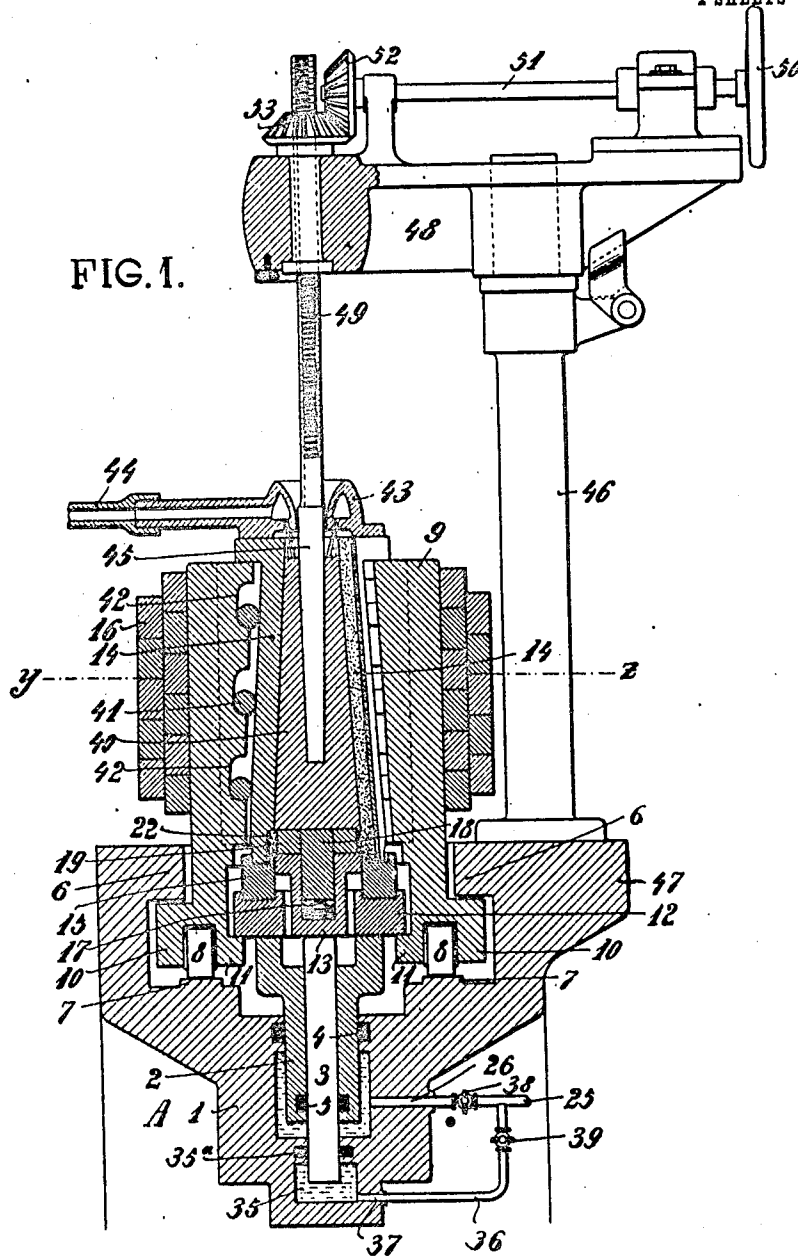


B. GERDAU.
 APPARATUS FOR COMPRESSING LIQUID METAL.
 APPLICATION FILED AUG. 20, 1912.

1,050,448.

Patented Jan. 14, 1913.
 2 SHEETS—SHEET 1.



Witnesses,

Alma Moersch.
 Daniel Holmgren.

