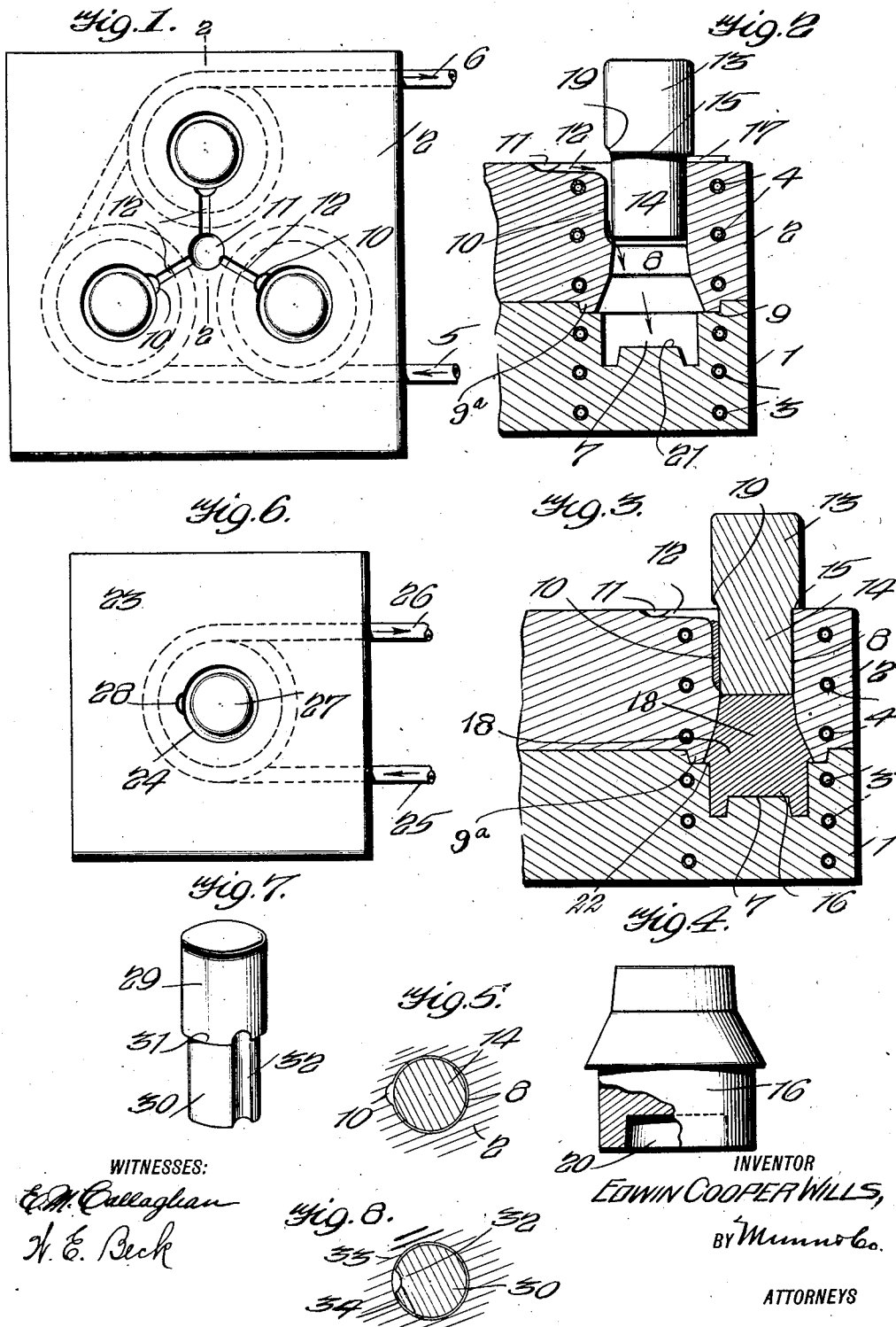


E. C. WILLS.
METHOD AND APPARATUS FOR MOLDING OR CASTING ARTICLES OR INGOTS FROM MOLTEN METAL.
APPLICATION FILED SEPT. 2, 1915.

1,347,728.

Patented July 27, 1920.

