therewith, and is slidable longitudinally of said bushing. Mounted upon bushing 89, between bushings 84 and 90 so as to rotate thereon, is the hub 92 of a large cam 93 having a boss 94 formed on the face thereof adjacent clutch member 91. Boss 94 is provided with teeth 95 which are adapted to be engaged by similar teeth 96 formed on the member 91. When the latter member is slid to the right (Fig. 8) the said teeth will become engaged and the cam will be caused to rotate. This action will continue until member 91 is moved to the left, thereby disengaging teeth 96 from teeth 95. Bushing 90 is rotated by a sprocket-wheel 97 which is keyed thereto by keys 91*a*. A chain 98 extends over the sprocket wheel and engages a second sprocket wheel (not shown) mounted on the shaft 99 of a speed reduction unit 100, the latter being driven by a motor 101 through shaft 101*a*.

For sliding the clutch member longitudinally along bushing 90 there is provided a clutch ring 102 which fits in a groove 103 formed in the hub of said member. The clutch ring is carried at the upper end of a vertical lever 104 which is pivoted intermediate its ends on a pivot pin 105 extending through apertures formed in a pair of ears 106 projecting from bracket 87. Lever 104 is connected at its lower end to a crank 107 by means of a link 108. The upper end of crank 107 embraces a horizontal shaft 109 and is fixed to rotate therewith by a pin 110. A hand-operated crank 111 is also rigidly connected to shaft 109 whereby the clutch may be manually operated. Downward pressure upon crank 111 will rotate shaft 109 clockwise looking at Fig. 9, and will cause the lower ends of crank 107 and lever 104 to be moved to the left. The clutch ring 102 and member 91 will be moved to the right until teeth 96 of member 91 engage teeth 95 of boss 94, causing cam 93 to rotate. The parts are held in this position by a detent 112, carried by a spring arm 113 in the path of travel of a finger 114 which projects upwardly from clutch ring 102. The free end of arm 113 terminates at a point adjacent cam 93 in the path of a releasing finger 115 which protrudes from said cam. During the rotation of the cam, the finger 115 engages arm 113 and deflects it a sufficient distance to move detent 112 out of engagement with finger 114, permitting the clutch ring to be moved to the left (Fig. 8) by a strong spring 116, one end of which is secured to finger 114, and disengaging clutch member 91 from teeth 95. The action of spring 116 upon finger 114 will be transmitted through lever 104, link 108, crank 107, shaft 109 to manually operated crank 111 to return all of said members to their original positions. The other end of spring 116 is fastened to an arm

117 carried by a bracket 118 extending upwardly from and secured to bushing 83 and which also supports spring arm 113.

Cam 93 operates through a bracket 119 to slide the movable mold section horizontally on guide rods 76 for opening and closing the mold. Bracket 119 is secured to mounting plate 72 by bolts 120 having screw-threaded end portions adapted to engage internal threads formed in the walls of apertures 121 in the face of said mounting plate. The outer ends of the two outside bolts 120 are threaded to receive nuts 122. The bracket is held against nuts 122 by heavy springs 123, one of which is placed around each bolt 120 between plate 72 and bracket 119. An arm 124 is formed integrally with said bracket, and a cam roller 125 is pivoted to the free end thereof in a laterally off-set position. Cam 93 is provided with a continuous groove 126 formed in the face thereof adjacent the edge of said cam and which is adapted to loosely receive roller 125. As the cam rotates, the sides of groove 126 function as cam surfaces, upon which the cam roller 125 is adapted to roll. The cam is so designed that the opening and closing movements of the mold are each accomplished during less than a quarter revolution of the cam, and for the remainder of the revolution, or approximately two hundred degrees, the mold remains closed. With the cam rotating in the direction of the arrow, (Fig. 1) the portion A—B serves as the closing portion. As this portion passes roller 125, the inner track of groove 126 exerts a pushing force on said roller and moves movable mold section 41 to the left until the mold face of said section just contacts with the mold face of stationary section 42. The mold remains in this position until the point C passes roller 125, when the outer track of the portion C—A of groove 126 pulls the roller and connected parts to the right until they occupy the position shown in Fig. 7.

