No. 698,590. Patented Apr. 29, 1902.

C. H. VEEDER.

CASTING MACHINE.

(Application filed Nov. 27, 1899.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.

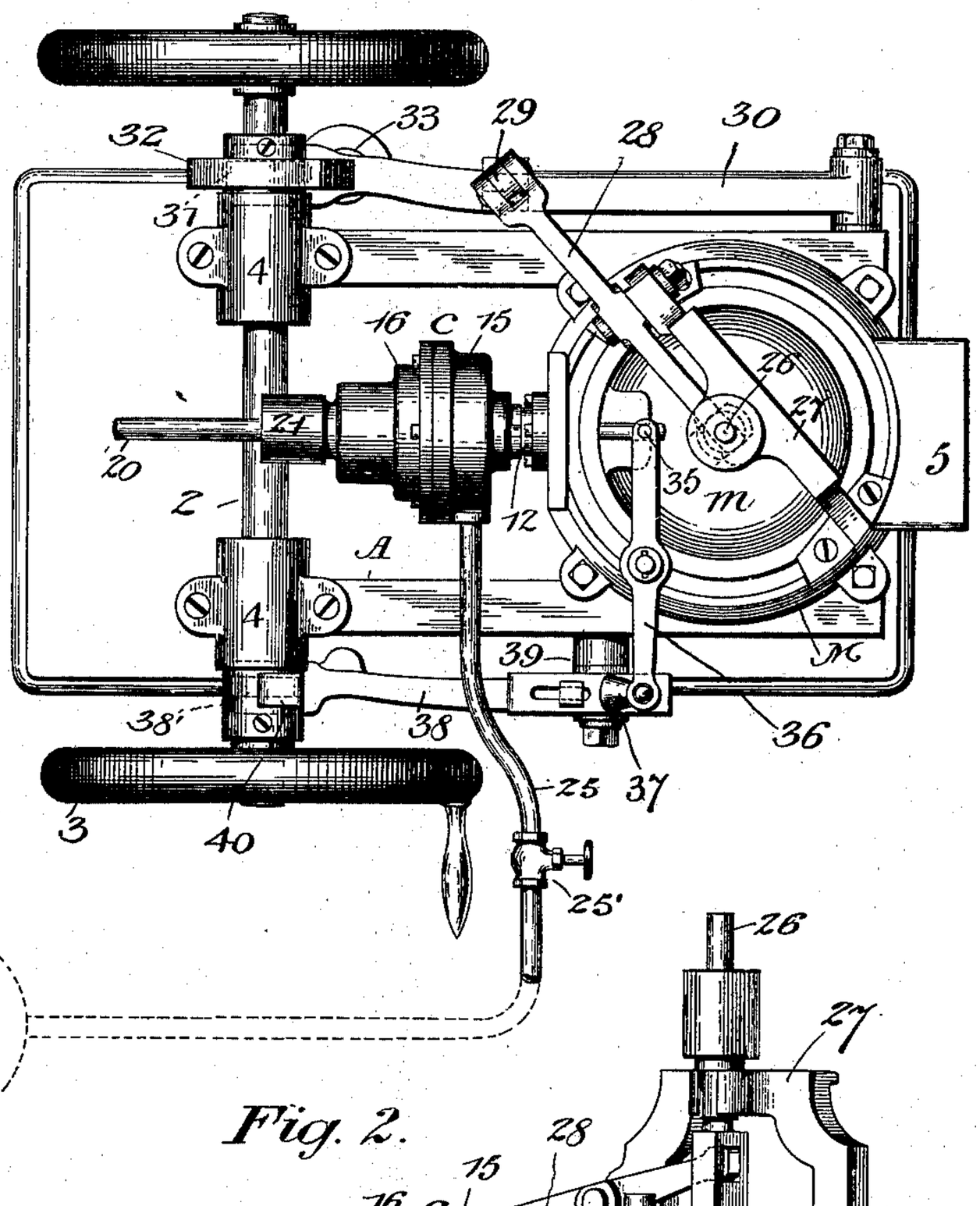
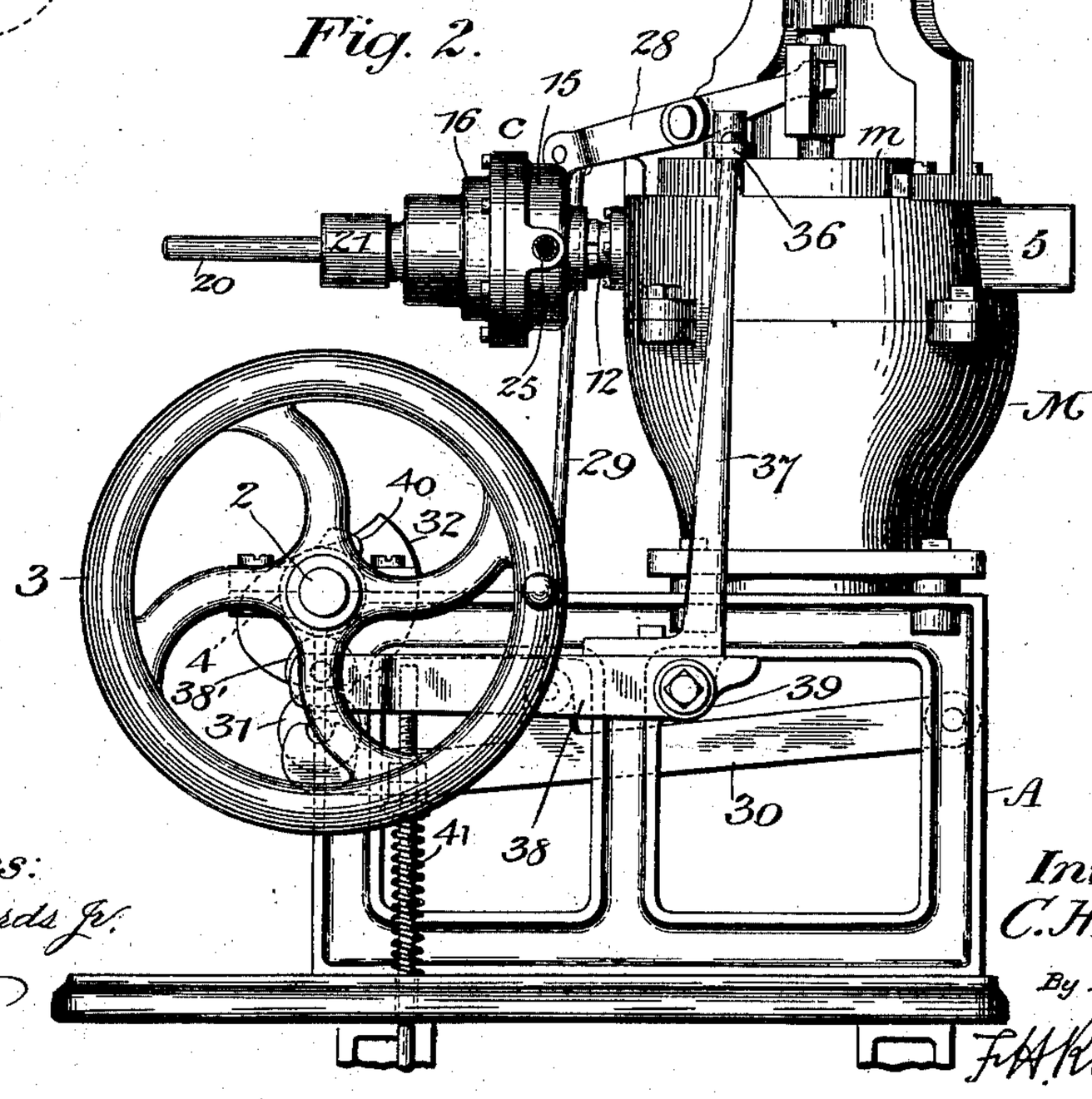