3 SHEETS—SHEET 1.



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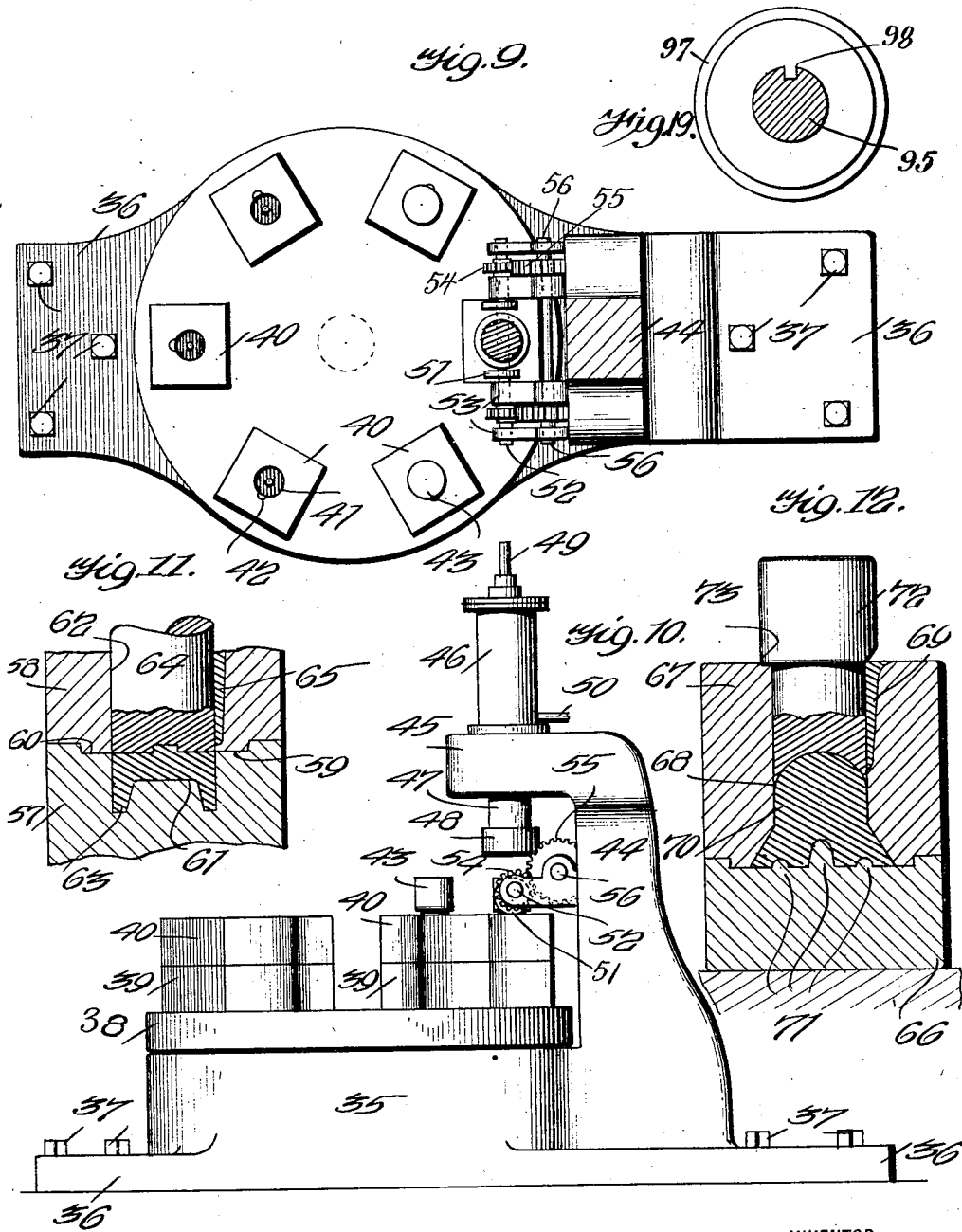
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3 SHEETS—SHEET 2.



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3 SHEETS—SHEET 3.

Fig. 13.

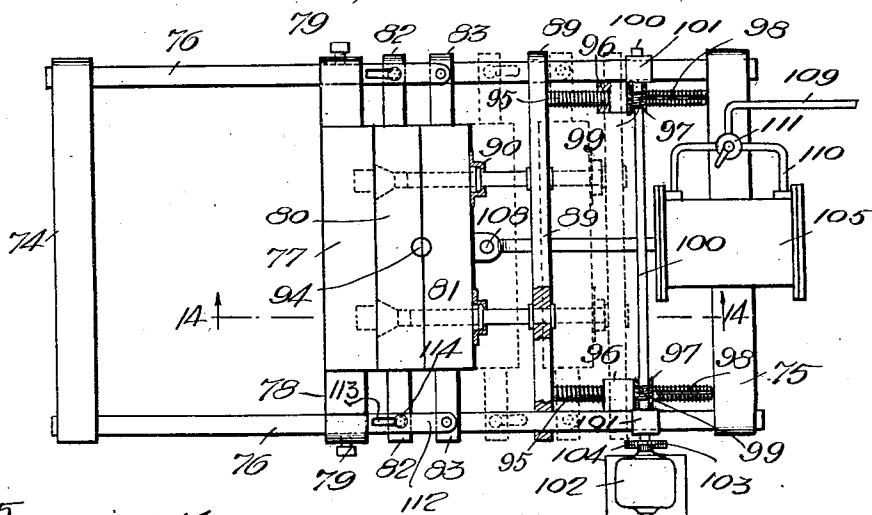


Fig. 14.

