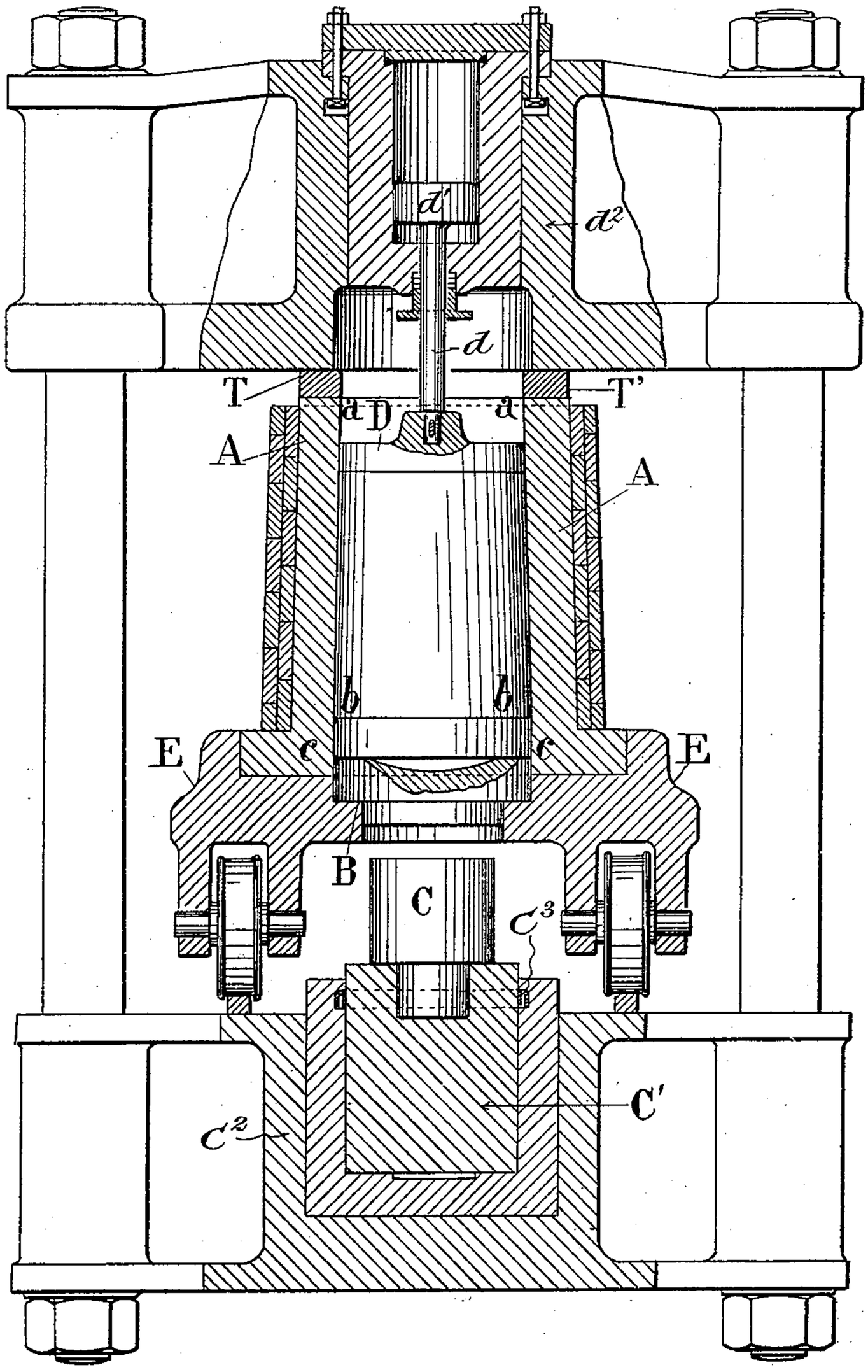
No. 679,072. Patented July 23, 1901.

H. HARMET.

COMPRESSING LIQUID STEEL.

(Application filed May 29, 1900.)

(No Model.)



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UNITED STATES PATENT OFFICE.

HENRI HARMET, OF ST. ETIENNE, FRANCE.

COMPRESSING LIQUID STEEL.

SPECIFICATION forming part of Letters Patent No. 679,072, dated July 23, 1901.

Application filed May 29, 1900. Serial No. 18,375. (No model.)

To all whom it may concern:

Be it known that I, HENRI HARMET, a citizen of the Republic of France, residing at St. Etienne, Loire, France, have invented certain new and useful Improvements in the Art of Compressing Liquid Steel, of which the following is a specification.

My invention has relation to the art of compressing liquid steel by a drawing operation.