Fig. 2.



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(No Model.) 3 Sheets—Sheet 2.

Fig. 3.

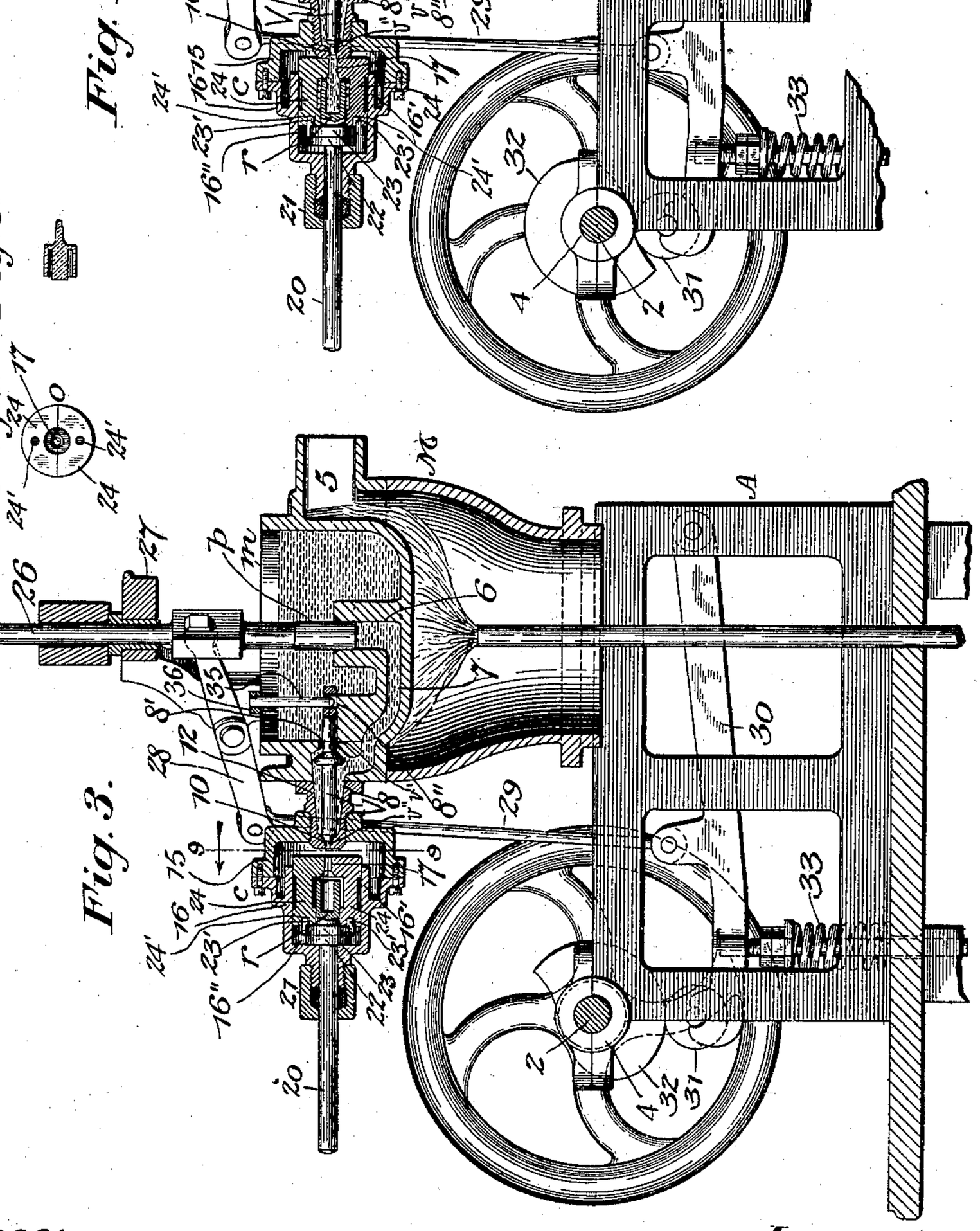

Fig. 4.

Fig. 5.

Fig. 6.

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(No