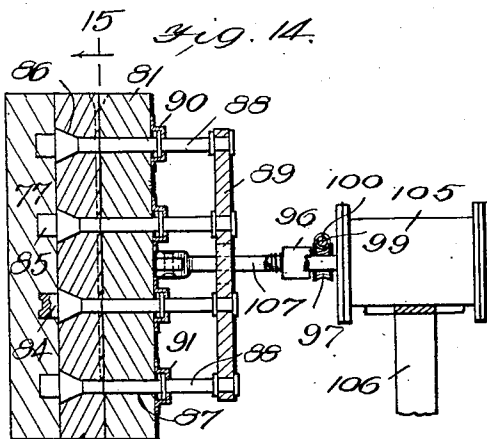


Fig. 16.

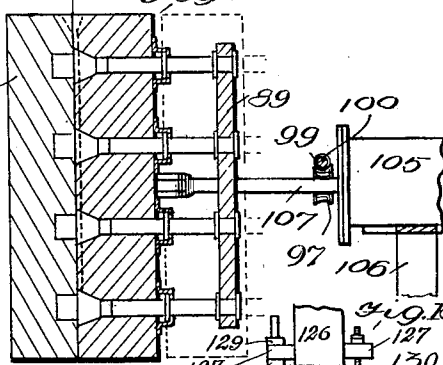


Fig. 15.

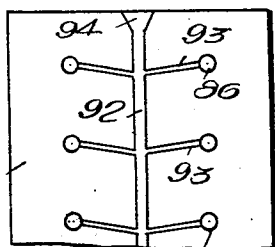


Fig. 17.

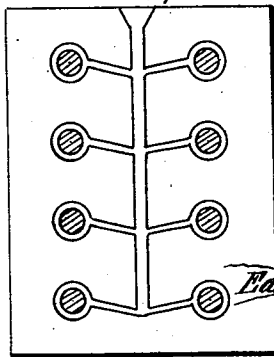
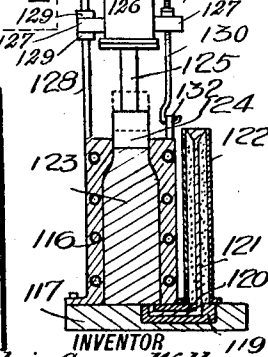


Fig. 18.



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METHOD AND APPARATUS FOR MOLDING OR CASTING ARTICLES OR INGOTS FROM MOLTEN METAL.

1,347,728.

Specification of Letters Patent.

Patented July 27, 1920.

Application filed September 2, 1915. Serial No. 48,679.

To all whom it may concern:

Be it known that I, EDWIN C. WILLS, a citizen of the United States, and a resident of Frederick, in the county of Frederick and State of Maryland, have invented a new and useful Improvement in Methods and Apparatus for Molding or Casting Articles or Ingots from Molten Metal, of which the following is a specification.

My invention is an improvement in methods and apparatus for molding or casting articles or ingots from molten metal, wherein all defects, such as piping are eliminated, and the invention has for its object to provide a method and apparatus for carrying out the invention by subjecting the cast articles or ingots while in a plastic state and in the mold to heavy pressure, for thoroughly compressing the molten metal in the mold to eliminate defects due to unequal expansion or contraction or from any other cause.

A further object is to provide a combined compressing device and gate, for simultaneously cutting off the flow of molten metal and compressing the article or ingot.

In the drawings:—

Figure 1 is a top plan view of one embodiment of the apparatus for carrying out the method,

Fig. 2 is a section on the line 2—2 of Fig. 1, with the parts in position to pour,

Fig. 3 is a view similar to Fig. 1 with the flow of metal cut off and the compression under way,

Fig. 4 is a front view of the completed article partly in section,

Fig. 5 is a partial horizontal section through the mold at the plunger,

Fig. 6 is a top plan view of another embodiment of the invention,

Fig. 7 is a perspective view of a modified form of plunger,

Fig. 8 is a section similar to Fig. 5 with the plunger shown in Fig. 7,

Fig. 9 is a top plan view with parts in section of a turret type of apparatus.