Inventor

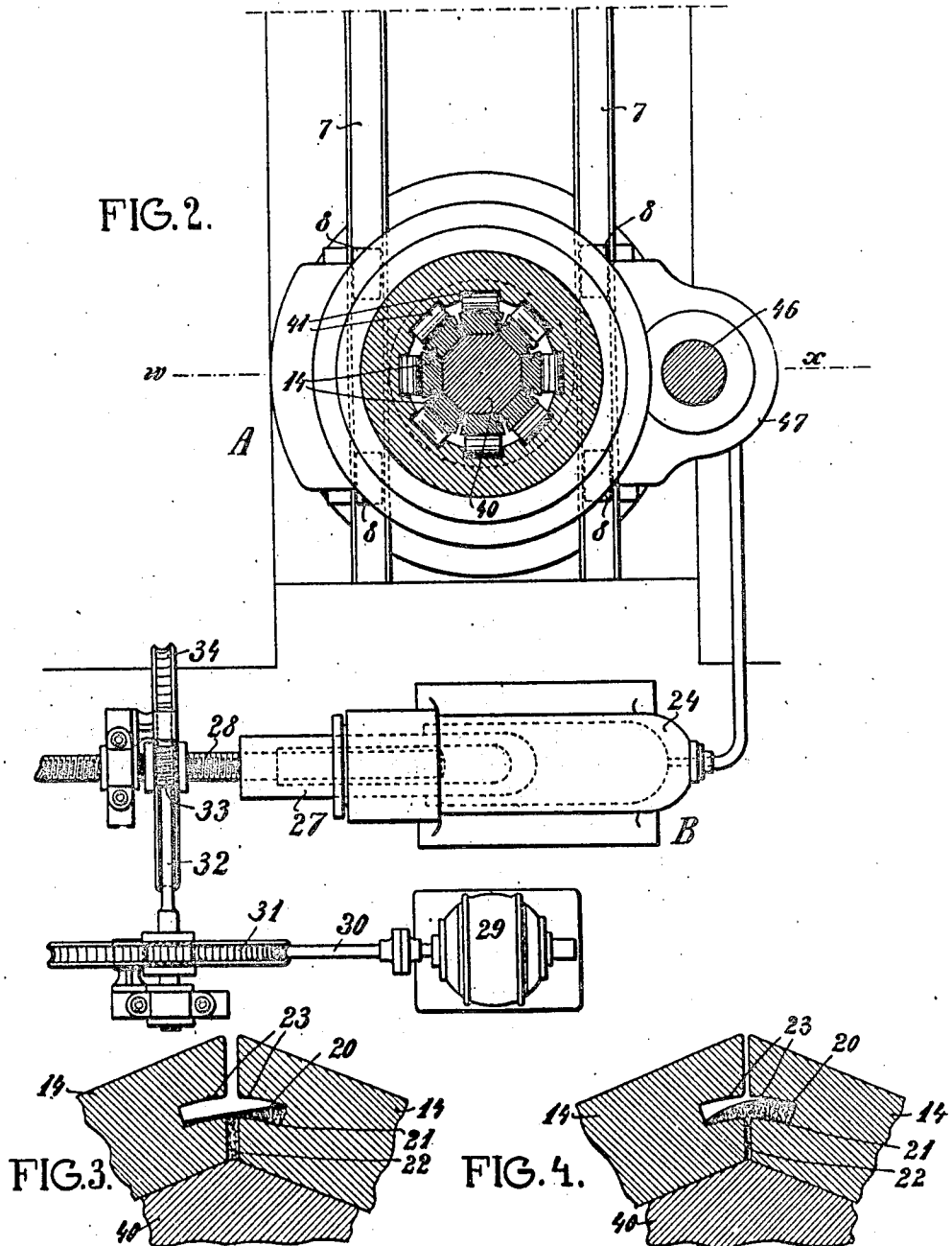
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UNITED STATES PATENT OFFICE.

BARTHOLD GERDAU, OF DUSSELDORF, GERMANY.

APPARATUS FOR COMPRESSING LIQUID METAL.

1,050,448.

Specification of Letters Patent.

Patented Jan. 14, 1913.