Model.) 3 Sheets—Sheet 3.

Fig. 7.

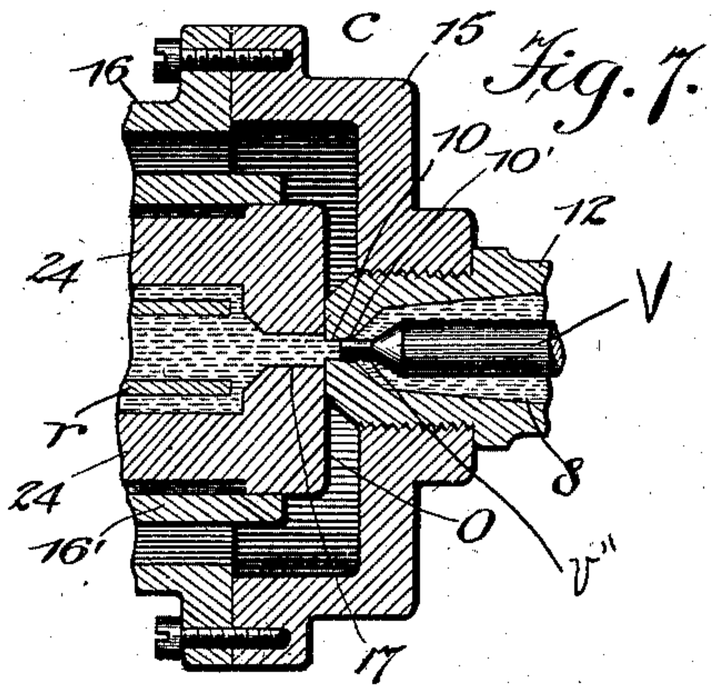


Fig. 8.

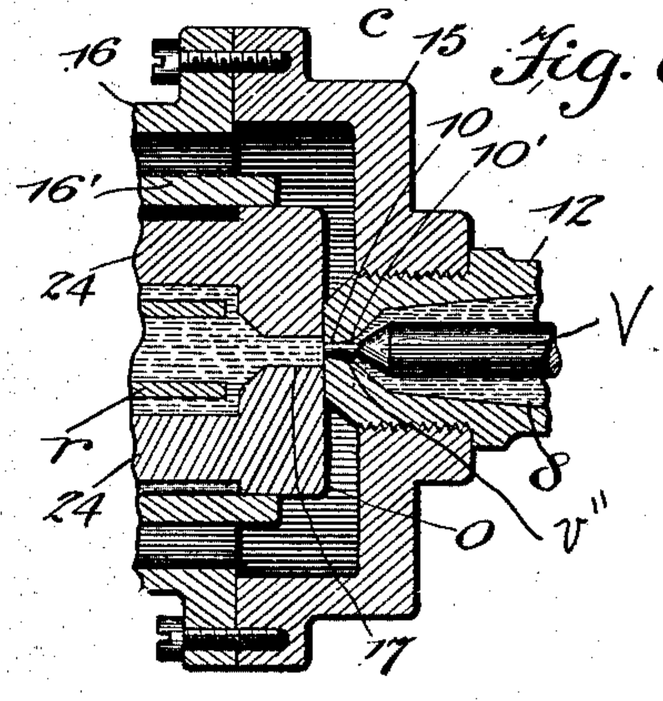
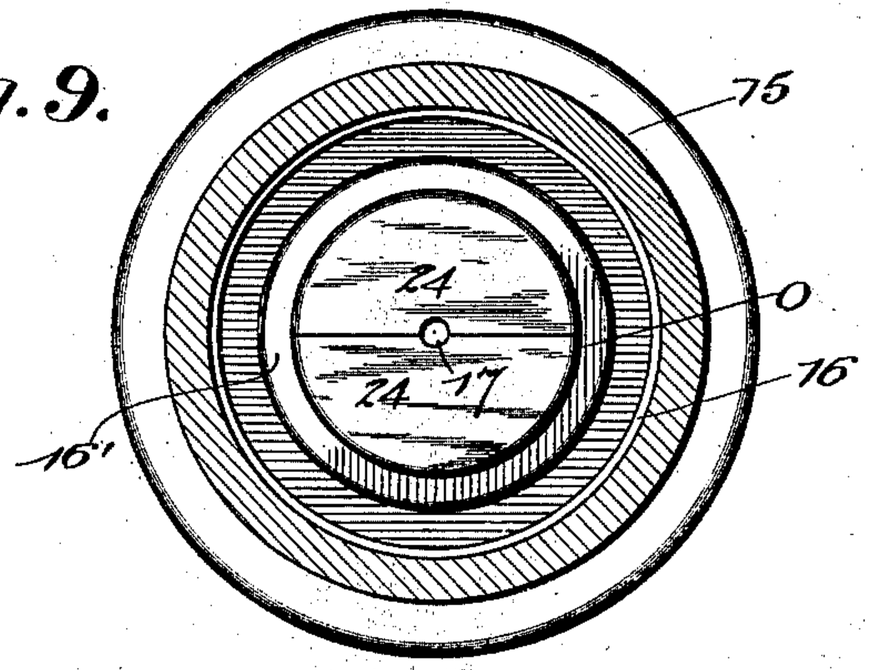


Fig. 9.