Fig. 10 is a side elevation of the construction shown in Fig. 9,

Fig. 11 is a sectional view of a mold showing the casting of another article,

Fig. 12 is a view similar to Fig. 11 of yet another article,

Fig. 13 is a top plan view of another em-

bodiment of the invention, with parts in section,

Fig. 14 is a section on the line 14—14 of Fig. 13, looking in the direction of the arrows adjacent to the line;

Fig. 15 is a view of one section of the mold, looking in the direction of the arrows adjacent to the line 15—15 in Fig. 14,

Fig. 16 is a view similar to Fig. 15 with the intermediate section of the mold omitted;

Fig. 17 is a section on the line 17—17 of Fig. 16, and

Fig. 18 is a sectional view of an ingot casting machine.

Fig. 19 is a sectional view showing the mounting of a part of the mold opening and closing mechanism.

As is known, in molding operations, as also in casting ingots of steel or the like, the molten metal is poured into a sectional mold, where it is permitted to cool and harden, after which the sections of the mold are separated and the completed article is removed. During the casting or molding blow-holes, pipes and the like, are very liable to develop, due to unequal expansion or contraction and the like, and the present invention is designed to provide a method of casting and an apparatus for carrying out the method for eliminating such irregularities.

In the embodiment of the invention shown in Figs. 1 to 3, the mold consists of a lower section 1, and an upper section 2, both of which are cooled by water pipes 3 and 4, respectively, the water being supplied to the pipes arranged within the material of the mold by inlet and outlet pipes 5 and 6, as shown in Fig. 1. The lower section 1 of the mold has a cavity 7 in its upper face, forming the lower section of the mold and the upper section 2 has a transverse opening 8 adapted to register with the cavity 7, and completing the mold, and the means for conducting the molten material thereto.

In the construction shown in Figs. 1 and 2, three complete mold cavities are provided, that is, the lower section 1 of the mold has three cavities and the upper section 2 has three openings. The lower section is counterbored as shown at 9 around each cavity 7 and the upper section has an extension 9^a at the lower end of each opening 8 for engaging the adjacent counterbored portion

to properly center the sections with respect to each other. The upper end of the cavity 8 is of uniform cross section, and a vertical groove or passage 10 is provided in the side wall of this upper portion of the opening for conducting the molten metal into the mold proper:

The molds 7—8 are arranged adjacent to each other as shown in Fig. 1, in such manner that the lines connecting their central axes would form a triangle, and the upper face of the section 2 of the mold is provided with a depression 11 at the center of this triangle.

Grooves or passageways 12 lead from the cavity or depression 11 to each mold, the said grooves 12 forming passages for conducting the molten metal to the molds. Each of the passage-ways 12 communicates with the adjacent groove or passage 10, and the flow of the molten metal is indicated by the arrows in Fig. 2. The molten metal is supplied to the cavity 11 in any suitable manner, and it flows from this cavity by way of the passages 12 and the grooves 10 into the several mold cavities.

In order to eliminate any blow-holes or pipes that may occur in the cast or molded article, I provide means for compressing the molten metal in the molds, and the said means act also as a gate to cut off the flow of molten metal to the mold cavity proper. The compressing means as shown in Fig. 2 is a plunger 13, the said plunger having a reduced portion 14 which fits within the upper uniform portion of the opening through the upper section of the mold.

An annular shoulder 15 is formed on the plunger between the body and the reduced portion and this shoulder is adapted to rest upon the upper face of the upper section of the mold to limit the downward movement of the plunger. When the shoulder 15 is in engagement with the upper surface of the upper section of the mold, the reduced portion is of such length that it will extend at its lower end to the upper end of the article as it should be when completed.

It will be noticed from an inspection of Figs. 2 and 3 that the groove or passage 10 stops just above the point where the upper end of the completed article 16 will reach, so that when the plunger 13—14 is in its lowermost position, the lower end of the plunger will cut off the groove 10 from the body of the mold.

During the pouring of the molten metal, the plunger is held in the slightly elevated position shown in Fig. 2, by means of a gib or key 17, which is arranged between the shoulder 15 and the upper surface of the mold. The gib or key is of such thickness that it will hold the plunger in the position of Fig. 2 with the lower end just above the lower end of the groove or passage 10, so

that the molten metal indicated at 18 in Fig. 3 can flow into the body of the mold. A portion of the shoulder 15 is cut away as indicated at 19 in Figs. 1 and 2 at the junction of the passage with the passage 10, so that the flow of the metal at this point is not interfered with whatever the position of the plunger. During the pouring of the molten metal and as long afterward as may be necessary the sections of the mold are cooled by a cooling liquid which flows through the pipes 5, 6, 3 and 4.