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To all whom it may concern:

Be it known that I, BARTHOLD GERDAU, a citizen of the Empire of Germany, residing at Dusseldorf, in the Empire of Germany, have invented a new and useful Apparatus for Compressing Liquid Metal, of which the following is a specification.

The oldest method (of Whitworth) of compressing liquid steel in a mold by means of a hydraulic piston bearing from above on the top of the metal presented the defect, that the gases in the steel were prevented from escaping, so that bubbles were necessarily formed and rendered the block porous, particularly in the upper part. A later method consisting in forcing the liquid steel by means of a hydraulic piston upward against the walls of an upwardly tapering mold presented the defect, that no uniform pressure could be exerted upon all parts of the block, since the pressure depended upon the inclination of the mold walls and upon the resistance produced by the friction on these walls, the effective pressure decreasing upward and becoming equal to zero at the top. Another known method of compressing liquid metal by means of two hydraulic pistons bearing from above and below against the metal, the lower piston being at the same time adapted to press the mold proper made in several parts inwardly by forcing them upward against inclined stationary abutments, presented the defect, that the gases inclosed in the metal were prevented from escaping, so that in consequence of this no compact steel could be produced. No lateral pressure could be actually exerted upon the liquid steel, since the force acting upon the lower piston was completely balanced by the force acting upon the upper piston. A special known method of reducing the formation of bubbles in the upper part of the block consisted in heating the top of the block by means of separate devices for keeping the steel in its liquid state after the casting, so as to enable the gases to escape. The effect of this method, however, was restricted and rendered uncertain by the comparatively rapid progress of the congelation of the parts of steel out of reach of the heating medium.

My invention relates to improvements in an apparatus for compressing metal blocks while still liquid, whereby the said defects are avoided.

The chief improvement consists in that the metal block is simultaneously subjected to vertical and horizontal pressures, which pressures can be regulated independently of one another, so as to compress the liquid metal from all sides excepting at the top, while permitting the gases to escape. Means are provided for keeping the upper part of the metal in a liquid state for a longer time by heating the same, so as to permit the slags to ascend and to separate from the metal.

The apparatus comprises a main hydraulic press with two coaxial pistons movable one within the other and one piston being adapted to horizontally compress the mold made in several pieces, while the other piston is adapted to press the liquid metal upward against the upwardly tapering wall parts of the mold.

The apparatus also comprises a subsidiary hydraulic press adapted to operate the main hydraulic press for driving its two pistons upward, while regulating valves are provided for adjusting the pressures of the two hydraulic pistons independently of one another. The mold is contained in a movable retainer adapted to be wheeled over the two pistons of the main hydraulic press and to engage under abutments.

I will now proceed to describe my invention with reference to the accompanying drawing, in which—

Figure 1 is a vertical longitudinal section through a main hydraulic press and a retainer with the mold embodying my invention on the line $w-x$ in Fig. 2. Fig. 2 is a horizontal section through the line $y-z$ in Fig. 1 and shows also in a plan view a subsidiary hydraulic press for operating the main hydraulic press and also a mechanism for operating the subsidiary press, and Figs. 3 and 4 are details which will be referred to later on.

Similar characters of reference refer to similar parts throughout the several views.

A denotes a main hydraulic press essentially consisting of a cylinder 1 and two coaxial pistons 2 and 3 movable one within the other, the outer piston 2 being tightened against the cylinder 1 by means of a suitable leather packing 4 and the two pistons being tightened against one another by a leather packing 5. The cylinder 1 is shown as made in one with two opposite hooked stationary

abutments 6, 6 and two rails 7, 7 (Fig. 2). Upon the two rails 7, 7 four wheels 8, 8 of a movable annular retainer 9 are made to roll, and the retainer 9 is provided with two opposite outer projections 10, 10 adapted to engage beneath the two abutments 6, 6 and also with two inner projections 11, 11 adapted to normally support an outer supporting ring 12. The inner piston 3 and the upper widened part of the outer piston 2 are made to normally extend upward to a point slightly lower than the upper surfaces of the two inner projections 11, 11. The inner piston 3 is made to support an inner supporting cylinder 13, which is open above and closed below. When the upper surfaces of the two coaxial pistons 2 and 3 are a little beneath the upper surfaces of the two inner projections 11, 11, the movable retainer 9 can be wheeled over the two pistons 2 and 3 of the main hydraulic press A and be shifted off over the two rails 7, 7. Where so preferred, the retainer 9 may be armed with mail, as shown at 16.