The compression of the steel in the present invention is accomplished by the use of an apparatus comprising an ingot-mold, the shape of which is frusto-conical, arranged vertically, with its greater diameter at the bottom, into which mold the liquid steel is poured, the mold having a movable bottom adapted to be forced upward in the mold to compress the steel, and in conjunction with the mold, its movable bottom, and means for forcing the bottom upward in the mold there may also be provided a cover located within the mold and resting upon the liquid metal, the cover adapted to be pressed downward in the mold with a pressure less than the upward pressure exerted upon the bottom of the mold. This compression so conducted has for its objects, first, the avoidance of lateral expansion, because the metal in proportion as its contraction becomes pronounced and in proportion as the ingot-mold expands is pushed toward the smaller base of the surrounding cone and is constantly pressed against the walls of the mold, sliding parallel with the axis of the cone; second, the laminating or drawing of the steel, which by pressure exerted upon its larger base slides axially, not only pressing against the walls, but restricting and diminishing its section in proportion as the pressure forces it to penetrate more into the narrow portions of the cone, and, third, the avoidance of lateral expansion and its replacement by a drawing of the metal, thus preventing in the steel tendency to cracking and also formation of pockets. The power necessary for this compression is not very great, because the compression is facilitated by the conical shape of the ignot-mold. The time during which the force of compression should act upon the metal varies according as the metal has more or less tendency to crack and according to the mass acted upon; but there is no reason for it to be greater than the time necessary for the complete cooling of the ingot. To obtain good results, the drawing of the metal in the mold from the larger to the smaller diameter should be timed to correspond to the amount of compression caused by the contraction of the walls of the mold.

A preferred form of apparatus for carrying my invention into effect is illustrated in the accompanying drawing, in which the same is shown partly in front elevation and partly in vertical section.

Referring to the drawing, A is the ingot-mold, frusto-conical from *a* to *b* and cylindrical from *b* to *c*.

B is the movable cylindrical bottom, of a diameter a little smaller than that of the cylindrical portion of the ingot-mold.

C is the ram of the press, raising the bottom B with the power and speed required for compression.

D is the cover, placed on the top of the liquid metal and pressed down upon it by a rod *d*, extending from a piston or ram d', working in the upper cylinder d^2. The pressure of the piston d' upon the cover D is relatively feeble, the object being to maintain the cover on top of the ingot to prevent swelling. This cover and the piston pressing it downward, moves backward with the ingot in proportion to the pressure exerted by the lower ram C.

E is the carrier-truck.

The ram C is mounted upon a block C', which is elevated under hydraulic pressure in a casing C^2. At the upper end of this casing C^2 is arranged a packing-ring C^3 between the casing C^2 and block C', which ring is adapted to make a water-tight joint between the block C' and the casing C^2, in which it slides.

With this arrangement the operation is as follows: The truck E, carrying the ingot-mold, receives the steel from below the casting-ladle. Then the liquid metal being at the required level in the ingot-mold, the whole is run below the press into the position indicated by the drawing. The wedges T and T' are put in place between the ingot-mold and the upper frame of the press. The cover D is put on with the small pressure found suitable, and an upward movement is given to the ram C, which presses on the bottom B and forces it to push the metal into the inte-

rior of the ingot-mold rendered immovable by the wedges T and T'. The upward speed of the ram C, pushing the bottom B, should at first be rather great relatively to that which it will be later in order to immediately force the ingot which has already been contracted while the mold is being brought into place in contact with the walls of the ingot-mold which have expanded. From the moment the contact is established the upward speed should be regulated. At least it is preferable to regulate it, for it would be possible to go more quickly than it is desirable in such a manner as to keep the metal strongly pressed against the walls and to draw it down by causing it to advance, but without, however, going too quickly, which would cause spurting and swelling at the top. The power to be given at the commencement by the ram C is relatively small so long as the metal is liquid, increasing with the cooling. The total travel to be made is less than the cylindrical portion *b c*, and the forward motion, which gradually diminishes, should be timed in such a manner that the bottom B never passes beyond the cylindrical portion of the ingot-mold and that it arrives at *b* when there is no longer danger in the cold ingot developing cracks due to contraction.

The advantages obtained by such compression of liquid steel are, in point of view of the quality of the metal, first, the avoidance of flaws due to contraction, which is of great importance for certain manufactures and could not be avoided by compression as heretofore practiced, which caused the metal to expand laterally instead of drawing it down, and, second, the complete avoidance of pockets, and consequently the failures usually at the upper portion of the ingot.

Having thus described the nature and object of my invention, what I claim as new, and desire to secure by Letters Patent, is—

The improvement in the art of casting steel ingots, which consists in first pouring the steel in liquid form into a frusto-conical mold and in then subjecting the steel to pressure in the direction of the axis of the mold, from each end toward the middle, the pressure toward the smaller end being greater than the opposing pressure, substantially as and for the purposes described.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

HENRI HARMET.

Witnesses:
O. EARDU,
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