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UNITED STATES PATENT OFFICE.

CURTIS H. VEEDER, OF HARTFORD, CONNECTICUT.

CASTING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 698,590, dated April 29, 1902.

Application filed November 27, 1899. Serial No. 738,269. (No model.)

To all whom it may concern:

Be it known that I, CURTIS H. VEEDER, a citizen of the United States, residing in Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Casting-Machines, of which the following is a specification.

This invention relates to casting-machines, and has for its main object the provision of a machine for forming dense castings having faces of such smoothness that the castings will not need to be subjected to the usual operations of planing, turning, &c., but can be used and assembled with other parts with the bearing-surfaces in the condition in which they come from the molds and under conditions where exceptionally well-finished bearing-surfaces are required in order to permit the proper movement of parts upon one another. This result I attain by employing a casting-machine so constructed and capable of operating in such a manner as to condense the molten metal most perfectly during the making of the casting and before the completion thereof. I have found that the best results can be secured by producing a vacuum in the mold into which the metal is to be poured and then forcing molten metal under pressure into the exhausted mold until the mold is completely filled. When castings are formed in this way, all of the spaces and corners of the mold, no matter how small they may be, are completely filled by the molten metal forced thereinto, and the casting corresponds exactly in contour to the mold, every minute projection or indentation in which is reproduced perfectly as an indentation or projection in the finished casting, no matter how complex the pattern to be reproduced may be. Moreover, in every case castings formed in this manner are of a dense, homogeneous, and exceedingly fine crystalline structure throughout. The molten metal may be delivered to the mold in many ways; but I prefer to inject it into the same under high pressure, so that the stream will be forced violently into every portion of the mold. In the present case I have employed for this purpose mold-filling means operating, substantially, as a force-pump, in which a plunger of relatively large diameter exerts at the proper time a violent pressure upon a column of molten metal which is injected into the mold through a relatively small opening, and hence at a high velocity. The pressure exerted upon the column of molten metal should, of course, be such as to assure the filling of the mold before such pressure is removed. After the mold has been filled *in vacuo* I deem it desirable to still further condense the metal in the mold before the casting cools, and a suitable compressing force may be exerted upon the metal for this purpose. The manner in which such metal is compressed, and thereby condensed, is immaterial so long as the metal is condensed to the desired extent; but I deem it preferable to make use of a casting-compressor which will operate directly upon and against the metal in the mold and will not only compress the metal therein, but also cut off the supply to the mold after the latter has been filled. Hence not only does the casting-compressor serve as a means for compressing and condensing the metal of the casting, but it also forms a means for positively interrupting communication between the mold and the source from which the supply of molten metal is taken, and thus the length of the sprue formed in the ingate or sprue-hole may be positively governed.

In order that the several operations of filling and exhausting the mold and compressing the metal of the casting may be performed to the best advantage, I have shown herein a vacuum-chamber in which the mold may be mounted, and this mold will preferably be movable within the vacuum-chamber in one or several directions, as may be desired.

In the drawings accompanying and forming part of this application, Figure 1 is a plan of a casting-machine embodying my present invention, an air-pump and means for exhausting the mold being indicated by dotted lines. Fig. 2 is a side elevation of said casting-machine. Fig. 3 is a central vertical longitudinal section of the same, illustrating the positions of the parts when communication between the mold and the mold-filling means is interrupted. Fig. 4 is a similar view illustrating the positions of the parts during the filling of the mold with metal. Fig. 5 is a detail illustrating in elevation one end of the mold. Fig. 6 is a detail illustrating in longitudinal section a casting formed by the ma-

chine. Fig. 7 is an enlarged detail of a portion of the mold and the casting-compressor, illustrating the positions of the parts at the end of the mold-filling operation and before the compression of the metal in the mold begins. Fig. 8 is a similar view showing the position of said compressor at the end of its compressing stroke. Fig. 9 is an enlarged sectional elevation of the vacuum-chamber and the mold, the section being taken in line 9 9, Fig. 3, looking in the direction of the arrow.

Similar characters designate like parts in all the figures of the drawings.

In the present case I have illustrated a simple type of mechanism for carrying my invention into effect, and while all of the principal parts will usually be so organized as to coöperate with one another and will preferably be power-operated, yet the primary source of power from which their movements are derived may be a hand-wheel, such as is shown in the drawings.

The several operative parts of the machine will be mounted, ordinarily, on a suitable framework, which may be of the type indicated herein by A, and on this framework a shaft 2, having a hand-wheel 3, may be mounted in suitable bearings 4 4. From this shaft connection may be made in any desired manner to such of the parts as it is desirable to operate therefrom, and these parts will usually embody those devices by means of which the flow of molten metal is controlled and the compression of the metal in the mold effected after the latter has been filled.