The action of lead pump 14 is controlled by a valve 127 of the rotary plug type mounted on plate 85 and having three ports 128, 129 and 130. Plug 131 of the valve is provided with a right-angle passageway 132 adapted to establish communication between port 129 and either of the ports 128 and 130. Port 130 communicates with the atmosphere. A pipe 133 connects port 129 with a cylinder 134 mounted on a bracket 135. Port 128 is connected to a source of supply of air under pressure (not shown) by means of pipe 136. Mounted rigidly upon the valve plug is an arm 137, the free end of which is positioned in the path of travel of a small cam 138 formed integrally with boss 94. A coiled spring 139 having one end secured to arm 137 tends to hold the arm in its downward or lowermost position. During the rotation of cam 138 it engages the free end of arm 137 and rotates it to its upper position against the tension of spring 139.

Directly above cylinder 134 is a yoke 140, the sides of which act as guides for a counter weight 141 in the form of a rectangular frame having a central horizontal partition 142. A piston 143 within cylinder 134 is connected to counter-weight 141 by means of a rod 144 which extends through the top of said cylinder and into a recess 145 formed in the bottom of said counterweight. A set screw 146 holds the rod in said recess. The free end of lever 34 extends through said counter-weight between partition 142 and the bottom thereof. A rod 147 extends through an aperture in the top of yoke 140 and is screw-threaded or otherwise secured to partition 142, so as to be slidable with the counter-weight. A coiled spring 148 is placed around rod 147, the lower end thereof resting on the top of yoke 140 and the upper end being adapted to be engaged by a collar 149 secured to rod 147 by a set screw 150.

The operation of the machine will be described, starting with the various parts in the position shown in Fig. 1. It will be noted that cam roller 125 has just passed point B of cam groove 126, so that the mold has just been moved to the closed position. Piston 143, counter-weight 141 and lever 34 are occupying their uppermost positions, and piston 17 is at the extreme left hand end of its stroke. Port 15a is uncovered and cylinder 15 is filled with molten metal. Arm 137 and valve plug 131 have been rotated by cam 138 to the position shown, in which passageway 132 is in registry with ports 129 and 130. The clutch mechanism is at this time in the position shown in Figure 8. Clutch member 91 has been moved to the right and is being held in operative engagement with cam 93 by detent 112 and clutch ring 102. The instant that valve 127 has assumed the position shown, the air in cylinder 134 will exhaust to the atmosphere and the piston 143, counter-weight 141 and lever 34, due to the force of gravity, will drop freely and rapidly for a short distance. This short quick movement of lever 34 which is transmitted to piston 17 through bell crank lever 31, will cause a portion of the metal in cylinder 15 to be forced through nozzle 39, lead receiving chambers 57 and 58 and feeders 59, at a relatively high velocity and the small passageways 61 and 62 will be filled with metal almost instantaneously and before any of the metal has had an opportunity to solidify. I have found that by tapering the inner wall of the nozzle as shown, the velocity of the metal flowing into the mold during this part of the feeding operation may be substantially increased. The weight of the mold assembly acting upon the top of nozzle 39 effectively prevents the flow of any molten metal therebetween. This rapid movement of piston 17 occurs only during the initial portion of its stroke, and is checked by the cushioning effect of the molten metal trapped within cylinder 15 and also by the action of spring 148 upon collar 149. These two forces cause a deceleration in the drop of counterweight 141, which is initially very rapid, becoming very slow towards the end of the movement, and a consequent slowing up in the speed of piston 17, until during the latter part of its stroke, its movement is very gradual and its velocity is very nearly uniform. During the initial rapid portion of the piston stroke, the metal is forced into the mold at a very high velocity and the mold is completely filled substantially instantaneously. In the smaller grooves 61 and 62, the metal solidifies almost immediately upon coming into contact with the mold surfaces. In the larger grooves, however, solidification occurs more slowly due to the larger cross-sectional area of the grooves. The metal at the center of these grooves is the last to solidify and there is a tendency for that part of the metal, if fed at a high velocity, to flow out of the mold cavity into the overflow space 42' provided in the mold at the top of said cavity. The latter portion of the piston stroke serves not only to replace any metal which may have flowed into the space 42' and there solidified, but also to retain all the metal in the mold until solidification has been completed. By providing a mold having its top open to the atmosphere, the possibility of forming air pockets is eliminated. The

air is expelled through the open top at the same rate that the metal enters through the bottom.