The mold proper is shown to consist of several longitudinal pieces 14, 14 (Figs. 3 and 4) which can be moved together and apart in radial directions and are adapted to slide on the upwardly tapering inside of the retainer 9. The lower ends of the pieces 14, 14 are reduced in thickness in the radial direction and may be made to slide radially on a second ring 15 supported by the outer supporting ring 12, the upper surface of the ring 15 being made either smooth or so recessed as to leave sufficient play to the pieces 14, 14. On the bottom of the cylinder 13 a spring of any known construction, for example a pair of superposed disk-springs 17, may be disposed, on which a cylinder 18 guided in the supporting cylinder 13 is made to bear. The upper end of the cylinder 18 forms one part of the bottom of the mold proper, while the other part of the bottom is a ring 19 surrounding the cylinder 18 and bearing on the supporting cylinder 13. The mold pieces 14, 14 may be provided in their joint faces with grooves 23, 23, in which elastic feathers 20, 20 and refractory material 21 may be placed for filling them up. Also the spaces between the several mold pieces 14, 14 and between them and the bottom ring 19 may be filled up with refractory material 22 as shown at Figs. 1, 3 and 4, whereby the mold is closed on all sides except at the top.

A subsidiary hydraulic press B (Fig. 2) may be provided for operating the main hydraulic press A, the cylinder 24 of the former being connected with the cylinder 1 of the latter by means of a suitable tube 25 and a channel 26. The plunger 27 of the subsidiary press B may be actuated in any known manner, for example by means of a screw spindle 28 as shown, which may be

operated from an electromotor 29 by means of a shaft 30, a worm (not shown), a worm wheel 31, a shaft 32, another worm 33 and a worm wheel 34 fastened on the screw-spindle 28. The two pistons 2 and 3 are to be actuated independently of one another, for which reason the inner piston 3 is made to extend through the bottom of the main cylinder 1 and to work in a second chamber 35, where it is tightened by means of a suitable leather packing 35^a. The second chamber 35 is connected with the tube 25 by means of a tube 36 and a channel 37. Two regulating valves 38 and 39 of any known construction are inserted in the two tubes 25 and 36, so that with their aid the pressures upon the two coaxial pistons 2 and 3 can be varied at will.

The molten metal is in any known manner cast into the mold described, while the retainer 9 may be directly above the main cylinder 1 or may occupy any position on the two rails 7, 7, after which it is wheeled over the upper ends of the two coaxial pistons 2 and 3. Then the motor 29 is started for actuating the plunger 27. When assuming the inner piston 3 to be alone driven upward, it will by means of the parts 13 and 17 force the two bottom parts 18 and 19 against the lower surface of the liquid metal 40, so that the latter moving along the upwardly tapering walls of the mold will be substantially vertically compressed while congealing. When, on the contrary, assuming the outer piston 2 to be alone driven upward, it will by means of the two superposed rings 12 and 15 force the longitudinal mold pieces 14, 14 upward along the upwardly tapering inside (on the right in Fig. 1) of the retainer 9, whereby the several mold pieces 14, 14 will be moved together, while the elastic feathers 20, 20 are bent (Fig. 4) and the refractory material 21, 22 is laterally squeezed out, so that the congealing liquid metal will be substantially horizontally compressed. It is now obvious, that by suitably adjusting the pressures upon the two coaxial pistons 2 and 3 by means of the two regulating valves 38 and 39 and therewith adjusting the speeds of the two pistons 2 and 3 relatively to one another, also by simultaneously compressing the liquid metal vertically and horizontally, it is possible to more energetically and uniformly compress the congealing metal 40, than was hitherto possible.