The completed article 16 shown in Fig. 4, is a fuse cap of a shell, the said article having in its lower end a depression or recess 20, which is formed by a boss or extension 21 in the bottom of the cavity 7. The article, as a whole, may be considered as composed of three integral portions, namely, the cylindrical portion at the bottom, a frusto-conical or tapering portion above the cylindrical portion, and a second frusto-conical or tapering portion at the top. The taper of the central portion of the article is sharper than that at the upper end of the article, and an annular shoulder 22 is formed between the cylindrical portion and the adjacent tapering portion.

After the article has cooled sufficiently, the sections of the mold are separated and the completed article is permitted to drop out. At the same time the plunger is displaced, and the mold is ready for the molding of another article.

The operation of the embodiment just described is as follows:—With the parts in the position of Figs. 1 and 2, each plunger 13—14 being supported in the position of Fig. 2 by the gib or key 17, the molten metal is poured into the well or cavity 11 and from there it flows through the three passages 12 to the respective molds, passing down the grooves or passages 10 into the bodies of the molds. As soon as a sufficient quantity of the molten metal flows into the mold, and this point will be reached when the molten metal contacts with the lower end of the plunger in the position shown in Fig. 2, the gib or key 17 is removed, and the upper end of the plunger is struck a blow with a sledge or with any other suitable striking mechanism. This striking of the plunger causes it to move downward until the shoulder 15 contacts with the upper face of the upper section of the mold.

The metal in the mold is compressed, causing the same to fill closely every part of the mold and absolutely eliminating pipes or blow-holes or other defects due to air bubbles or the like. The downward movement of the plunger also cuts off the flow of the molten metal from the passage 10 to the body of the mold as shown in Fig. 3. It will be understood that the sections of the mold are compressed or clamped to-

gether during the striking of the plungers to prevent separation of the mold sections due to the compression in the molds. Any suitable compressing or clamping means may be used.

In the embodiment of the invention shown in Fig. 6, the mold has but a single mold cavity. The mold indicated, as a whole, at 23, is provided with a single mold cavity 24, and the mold is cooled by water pipes, the inlet pipe being indicated at 25 and the outlet pipe at 26. The plunger indicated at 27 is similar to that shown in Figs. 2 and 3, and the molten metal flows into the body of the mold through a vertical groove or passage 28. The sections of the mold are clamped together during the striking of the plunger in any suitable or desired manner and the operation and procedure is precisely the same in the construction of Fig. 6 as in the construction of Fig. 1.

In Figs. 7 and 8, is shown a modified form of plunger, wherein the plunger 29 has the reduced portion 30 and the annular shoulder 31 between the body of the plunger and the reduced portion. The groove for the molten metal is in the plunger however, instead of in the mold indicated at 33 in Fig. 8. This groove indicated at 32 extends from the lower end of the plunger the full length of the reduced portion and past the shoulder 31. With this form of plunger the opening 34 through the upper mold 33 has no passage 10, the molten metal flowing into the body of the mold by means of the groove or passage 32.

In Figs. 9 and 10 is shown a turret type of machine, wherein a suitable base 35 is provided of approximately cylindrical form, and having base flanges 36, having openings through which may be passed securing means 37 to secure the base to a fixed support as for instance, a suitable base structure. A turret or table 38 is mounted to rotate on the base, and the turret or table is provided with a series of molds, each consisting of a lower section 39 and an upper section 40. The mold cavity 41 of the sections has a vertical groove 42, corresponding to the groove 10 of Fig. 1, and plungers 43 are provided, similar to the plungers 13-14.

The base 35 is provided with an upstanding arm or column 44, having a portion 45, which overhangs the table or turret at one side thereof. Each of the molds after pouring is brought into position beneath the overhanging portion 45 of the arm or column, and striking or compressing mechanism is supported by this portion of the arm or column. This mechanism consists of a cylinder 46, which is supported above the portion 45 of the arm or column, and the piston within the cylinder has a ram or

hammer 47, which extends through an opening in the portion 45 of the arm or column and is provided with a head 48 at its lower end.

The cylinder 46 has suitable supply pipes 49 and 50 for the motive fluid as for instance, compressed air, steam, or the like, and suitable valve mechanism, not shown, is provided for moving the piston in opposite directions. Means is also provided for compressing or clamping the sections of the mold together during the striking operation.