Ordinarily a casting-machine embodying my invention will have a melting-pot for melting and containing molten metal, means for supplying the molten metal from such pot to a mold and for controlling the flow of the metal, a mold positioned to receive at the proper time a charge of this molten metal, a vacuum-chamber and exhausting means therefor for exhausting the air from the mold before the molten metal is supplied thereto, a casting-compressor for compressing and condensing the metal of the casting while in the mold, and means for timing the mold-filling and casting-compressing operations, so that they will always take place in proper order; but in some forms of my improved casting mechanism one or more of these elements may be dispensed with and the operation of forming dense and homogeneous castings successfully practiced.

In the present case the framework A supports a melting-pot of any suitable type, such as M, said melting-pot being in this case a two-part one having a flue 5 leading therefrom, the contents of the melting-pot proper, which is designated by *m*, being kept hot ordinarily by a gas-jet. In the construction shown herein the melting-pot or melting-tank *m* has a well 6, from which a passage 7 leads to a chamber 8, having two openings leading therefrom. One of these openings is indicated herein by 8′ and is intended to receive molten metal from the tank M at a point considerably below the surface of the metal and keep the chamber 8, the passage 7, and the well 6 filled with the molten metal. The other opening, which is designated by 10, serves as an outlet through which the metal may be delivered to the mold at each operation. The chamber 8 in the present case is formed partly within and partly without the melting-pot, a nipple, such as 12, being secured to the melting-pot *m* in the construction shown and being so shaped internally as to contain a portion of the valve-chamber 8 and also the discharge-opening 10. This nipple is securely fastened to the melting-tank by a tight joint and forms the discharge-nozzle thereof.

For the purpose of controlling the flow of molten metal I prefer to mount within the valve-chamber 8 and the openings 8′ and 10 a valve device, (designated herein in a general way by V.) This valve device may be so constructed as not only to close the opening 10, but also to serve for controlling communication through the passage 8′ with the main body of metal in the melting-tank, and when so constructed as to accomplish both of these results constitutes a double-action valve.

For the purpose of supplying a charge of metal to the mold I prefer to make use of mold-filling means embodying a member which will act upon the metal in such a manner as to force the molten charge under high pressure into the mold, and thus assure the filling of all corners thereof. Ordinarily a plunger, such as *p*, will work in the well 6 and when depressed will cause the metal to be injected in a small column or stream into the mold, the plunger and its coacting parts operating in this case substantially as a force-pump.

The mold into which the metal is to be delivered may be of any suitable type and may be mounted in any proper manner for coöperation with the other parts; but in this construction the mold is supported for movement in a vacuum-chamber so disposed as to coöperate with the discharge end of the nozzle or nipple 12. Here a vacuum-chamber (designated in a general way by *c*) is screwed onto the end of the nipple 12 in such a manner as to form an air-tight connection therewith, said chamber in the present case being formed in two parts, such as 15 and 16, in the latter of which the mold may be mounted. Here this latter half 16 of the chamber or casing has a cylindrical mold-carrier 16′, in which the mold is free to move in different directions, one of its movements in this case being an axially reciprocatory one toward and from the discharge end of the nozzle 12, while the other is a turning movement within the cylindrical casing 16′.

The mold which I prefer to employ in this case will be substantially cylindrical and will be a separable one in order that the casting may be removed readily therefrom. Here I have shown a mold *o*, made in two parts and

having the usual ingate or sprue-hole 17, adapted to communicate with the opening 10 in the nozzle 12. At the opposite end thereof said mold will preferably be so constructed as to receive a core *r*, which core may be shifted relatively to the casing *c* and also relatively to the mold in which it is mounted, the former being reciprocatory and the latter rotatable for the purpose of facilitating the stripping of the casting. In the construction shown a cup-shaped core is carried at the inner end of a core-rod 20, which is passed through a suitable packing device 21 at the outer end of the casing *c*, and said core-rod carries a pair of collars 22 and 23, the former of which constitutes a stop-collar for limiting the movement of the mold away from the mold-filling means, while the other collar 23 in this case carries a pair of dowel-pins 23′, adapted to enter corresponding openings 24′ in the two members 24 of the separable mold.

The two sections of the casing *c* may be secured together in any suitable manner to form an air-tight joint, and the chamber, and hence the mold contained therein, may be exhausted in the usual way—*i. e.*, by means of an air-pump (indicated in dotted lines) connected in this case by a pipe 25 with the section 15 of such chamber, said pipe having therein a valve 25′ for maintaining the vacuum for the proper period after it has been produced and also for admitting air into the vacuum-chamber after a casting has been completed.

As before stated, the principal devices will usually be operated by power mechanism and will be timed to coöperate properly with one another, and this is especially true of the valve V and the plunger *p*. In this case the latter is carried at the lower end of a plunger-rod 26, which may be supported for vertical reciprocation in a support or cross-piece 27, bolted in this case to the melting-tank M, and said plunger-rod is operated by a lever 28, pivoted on said cross-piece and having at its outer end a connecting-rod 29, pivoted thereto, the lower end of said connecting-rod being pivoted to a lever 30, one end of which is pivoted on the framework A, while the other end thereof may carry an antifriction-roll 31, coacting with a cam 32 on the shaft 2. Said lever 30 may be held up to its work by a spring 33 in a manner which is well understood.