Where so preferred, the friction between the outside of the mold pieces 14, 14 and the inside of the retainer 9 may be reduced by inserting rollers 41, 41 between these parts, as is shown in Figs. 1 and 2. These rollers 41, 41 can be made to roll within suitable recesses 42, 42 on inclined races for moving together the mold pieces 14, 14.

In order to promote the formation of com-

5 pact metal, also any known heating device may be employed. For example an annular inverted burner 43 attached to a gas supplying tube 44 may be in any known manner moved over the mold pieces 14, 14, so that after igniting the gas the flames projecting from the burner 43 are directed downward on the top of the liquid metal for maintaining the upper part of the cast metal in its liquid state. When after a comparatively short time the slag in the metal has risen to the top, the gas can be turned off for extinguishing the flames and then the heating device may be moved away from the mold.

10 For the production of hollow metal blocks a suitable tool, such as for example a tapering punch 45 in Fig. 1, may be employed, which can be vertically moved and forced downward in any known manner through the liquid metal, say until its lower end strikes the cylinder 18 and may depress it against the pressure of the springs 17 in the supporting cylinder 13. For example a suitable column 46 may be fastened on a projection 47 of the main cylinder 1 and may carry on its upper end a turnable frame 48, which can be swung by hand or in any known manner for moving the punch 45 into and out of the axis of the mold. The punch 45 may be connected with a vertical screw-spindle 49, which can be moved up and down in any known manner, for example by means of a hand-wheel 50, a shaft 51 and bevel wheels 52 and 53. It will then be possible to move the punch 45 and also the heating device 43, 44 out of the way and to cast the liquid metal from some ladle above into the mold 14, 18, 19. Afterward the heating device 43, 44 is moved over the mold and the gas is turned on and ignited, then the frame 48 is turned to move the punch 45 into the vertical axis of the mold after which the punch 45 is made to descend and to pierce the liquid metal 40. When the slag and gases in the metal have arisen and the gas for the heating device 43, 44 is turned off, the liquid metal can commence to congeal while being compressed and the punch 45 may be slowly withdrawn upward from the metal.

For removing the compressed and congealed metal block from the mold, the two coaxial pistons 2 and 3 are caused to descend and the wheeled retainer 9 may be shifted to the side on the rails 7, 7, after which it may be in any known manner lifted together with the mold pieces 14, 14, so that the metal block is left behind on the bottom parts 18, 19 and can be taken off.

Where so preferred, the retainer 9 may be divided into two coaxial parts, of which the inner part indicated by the dotted lines in Fig. 1 is cylindrical on the outside and is in any known manner connected with the

mold pieces 14, 14. Then it will be possible to withdraw upward the inner cylindrical part together with the mold pieces 14, 15 and the cast metal block 40 for removing the latter.

The apparatus described can be varied in many respects without departing from the spirit of my invention.

I claim:

1. In an apparatus for compressing liquid metal, the combination with a vertical annular retainer having an inside tapering upward, of mold pieces vertically movable on the inside of said retainer and adapted to be packed so as to form the mantle of a mold having an inside tapering upward, a bottom adapted to be packed in said mold mantle, a hydraulic press cylinder adapted to be connected with the lower end of said retainer, two coaxial pistons in said hydraulic press cylinder, the inner piston being adapted to act upon said bottom and the outer piston to act upon said mold pieces, and means for forcing said two pistons upward.

2. In an apparatus for compressing liquid metal, the combination with a vertical annular retainer having an inside tapering upward, of mold pieces vertically movable on the inside of said retainer and adapted to be packed so as to form the mantle of a mold having an inside tapering upward, a bottom adapted to be packed in said mold mantle, a hydraulic press cylinder adapted to be connected with the lower end of said retainer and having two separate coaxial chambers, two coaxial pistons movable one within the other and working severally in the two chambers of said hydraulic press cylinder, the inner piston being adapted to act upon said bottom and the outer piston to act upon said mold pieces, and means for separately forcing said two pistons upward from said hydraulic press cylinder.