This mechanism as shown in Figs. 9 and 10 is in the form of cam wheels 51, each of which is mounted upon the inner end of a stub shaft 52, journaled in bearing arms 53, extending over the table from the column. The cams 51 are arranged in such position that they will be at the opposite sides of the molds, when the plungers of the molds are directly beneath the head 48 of the ram. Each of the stub shafts 52 has a pinion 54, and each pinion meshes with the gear wheel 55 of an operating shaft 56, journaled in the bearing arms 53 on opposite sides of the ram or hammer and the column and parallel with the stub shafts, the said stub shafts being in alinement.

The operating shaft 56 is driven in any suitable manner, and it will be evident that when this shaft is rotated in the proper direction, the stub shafts 52 will be operated in a direction to cause the cams to press the upper sections 40 of the molds on to the lower sections to prevent displacement of the sections during the striking of the ram or hammer.

The operation of the above embodiment is as follows:—It will be noted that in the present instance six complete molds are provided, the molds being arranged upon the upper surface of the table in spaced relation. The molds are poured in succession and after pouring each mold passes beneath the ram or hammer 47. When the mold is beneath the ram or hammer and in position for striking the cams are turned to press or clamp the upper section of the mold on to the lower section. By means of the valve mechanism the piston is caused to move downward in the cylinder and the head of the ram or hammer strikes the plunger 43 moving it into the position shown in Fig. 3 and compressing the molten material in the mold. The table is again moved, and another mold is brought beneath the plunger. The mold which has just been operated upon by the plunger moves out from beneath the plunger and at the proper point in the travel of the mold the completed article is removed by separating the mold sections.

In Figs. 11 and 12, mold cavities of different shape are provided for forming fuse caps of different shapes. In Fig. 11 the sec-

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105

110

115

120

125

130

tions 57 and 58 of the mold have the same centering mechanism, consisting of the counterbore or recess 59 on the lower section and the extension 60 on the upper section, fitting within the recess and properly centering the mold sections with respect to each other. The cavity 61 in the lower section registers with the transverse opening 62 in the upper section, and with this construction the completed article indicated at 63 extends only to the bottom of the counterbore or recess 60 when completed. In both Figs. 11 and 12 the plunger is shaped at its lower end to assist in forming the completed article.

In Fig. 11 the plunger 64 has a recess in its lower end, and the opening 62 has the groove or passage 65 corresponding to the groove or passage 10 for permitting the passage of the molten metal into the body of the mold.

In Fig. 12 the sections 66 and 67 of the mold are centered in the same manner as in Fig. 11, but the article is formed entirely in the upper mold section. In this upper section a transverse or vertical opening 68 is provided, having the groove 69 corresponding to the grooves 10 and 65 for permitting the passage of the molten metal into the body of the mold. The article 70 in Fig. 12 has a flaring or frusto-conical bottom portion, and it will be obvious that with such a shape it could not be disengaged from the lower mold section if any part of the flaring bottom was in the lower mold section. The lower mold section 66 has extensions 71 on its upper face, which assist in shaping the lower end of the article 70, and the plunger 72 has its lower end provided with a cavity or recess for shaping the upper end of the article 70.

The plunger has the shoulder 73, for limiting its downward movement by the engagement of the shoulder with the upper face of the mold section, and this shoulder is cut away at the groove 69. In both Figs. 11 and 12 as also in Fig. 9, the plunger acts as a gate to cut off the flow of the molten metal into the mold cavity when the plunger is in lowered position.

It will be obvious that the form of the mold cavity is dependent upon the shape of the article, and whatever the shape, the compression of the molten metal in the cavity causes the said metal to fill every part of the cavity however irregular the shape so that at every operation a complete and perfect article free from pipes, blow-holes, and the like, is turned out.

With Fig. 9 the process is practically continuous for each mold is emptied and ready for a new charge before the said mold again reaches charging position. It will be understood that the molds 39—40, 57—58 and 66—67 may be cooled in any desired manner.

In the embodiment of the invention shown in Figs. 13 to 17, a suitable supporting frame is provided, consisting of spaced parallel bars or beams 74 and 75, and guide rails 76 connect the ends of the bars or beams, the said rails being parallel, as shown. The mold is composed of three sections, in the form of plates, and the said mold is provided with eight mold cavities, the cavities being arranged in two series of four each.

The mold section 77, which is stationary but adjustable, and which corresponds to the section 1 of Fig. 1, is connected with supporting bars or beams 78, and these bars or beams have openings in their ends through which extend the guide rails 76. Set screws 79 are threaded through the ends of the bars or beams into engagement with the guide rails to hold the mold section in adjusted position, and it will be evident that by loosening the set screws the section may be adjusted on the guide rails. The intermediate mold section 80 is supported by bars or beams 82, which, like the bars or beams 78, have openings in their ends through which the guide rails pass. The intermediate section 80 of the mold corresponds to the upper section 2 of Fig. 1, while the section 81 of the mold is in effect a guide for the plungers to be later described. This section 81 is supported by bars or beams 83 which have openings in their ends through which the guide rails 76 pass, and the beams 82 and 83 are in effect carriages for carrying the mold sections.