The valve parts *v*′ and *v*″ of the valve device V are intended to reciprocate in the respective openings 8′ and 10, and the valve-stem may have at its inner end an extension with an opening 8″ therein, into which may be passed the lower end of a finger 35, secured in this case to the inner end of a lever 36, pivoted on the top of the melting-pot M and connected at its outer end to the upper long arm 37 of an angle-lever pivoted on a stud 39 on the framework A, the other arm 38 of said angle-lever having at its outer end an antifriction-roll 38′, coacting with a cam or wiper 40 on the shaft 2, the arm 38 being preferably held up to its work by a spring 41, substantially similar to the spring shown at 33.

By referring to Fig. 2 it will be evident that the wiper 40 operates to actuate the valve during only a small portion of a complete rotation of the shaft 2, while the cam 32, which controls the plunger, permits the latter to move during a considerably longer period than the valve. The face of the cam 32 is so shaped as to maintain the plunger *p* in its uppermost position during about one-half a rotation of the shaft 2 and permits a quick let-off movement of the lever 30 when the antifriction-roll 31 reaches the let-off point of the cam-face. When the antifriction-roll reaches this point and the lever is thrown upward by the actuating-spring, the plunger is quickly forced down into the well 6 and operates to drive the molten metal through the communicating passage into the mold. Just before the plunger descends the antifriction-roll 38′ rides up the wiper 40 and the valve device V is shifted to the right, as shown in Fig. 4, to close the opening 8′ and open that at 10, which latter passage is so shaped, as will be hereinafter more particularly described, as to permit the molten metal to flow therethrough into the mold, which of course at this time should be in the working position shown in Fig. 4, with the face thereof abutting against the discharge end of the nozzle 12. The valve device V may begin to move to the left again to cut off the flow into the mold just before the plunger reaches the limit of its downward movement and will remain in that position until there is another working stroke of the plunger; but the latter may begin to rise as soon as it reaches the limit of its downward movement and continue to rise gradually until it reaches its original position. During the ascent of the plunger a fresh supply of molten metal will of course flow through the opening 8′ into the passage 7 and well 6 to fill all of these communicating chambers and passages preparatory to forming another casting.

From the foregoing it will be evident that by turning the hand-wheel 3 the plunger and the valve will be operated in their proper order and that the actuators therefor will impart to their respective operated members—viz., the plunger and the valve—working strokes of decreasing force when the antifriction-rolls ride down the quick-let-off faces of their respective cams, this result being due to the gradually-decreasing force exerted by each of the springs.

After the mold has been placed in position in the vacuum-chamber, as shown in Fig. 3, the air is exhausted from that portion of the chamber which communicates with the mold, and the latter may then be shifted to the position shown in Fig. 4 by pushing in the core-rod 20. It should be noted here that if the mold fits tightly within the chamber 16′ the air in the space 16″ will not be exhausted, but in expanding will serve, by its pressure

against the rear end of the mold, as a means for holding the face of the mold tightly against the juxtaposed end of the nozzle 12. After the mold and the main space in the vacuum-chamber have been exhausted in this manner the hand-wheel may be turned to supply molten metal to the mold, and a charge will be delivered thereinto in substantially the manner hereinbefore described. During the time that the valve V is in the position shown in Fig. 3, with the mold retracted and the opening 8′ in communication with the passage 7, the valve part *v*′ permits a new supply of molten metal to flow into the passage 7 and fill the same and the well 6, while the valve part *v*″ prevents the discharge of molten metal into the mold. Of course in order to permit the influx of metal to the passage 7 the opening 8′ should be of larger diameter than the adjacent portion of the stem of the valve working therein. The member V, however, serves not merely as a valve for cutting off the flow of metal at the inlet-opening 8′ or the outlet-opening 10, but also as a means for compressing the metal delivered into the mold to form a casting. In order that this member V may serve as a casting-compressor as well as a valve, it is desirable to so form the end of the valve-stem or to so shape the opening 10 as to permit the fluid metal to flow freely through said opening when the valve is in the position shown in Fig. 4, and yet close this opening before the casting-compressor reaches the end of its working or compressing stroke. In this case the opening 10 is so shaped as to accomplish this result, and it will usually be a bore tapered for a portion of its length, as at 10′, and cylindrical from the end of the tapered portion to the outlet end of the nozzle 12, as shown most clearly in Figs. 7 and 8. The tapered portion 10′ provides a space through which the metal may flow while the compressor is in its retracted position, (shown in Fig. 4,) and yet forms a guide for maintaining the combined compressor and supply-controlling means or valve in its proper position. When the working stroke of the compressor begins, the metal may continue to flow into the mold until such compressor reaches the position shown in Fig. 7, when it will operate as a cut-off valve and will interrupt communication between the source of supply and the mold, and thereafter until the end of the stroke it will operate solely as a compressor for forcing the metal into every portion of the mold and condensing and compressing the same. The spring which operates the valve will actuate it to the point where it will cut off the supply of material from the valve-chamber, and the forward movement of the valve for the purpose of compressing the metal in the mold will be aided by the force exerted upon the valve by the metal behind the point of cut-off, and especially by the force exerted upon the enlarged or flanged portion of said valve. When the compressor reaches the end of its working stroke, it may be in the position shown in Fig. 8, with its working face, which, of course, is the cut-off face of the valve, in the plane of the abutting faces of the nozzle and the mold, and of course the end of the sprue on the casting, when the mold is so shaped as to form a sprue that must afterward be removed, will end in the same plane.