3. In an apparatus for compressing liquid metal, the combination with a vertical annular retainer having an inside tapering upward, of mold pieces vertically movable on the inside of said retainer and adapted to be packed so as to form the mantle of a mold having an inside tapering upward, a bottom adapted to be packed in said mold mantle, a hydraulic press cylinder adapted to be connected with the lower end of said retainer, two coaxial pistons movable one within the other in said hydraulic press cylinder, the inner piston being adapted to act upon said bottom and the outer piston to act upon said mold pieces, means for forcing said two pistons upward from said hydraulic press cylinder, and a heating device adapted to be moved over the mold for heating the top of the liquid metal.

4. In an apparatus for compressing liquid metal, the combination with a vertical an-

nular retainer having an inside tapering upward, of mold pieces vertically movable on the inside of said retainer and adapted to be packed so as to form the mantle of a mold having an inside tapering upward, a bottom adapted to be packed in said mold mantle, a hydraulic press cylinder adapted to be connected with the lower end of said retainer and having two separate coaxial chambers, two coaxial pistons movable one within the other and working severally in the two chambers of said hydraulic press cylinder, the inner piston being adapted to act upon said bottom and the outer piston to act upon said mold pieces, means for separately forcing said two pistons upward from said hydraulic press cylinder, and a heating device adapted to be moved over the mold for heating the top of the liquid metal.

5. In an apparatus for compressing liquid metal, the combination with a vertical annular retainer having an inside tapering upward, of mold pieces vertically movable on the inside of said retainer and adapted to be packed so as to form the mantle of a mold having an inside tapering upward, a bottom adapted to be packed in said mold mantle, a hydraulic press cylinder adapted to be connected with the lower end of said retainer, two coaxial pistons movable one within the other in said hydraulic press cylinder, the inner piston being adapted to act upon said bottom and the outer piston to act upon said mold pieces, means for forcing said two pistons upward from said hydraulic press cylinder, a punch adapted to pierce from above the liquid metal in the mold, means for moving said punch into and out of the axis of said retainer, and means for vertically moving said punch.

6. In an apparatus for compressing liquid metal, the combination with a vertical annular retainer having an inside tapering upward, of mold pieces vertically movable on the inside of said retainer and adapted to be packed so as to form the mantle of a mold having an inside tapering upward, a bottom adapted to be packed in said mold mantle, a hydraulic press cylinder adapted to be connected with the lower end of said retainer and having two separate coaxial chambers, two coaxial pistons movable one within the other and working severally in the two chambers of said hydraulic press cylinder, the inner piston being adapted to act upon said bottom and the outer piston to act upon said mold pieces, means for separately forcing said two pistons upward from said hydraulic press cylinder, a punch adapted to pierce from above the liquid metal in the mold, means for moving said punch into and out of the axis of said retainer, and means for vertically moving said punch.

7. In an apparatus for compressing liquid metal, the combination with a vertical an-

nular retainer having an inside tapering upward and recesses with inclined bottoms in this inside, of rollers in the recesses of said retainer, mold pieces vertically movable on said rollers and adapted to be packed so as to form a mantle of a mold having an inside tapering upward, a bottom adapted to be packed in said mold mantle, a hydraulic press cylinder adapted to be connected with the lower end of said retainer, two coaxial pistons movable one within the other in said hydraulic press cylinder, the inner piston being adapted to act upon said bottom and the outer piston to act upon said mold pieces, and means for forcing said two pistons upward from said hydraulic press cylinder.