The mold section 77 has on its inner face, the cavities 85, corresponding to the cavities 7 of Fig. 1, and the section 80 has registering transverse openings 86 which correspond to the transverse openings 8 of Fig. 1. The section 81 of the mold has transverse openings 87 registering with the mold cavities, and plungers 88 are movable through these openings and through the openings 86 of the section 80. All of the plungers 88, eight in number in the present instance, are connected at their outer ends to a plate 89. The plungers are passed through openings in the plate and have stops at the opposite faces of the plate to limit the movement of the plungers with respect to the plate. Each plunger 88 is provided with a fixed collar 90 at the outer face of the section 81 and these collars are received in bearing caps 91 which are secured to the outer face of the section 81. The collars have a limited movement in the bearing caps for a purpose to be presently described; and the adjacent faces of the mold sections 80 and 81 have cooperating grooves forming ports or passages for distributing the molten metal to the mold cavities. These grooves 92 extend from the upper edge of the sections and at the centers of the said edges to near the

bottom of the section and lateral grooves 93 lead from the groove 92 to the openings 86 for conducting the molten metal from the central passage formed by the grooves 92 to the mold cavities. It will be noted that the upper ends of the grooves 92 are funnel-shaped or flaring as indicated at 94 to permit the free entrance of the metal. Screw threaded shafts or rods 95 are connected with the cross head or plate 89, near the rails 76, and these rods extend in the opposite directions to the plungers. Each rod passes through a fixed nut 96 held in the adjacent rail, and a worm wheel 97 is arranged on each rod on the opposite side of the nut from the plate or cross head 89. Each rod 95 is provided with a groove 98 near its upper end, which is engaged by an inwardly extending lug or tooth in the bore of the worm wheel. Each worm wheel is engaged by a worm 99, on a countershaft 100 which is journaled transversely of the rails in bearings 101 on the rails, and a suitable motor 102, an electric motor in the present instance, is provided for driving the countershaft. The motor shaft of the motor has a pinion 103 which meshes with the gear wheel 104 on the countershaft. When the motor is running in the proper direction, the countershaft will be turned, and in turn the rods 95 will be rotated, it being understood that these rods are journaled in the plate or head 89. Since the nuts 96 are fixed, the rotation of the rods 95 will constrain said rods to move longitudinally toward and from the mold section 77, in accordance with the direction of movement of the motor.

A cylinder 105 is arranged in convenient position on the supporting frame, on a suitable support 106, and the piston of the cylinder has connected therewith a rod 107, which extends through the inner end of the cylinder, and is pivoted to the section 81 of the mold as indicated at 108. A supply pipe 109 is provided for supplying fluid under pressure to the cylinder, and branch pipes 110 lead to the opposite ends of the cylinder from the supply pipe. A controlling valve 111 is provided for controlling the flow of fluid under pressure from the supply pipe to the branch pipes.

When the valve is in one position, one end of the cylinder is connected with the supply for motive fluid, and the other end with the exhaust, while when the valve is in the other position, the conditions are reversed.

The operation of the above described embodiment is as follows:—

When the parts are in the position of Fig. 13, the molds are ready for charging. The molten metal is poured through the funnel-shaped passage 94 and flows through the passage 92 and the branch passages 93 to

the mold cavities, filling the same to the desired level. When the mold cavities are filled, or charged, the motor 102 is started in a direction to cause the cross head or plate 89 to move toward the mold section 77. The plungers 88 are forced into the mold cavities, thoroughly compressing the metal and forcing it into every part of the molds, and eliminating any tendency to pipes, or blow holes and the like. The connection at the elements 90—91 permits a limited movement of the plungers with respect to the section 81, sufficient movement to provide the proper compression. After compression, the motor 102 is reversed, and the plungers are withdrawn to the position shown in Fig. 14. The valve 111 is now turned to connect the inner end of the cylinder to the source of fluid pressure supply and the outer end to the atmosphere. The piston not shown moves to the outer end of the cylinder, and the mold section 81 is moved into the dotted line position of Fig. 13.