It will be noticed that this combined valve and compressor works in a chamber that is filled with molten metal and unless properly constructed is liable to stick and become clogged. For this reason I have found it advantageous to make use of a metallic valve and compressor having a chilled surface, and such a one gives the best results. Either before or after the cooling of the casting the valve 25′ may be opened to admit air to the chamber *c*, and after such cooling this chamber may be opened, the mold withdrawn from the core, and the casting removed from such mold, after which the mold may be restored to its original position and the sections of the chamber fastened together again ready for another operation.

Having thus described my invention, I claim—

1. In a casting-machine, the combination with means for subjecting a mass of molten metal to a pressure greater than atmospheric, of an outlet-nozzle through which molten metal is discharged; a shiftable mold; means for advancing the mold to a position when a casting is to be made in which it contacts with the nozzle and for withdrawing it therefrom; a valve independent of the mold for controlling the entrance of molten metal thereinto; means for exhausting the space extending from the valve to the bottom of the mold-space proper and through and into which the molten metal passes during its flow; a power-driven device in the machine; and means operatively connected with such device for actuating said valve to first admit molten metal under pressure to the exhausted mold, and then to shut off all communication of the metal therewith.

2. In a casting-machine, the combination with a plunger for subjecting a mass of molten metal to pressure, of an outlet-nozzle through which molten metal is discharged; a shiftable mold; means for advancing the mold to its casting position and for withdrawing it therefrom; a valve independent of the mold for controlling the entrance of molten metal thereinto; means for exhausting the space extending from the valve to the bottom of the mold-space proper, and through and into which the molten metal passes during its flow; a power-driven device in the machine; and means operatively connected with such device for first opening said valve, and immediately afterward actuating the plunger, and then closing the valve after the mold has been filled.

3. In a casting-machine, the combination with a melting-tank and a plunger, of an out-

let-nozzle through which molten metal is discharged; a shiftable mold; means for advancing the mold to its casting position and for withdrawing it therefrom; a valve independent of the mold for controlling the entrance of molten metal thereinto; means for exhausting the space extending from the valve to the bottom of the mold-space proper and through and into which the molten metal passes during its flow; a shaft; cams on said shaft, one for holding the plunger in an inoperative position, and another for opening said valve; and springs for effecting the operation of the plunger and the valve when released from their respective cams.

4. In a casting-machine, the combination with means for subjecting a mass of molten metal to a pressure greater than atmospheric, of an outlet-nozzle through which molten metal is discharged; a shiftable mold; a vacuum-chamber in which the mold is located; means for advancing the mold to a position when a casting is to be made in which it contacts with the nozzle and for withdrawing it therefrom; a valve independent of the mold for controlling the entrance of molten metal thereinto; means for exhausting said vacuum-chamber, and thereby exhausting the space extending from the valve to the bottom of the mold-space proper, and through and into which the molten metal passes during its flow; a power-driven device in the machine; and means operatively connected with such device for actuating said valve to first admit molten metal under pressure to the exhausted mold, and then to shut off all communication of the metal therewith.

5. In a casting-machine, the combination with means for subjecting a mass of molten metal to pressure greater than atmospheric, of a shiftable mold; a vacuum-chamber in which the mold is located; a stuffing-box in a wall of the vacuum-chamber; a mold-actuator extending through the stuffing-box; a valve independent of the mold for controlling the entrance of molten metal thereinto; means for exhausting the vacuum-chamber, and thereby exhausting the space extending from the valve to the bottom of the mold-space proper; a power-driven device in the machine; and means operatively connected with such device for actuating said valve to first admit molten metal under pressure to the exhausted mold, and then to shut off all communication of the metal therewith.

6. In a casting-machine, the combination with means for subjecting a mass of molten metal to pressure greater than atmospheric, of a shiftable mold; a vacuum-chamber in which the mold is located; a stuffing-box in a wall of the vacuum-chamber; a mold-actuator extending through the stuffing-box; a valve independent of the mold for controlling the entrance of molten metal thereinto; means for exhausting the vacuum-chamber, and thereby exhausting the space extending from the valve to the bottom of the mold-space proper; a shaft; cams on said shaft, one for holding the plunger in an inoperative position, and another for opening said valve; and springs for effecting the operation of the plunger and the valve when released from their respective cams.

7. In a casting-machine, the combination with a melting-tank and an outlet-nozzle through which molten metal is discharged, of a well communicating with the melting-tank; a plunger for subjecting molten metal therein to pressure; a valve device embodying a pair of valve parts for simultaneously closing communication between the well and the melting-tank, and opening the passage through the nozzle and vice versa; a shiftable mold; means for advancing the mold to its casting position and for withdrawing it therefrom; means for exhausting the space extending from the valve part controlling the passage through the nozzle, to the bottom of the mold-space; a power-driven device in the machine; and means operatively connected with such device for actuating the plunger and the valve device in proper order.

8. In a casting-machine, the combination with a melting-tank and an outlet-nozzle through which molten metal is discharged, of a well communicating with the melting-tank; a plunger for subjecting molten metal therein to pressure; a valve device embodying a pair of valve parts for simultaneously closing communication between the well and the melting-tank, and opening the passage through the nozzle, and vice versa; a shiftable mold; a vacuum-chamber in which the mold is located; means for advancing the mold to its casting position and for withdrawing it therefrom; means for exhausting the vacuum-chamber, and thereby exhausting the space extending from the valve part controlling the passage through the nozzle to the bottom of the mold-space; a power-driven device in the machine; and means operatively connected with such device for actuating the plunger and valve device in proper order.