It is to be noted that the success of my casting machine is primarily due to the above described manner of feeding the molten metal to the mold. If the lead were fed at a uniform rate it would be impossible, because of the varying cross-sectional areas of the mold grooves, to fill completely all of the grooves with metal. A velocity sufficient to fill all of the smaller grooves 61 before solidification occurs will leave the larger grooves 63 but partially filled, and, conversely, if the velocity is reduced to a degree which permits metal to remain in passages 63 until it solidifies the molten metal will be prevented from reaching the more remote grooves 61 by the metal which will solidfy prematurely in those grooves 61 nearer the inlet. It is only by varying the rate of feeding in the manner above described that it is possible to cast a perfect grid. The proper rate of diminution necessary for the successful operation of the machine will vary for different size grids and may be arrived at by adjusting collar 149 and/or weights 151.

At approximately the instant that piston 134 and connected parts reach the end of their stroke, arm 137 is released from cam 138 and is snapped downwardly by spring 139 until passageway 132 is brought into registration with ports 128 and 129, admitting air under pressure to cylinder 134, and raising piston 143, counter-weight 141 and lever 34 back to the position shown in Figure 1. The movement toward the left of piston 17 will cause the molten metal which still remains in nozzle 39 and the chamber formed by recesses 57, to be drawn back into the pump. Due to the relatively large cross-sectional area of said chamber, the metal therein contained will always be in the molten state at this time. During the action so far described, cam roller 125 has been in the semi-circular section B—C of track 126 and the mold has remained closed. As soon as piston 143 reaches the top of its stroke, the point C of cam groove 126 passes the cam roller and the outer track of section C—A of said groove functions to open the mold. Finger 115 is so positioned on cam 93 that it will engage the free end of arm 113, deflecting said arm and releasing finger 114 from detent 112, thereby disengaging clutch member 91 from cam 93 and stopping the rotation of the cam, just as the cam roller comes in contact with point A of the cam groove, or, in other words, when the mold is in the full open position shown in Fig. 7. The grid may now be removed from the mold by the operator.

To start the rotation of the cam, the operator pushes downwardly upon the free end of crank 111 and this motion is transmitted to the clutch 91 in the manner already described, to move the latter into engagement with the cam. The inner wall of section A—B of the cam groove will then move the mold to the closed position shown in Figure 1 and the cycle of operation already described will be repeated.

I have found aluminum bronze to be the most satisfactory alloy from which to make the molds as it is very hard, is a good heat conductor and there is no tendency of the metal to adhere thereto. The faces of the molds are smoked in the usual manner with a smoking torch. By mounting the movable mold section in the manner described, no serious injury will result from the closing of the mold should the layer of smoke be too thick or should a tool or other object be accidentally dropped between the mold sections. In either case the result will be a relative motion between bracket 119 and bolts 120 against the tension of springs 123.

In the above description I have illustrated one form of my invention. I am aware that various details of construction may be modified. I therefore do not intend to limit the patent granted to the form shown, but intend it to cover all modifications falling within the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. In a casting machine, a mold, mechanism for feeding molten metal to said mold, gravity operated means for actuating said mechanism, and means for modifying the gravitational effect upon said gravity-operated means.

2. In a casting machine, a mold, mechanism for feeding molten metal to said mold, gravity-operated means for moving said mechanism in one direction, means for modifying the gravitational effect upon said gravity-operated means, and means for returning said mechanism and said gravity-operated means to their respective original positions.