At the beginning of its movement section 81 moves freely with respect to the section 80, but there is a lost motion connection between the two sections. This connection as shown in Fig. 13 comprises plates 112, each of which is connected at one end to the bar 83, and at the other end each plate is slotted longitudinally as shown at 113, and the slot of each plate is engaged by a headed pin 114 on the bar or beam 82. The arrangement is such that the bar or beam 83 may move a limited distance with respect to the bar or beam 82, that is, until the headed pins 114 engage the ends of the slots 113 remote from the bar or beam 83. The article 84 formed in the mold just described is similar to that shown in Fig. 3, the said article being shaped similar to that of Fig. 3.

The embodiment of the invention shown in Fig. 18 is an ingot casting machine, wherein the mold 116 is connected to a suitable base 117 in the usual manner. The base has a depression in its upper face, and a block 119 is arranged in the depression, said block having its upper surface flush with the surface of the base, and extending transversely of the mold wall. This block has a longitudinal passage 120, and the passage opens at the top of the block by branches or angular portions at each end of the block. One of these angular portions opens into the mold, while the other opens into a runner 121, arranged adjacent to the mold. This runner has a vertical passage, registering with the upper end of the angular portion at the outer end of the block. This passage is formed by inserting a pipe, after which, sand indicated at 122 is filled in around the pipe, and the pipe is then withdrawn, leaving the passage. The mol-

ten metal is poured through the passage and passes through the passage 120 into the mold, forming the ingot indicated at 123.

As is known approximately 25% of the top of each ingot is cut away to eliminate pipes, blow-holes and the like. The present arrangement is designed to eliminate this loss, by preventing the formation of pipes or blow holes. For this purpose, a plunger 124 is mounted to move vertically in the upper end of the mold, and the plunger is connected to a rod 125 which passes into a cylinder 126 and is connected to a piston in the cylinder. The cylinder has oppositely extending perforated lugs 127, and a rod or shaft 128 extends upwardly from the mold at one side thereof and passes through the adjacent lug. Lock nuts 129 are arranged above and below one of the lugs 127 to prevent a downward movement of the cylinder and the cylinder is rotatable on the rod. The cylinder is supplied with fluid under pressure in any suitable or desired manner, and the flow of the fluid is controlled in the usual manner. The cylinder is mounted to swing over the mold or away from over the same, and means is provided for clamping the cylinder to the mold during the operation of the plunger. This mechanism comprises a clamping rod 130 which passes over that lug 127 remote from the shaft 128. The lower end of the rod 130 is hooked as indicated and this hook is designed to engage a fixed hook 132, on the mold, at the opposite side from the rod 128. The rod 130 by its engagement with the fixed hook resists any tendency of the cylinder to swing out of alinement with the mold.

The operation of the above described embodiment is as follows:—

The plunger during the filling of the mold with the molten steel is lifted out of the mold and swung to one side, or the plunger may occupy the dotted line position of Fig. 18. As the molten steel flows into the mold it gradually rises to the required level. When this level has been attained, the cylinder is swung into position over the mold and the plunger is depressed. The downward movement of the plunger thoroughly compresses the steel and positively eliminates all blow holes, pipes or the like.

It will be understood that in either form shown, the pressure on the article may be

a gradual pressure, or it may be a striking pressure; that is, by compression, or as for instance, in the form shown in Figs. 1 and 2, a sledge may be used. The effect is the same in either case.

The ingot mold is shown as provided with cooling pipes.

I claim:

1. A method of molding or casting metals, which consists in placing the molten metal in a mold and in filling the mold to a higher level than the ultimate dimension of the article desired in one of its axes, and in subjecting the molten mass to pressure prior to its ultimate solidification by an agent having a rigid unyielding compression surface, whose area is equal to that of the surface of the adjacent end of the article, and which engages the said end throughout its entire area, and which, simultaneously with its engagement with the molten metal cuts off the flow of metal to the mold.

2. A molding machine, comprising upper and lower sections, the sections having co-operating cavities forming molds, and said cavities extending through the upper section, said mold cavities being arranged around a common axis, a central depression in the upper face of the upper section and having grooves leading to the several cavities, each cavity having a groove in its side wall extending from the groove in the upper face of the section to the mold cavity, a plunger fitting each cavity for compressing the molten material in the mold, each plunger having an annular shoulder intermediate its ends for engaging the upper surface of the mold to limit the downward movement of the plunger, and said plungers being of a length to cut off the supply of molten metal to the mold cavity when the shoulder is in engagement with the upper section of the mold cavity.

3. A molding machine having an open mold and a plunger fitting the opening of the mold and adapted to move into the mold and having an area at its lower end equal to the area of the surface of the adjacent end of the article, said mold having a feed passage for the molten metal, the plunger serving as a gate to close the communication between the passage and the mold cavity at the moment when the plunger engages the molten metal.

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