9. In a casting-machine, the combination with a melting-tank and an outlet-nozzle through which molten metal is discharged, of a well communicating with the melting-tank; a plunger for subjecting molten metal therein to pressure; a valve device embodying a pair of valve parts for simultaneously closing communication between the well and the melting-tank, and opening the passage through the nozzle, and vice versa; a shiftable mold; a vacuum-chamber in which the mold is located; a stuffing-box in a wall of the vacuum-chamber; a mold-actuator extending through the stuffing-box; means for exhausting the vacuum-chamber, and thereby exhausting the space extending from the valve part controlling the passage through the nozzle, to the bottom of the mold-space; a shaft; and springs and cams operatively connected with such shaft for controlling the movements of said plunger and said valve device.

10. In a casting-machine, the combination of a plunger for subjecting a mass of molten metal to pressure; a mold forming a closed mold-space for the injection of molten metal when in its casting position; a valve independent of the mold for controlling the entrance of molten metal to the mold; means for exhausting the closed mold-space extending from the valve to the bottom of the mold-space proper and through and into which the molten metal passes during its flow; a casting-compressor independent of the plunger and operating in unison with said valve; a power-driven device in the machine; and means operatively connected with such device for actuating the plunger and opening and closing the valve in proper order.

11. In a casting-machine, the combination with a melting-tank and an outlet-nozzle through which molten metal is discharged, of a well communicating with the melting-tank; a plunger for subjecting molten metal therein to pressure; a valve device embodying a pair of valve parts for simultaneously closing communication between the well and the melting-tank and opening the passage through the nozzle and vice versa; a mold; means for exhausting the space extending from the valve part controlling the passage through the nozzle to the bottom of the mold-space proper and through and into which the molten metal passes during its flow; a casting-compressor independent of said plunger and operating in unison with said valve; a power-driven device in the machine; and means operatively connected with such device for actuating the plunger and the valve device in proper order.

12. The combination with a melting-tank and an outlet-nozzle through which molten metal is discharged, of a well communicating with the melting-tank; a plunger for subjecting molten metal therein to pressure; a shiftable mold; a vacuum-chamber in which the mold is located; means for advancing the mold to its casting position and for withdrawing it therefrom; a valve for controlling the entrance of molten metal from the well to the mold; a casting-compressor forming an extension of said valve; means for actuating the plunger; means for actuating the valve to close the same and maintain through the casting-compressor a pressure on the molten metal injected into the mold; a power-driven device in the machine; and means operatively connected with such device for causing the actuation in proper order of said means for actuating the plunger and said means for actuating the valve.

13. In a casting-machine, the combination with a melting-tank, a well communicating therewith and a plunger for subjecting molten metal therein to pressure, of a shiftable mold; a vacuum-chamber in which the mold is located; an actuator extending through a wall of the vacuum-chamber for actuating the mold; a valve for controlling the entrance of molten metal from the well to the mold; a casting-compressor forming an extension of said valve and terminating when the valve is in its closed position in the plane of the front face of the mold; means for actuating the plunger; means for actuating the valve to close the same and maintain through the casting-compressor a pressure on the molten metal injected into the mold; a power-driven device in the machine; and means operatively connected with such device for causing the actuation in proper order of said means for actuating the plunger and said means for actuating the valve.

14. In a casting-machine, the combination with a mold, of vacuum-producing means; means for filling the mold as soon as a vacuum is produced with molten metal practically instantaneously whereby a high pressure is exerted upon the molten metal and every point in the walls of the mold-space at the moment the mold is filled, a compressor and a compressor-actuator having means for exerting a gradually-decreasing force upon the metal in the mold.

15. In a casting-machine, the combination with a mold, of vacuum producing and maintaining means; means for filling the mold as soon as a vacuum is produced practically instantaneously whereby a high pressure is exerted upon the molten metal and every point in the mold at the moment said mold is filled, and a spring-actuated compressor having means for exerting a gradually-decreasing force upon the metal in the mold.

16. In a casting-machine, the combination, with a mold and with vacuum-creating means, of mold-filling means; a spring for operating said mold-filling means; a casting-compressor operative on the filling of the mold; a spring for operating said casting-compressor; quick-let-off cams operative successively and suddenly to release such springs; and automatic mechanical means for operating the same.

17. In a casting-machine, the combination with a mold and means for rotating and axially reciprocating the mold, of means for exhausting the mold and means for filling the exhausted mold with molten metal practically instantaneously, whereby a high pressure is exerted upon the molten metal and every point in the wall of the mold-space at the moment the mold is filled.

18. In a casting-machine, the combination with means for exerting a pressure greater than atmospheric upon a mass of molten metal, of a valve-controlled outlet-nozzle through which molten metal is ejected; a vacuum-chamber into which said nozzle opens; a mold mounted in said vacuum-chamber to reciprocate toward and away from the outlet-nozzle; and an eduction-pipe for exhausting the space of the vacuum-chamber forward of the mold and to which the mold is open when withdrawn from contact with the outlet-nozzle.

19. In a casting-machine, the combination with means for exerting a pressure greater than atmospheric upon a mass of molten metal,

of a valve-controlled outlet-nozzle through which molten metal is ejected; a vacuum-chamber into which said nozzle opens; a mold mounted in said vacuum-chamber to reciprocate toward and away from the outlet-nozzle; an eduction-pipe for exhausting the space of the vacuum-chamber forward of the mold and to which the mold is open when withdrawn from contact with the outlet-nozzle; and a mold-actuator extending through a stuffing-box in a wall of the vacuum-chamber.

CURTIS H. VEEDER.

Witnesses:
ELBRIDGE P. ANDERSON,
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