8. In an apparatus for compressing liquid metal, the combination with a vertical annular retainer having an inside tapering upward and recesses with inclined bottoms in this inside, of rollers in the recesses of said retainer, mold pieces vertically movable on said rollers and adapted to be packed so as to form the mantle of a mold having an inside tapering upward, a bottom adapted to be packed in said mold mantle, a hydraulic press cylinder adapted to be connected with the lower end of said retainer and having two separate coaxial chambers, two coaxial pistons movable one within the other and working severally in the two chambers of said hydraulic press cylinder, the inner piston being adapted to act upon said bottom and the outer piston to act upon said mold pieces, and means for separately forcing said two pistons upward from said hydraulic press cylinder.

9. In an apparatus for compressing liquid metal, the combination with a vertical annular retainer having an inside tapering upward and recesses with inclined bottoms in this inside, of rollers in the recesses of said retainer, mold pieces vertically movable on said rollers and adapted to be packed so as to form the mantle of a mold having an inside tapering upward, a bottom adapted to be packed in said mold mantle, a hydraulic press cylinder adapted to be connected with the lower end of said retainer, two coaxial pistons movable one within the other in said hydraulic press cylinder, the inner piston being adapted to act upon said bottom and the outer piston to act upon said mold pieces, means for forcing said two pistons upward from said hydraulic press cylinder, and a heating device adapted to be moved over the mold for heating the top of the liquid metal.

10. In an apparatus for compressing liquid metal, the combination with a vertical annular retainer having an inside tapering upward and recesses with inclined bottoms in this inside, of rollers in the recesses of said retainer, mold pieces vertically movable on said rollers and adapted

to be packed so as to form the mantle of a mold having an inside tapering upward, a bottom adapted to be packed in said mold mantle, a hydraulic press cylinder adapted to be connected with the lower end of said retainer and having two separate coaxial chambers, two coaxial pistons movable one within the other and working severally in the two chambers of said hydraulic press cylinder, the inner piston being adapted to act upon said bottom and the outer piston to act upon said mold pieces, means for separately forcing said two pistons upward from said hydraulic press cylinder, and a heating device adapted to be moved over the mold for heating the top of the liquid metal.

11. In an apparatus for compressing liquid metal, the combination with a vertical annular retainer having an inside tapering upward and recesses with inclined bottoms in this inside, of rollers in the recesses of said retainer, mold pieces vertically movable on said rollers and adapted to be packed so as to form the mantle of a mold having an inside tapering upward, a bottom adapted to be packed in said mold mantle, a hydraulic press cylinder adapted to be connected with the lower end of said retainer, two coaxial pistons movable one within the other in said hydraulic press cylinder, the inner piston being adapted to act upon said bottom and the outer piston to act upon said mold pieces, means for forcing said two pistons upward from said hydraulic press cylinder, a punch adapted to pierce from above the liquid metal in the mold, means for moving said punch into and out of the axis of

said retainer, and means for vertically moving said punch.

12. In an apparatus for compressing liquid metal, the combination with a vertical annular retainer having an inside tapering upward and recesses with inclined bottoms in this inside, of rollers in the recesses of said retainer, mold pieces vertically movable on said rollers and adapted to be packed so as to form the mantle of a mold having an inside tapering upward, a bottom adapted to be packed in said mold mantle, a hydraulic press cylinder adapted to be connected with the lower end of said retainer and having two separate coaxial chambers, two coaxial pistons movable one within the other and working severally in the two chambers of said hydraulic press cylinder, the inner piston being adapted to act upon said bottom and the outer piston to act upon said mold pieces, means for separately forcing said two pistons upward from said hydraulic press cylinder, a punch adapted to pierce from above the liquid metal in the mold, means for moving said punch into and out of the axis of said retainer, and means for vertically moving said punch.

13. In an apparatus for compressing liquid metal, the combination of a mold composed of a plurality of spaced sections having grooves at their opposed faces with elastic feathers engaging said grooves, and a refractory filling interposed between the sections.

BARTHOLD GERDAU. [L. S.]

Witnesses:

HELEN NUFER,
ALBERT NUFER.