3. In a casting machine, a mold, a melting pot adapted to contain molten metal, a pump cylinder submerged in said molten metal and connected to said mold, a piston in said cylinder, gravity-operated means for moving said pump piston in one direction, a spring for diminishing the gravitational effect upon said gravity-operated means whereby the speed of said piston and the rate at which molten metal is fed to said mold are reduced, and pneumatic means for returning said piston and said gravity-operated means to their respective original positions.

4. In a casting machine, a mold, a melting pot adapted to contain molten metal, a pump cylinder submerged in said molten metal and connected to said mold, a piston in said cylinder, means for producing a power stroke of the piston, and pneumatic means for returning said piston and said first-named means to their respective original positions.

5. In a casting machine, a mold, a melting pot adapted to contain molten metal, a pump cylinder submerged in said molten metal and connected to said mold, a piston in said cylinder, means for producing a power stroke of the piston, and means acting to retard the power stroke to thereby retard the feeding action at the end of the stroke.

6. In a casting machine, a mold, a melting pot adapted to contain molten metal, a pump cylinder submerged in said molten metal and connected to said mold, a piston in said cylinder, means for producing a power stroke of said piston, means acting to retard the power stroke to thereby retard the feeding action at the end of the stroke, and means for returning said piston and said first-named means to their respective original positions.

7. A casting machine comprising a mold, means for opening and closing said mold, gravity-operated means for feeding molten metal to said mold at a variable rate, and means controlled by said opening and closing means for returning said gravity-operated means to its original position.

8. A casting machine comprising a mold having a movable part and a stationary part, means for moving said movable part to open and close said mold, gravity-operated means for feeding molten metal to said mold, and pressure-operated

means for returning said gravity-operated means to its original position.

9. A casting machine comprising a mold having a stationary part and a movable part, means for moving said movable part to open and close said mold, gravity-operated means for feeding molten metal into said mold at a variable rate, and means for automatically returning said gravity-operated means to its original position.

10. A casting machine comprising a separable mold, a cam for moving a portion of said mold to open and close same, means for feeding molten metal to said mold, means operated in one direction by gravity for operating said feeding means, a cylinder adapted to receive a fluid under pressure, a piston in said cylinder, a piston-rod connecting said piston to said gravity-operated means, a source of supply of fluid under pressure, a conduit connecting said source with said cylinder, means interposed between said source and said cylinder for regulating the supply of said fluid to said cylinder, and a second cam rotatable with said first cam for operating said regulating means to alternately supply air to and vent air from said cylinder, whereby when said cylinder is vented, said gravity-operated means is permitted to drop and operate said feeding means and when fluid under pressure is again admitted to said cylinder, said gravity-operated means and said feeding means are returned to their respective original positions by said piston.

11. A casting machine comprising a separable mold having a mold cavity formed therein, a bracket secured to and movable with a portion of said mold, a roller carried by said bracket, a cam having a groove adapted to receive said roller formed in one face thereof, whereby rotation of said cam will cause said mold to open and close, a melting pot adapted to contain molten metal, a pump for feeding molten metal to said mold submerged in said metal, a nozzle extending from said pump into said mold cavity, said nozzle providing a point of support for said mold, a pair of guides, a weight adapted to be moved along said guides in one direction by gravity, a member extending through said weight and connected to said pump, whereby downward motion of said weight will effect a feeding stroke of said pump, a cylinder adapted to receive a fluid under pressure, a conduit connected with said cylinder and communicating with a source of fluid under pressure, a valve in said conduit adapted in one position to permit fluid to enter said cylinder and in another position to vent said cylinder to the atmosphere whereby said piston and said weight are raised and permitted to drop, and a second cam rotatable with said first cam for controlling said valve.

12. A casting machine comprising a separable mold having a mold cavity formed therein, a bracket secured to and movable with a portion of said mold, a roller carried by said bracket, a cam having a groove adapted to receive said roller formed in one face thereof, whereby rotation of said cam will cause said mold to open and close, a melting pot adapted to contain molten metal, a pump for feeding molten metal to said mold submerged in said metal, a nozzle extending from said pump into said mold cavity, said nozzle providing a point of support for said mold, a pair of guides, a weight adapted to be moved along said guides in one direction by gravity, a member extending through said weight and connected to said pump, whereby downward motion of said weight will effect a feeding stroke of said pump, a cylinder adapted to receive a fluid under pressure, a conduit connected with said cylinder and communicating with a source of fluid under pressure, a valve in said conduit adapted in one position to permit fluid to enter said cylinder and in another position to vent said cylinder to the atmosphere whereby said piston and said weight are raised and permitted to drop, and a second cam rotatable with said first cam for controlling said valve, a source of power for rotating said cams, and a manually operated clutch interposed between said cams and said source of power for controlling the rotational movement of said cams.

13. In a casting machine, a mold comprising a stationary section and a movable section, a plurality of passages extending through each said section, a plate having grooves formed therein secured to each end of each mold section, each of said grooves serving to connect two said passageways to form a continuous passage through each of said sections, a cooling chamber secured to each of said mold sections in heat exchange relationship therewith, and a conduit connecting each cooling chamber with one end of said passageway formed in the mold section to which said cooling chamber is secured, whereby cooling fluid may be caused to flow from said chambers through said conduits and said passageways to control the temperature of said mold sections.

14. In a casting machine, a mold comprising a stationary section and a movable section, a plurality of passages extending through each said section, a tube extending through each said passageway, a plate having grooves formed therein secured to each end of each mold section, each of said grooves extending over the ends of two said tubes whereby a continuous passage through each of said mold sections is formed, a cooling chamber secured to each of said mold sections in heat-exchange relationship therewith, and a conduit connecting each cooling chamber with one end of said passageway formed in the mold section to which said chamber is secured, whereby cooling fluid may be caused to flow from said chambers through said conduits and said passageways to control the temperature of said mold sections.

15. In a casting machine, a mold section having passages for cooling fluid, a cooling chamber secured to the section in heat-exchange relationship therewith and connected to said passages, and means for supplying a cooling fluid to said chamber.

16. In a casting machine, a mold section having passages for cooling fluid, a reinforcing member secured to the outside of the section and having a cooling fluid chamber in heat-exchange relationship therewith, means for connecting one end of said chamber to said passages, and means for supplying cooling fluid to another end of said chamber.

17. In a casting machine, a mold comprising a stationary section and a movable section and having a mold cavity formed therebetween, said cavity communicating with the atmosphere at its top, a metal-receiving chamber, a plurality of vertical passages in said mold cavity, a plurality of passages extending from said metal-receiving chamber to said mold cavity, one of said last named passages being in registry with each of said vertical passages, whereby said vertical passages may be filled substantially instantaneously with molten metal fed to said mold cavity at high velocity.

18. In a casting machine, a mold having a

cavity therein providing a plurality of longitudinal passages, a source of fluid metal, a metal receiving chamber formed in said mold and communicating therewith, and means interposed between the passages and said chamber for increasing the speed of movement of the metal into said passages.

19. In a casting machine, a mold having a cavity therein providing a plurality of longitudinal passages, a source of fluid metal, a metal receiving chamber formed in said mold and communicating therewith, means for feeding metal from said chamber to the mold cavity, and means interposed between said chamber and said mold cavity constructed to increase the velocity beyond the capacity of the feeding means to each passage.

20. In a casting machine, a mold having a cavity therein providing a plurality of longitudinal passages, a source of fluid metal, a metal receiving chamber formed in the mold and communicating therewith, and means interposed between said chamber and said mold cavity for dividing the metal delivered by the chamber into streams individual to each passage in the cavity.

21. In a casting machine, a mold having a cavity therein providing a plurality of longitudinal passages, a source of fluid metal, a metal receiving chamber formed in said mold and communicating therewith, and means interposed between said chamber and said mold cavity for dividing the metal delivered by the chamber into streams individual to each passage in the cavity, said means serving to increase the velocity of the metal.

ERNST BAUER.