T. CRITCHLOW.

PROCESS OF AND APPARATUS FOR CASTING METAL.

APPLICATION FILED JUNE 6, 1908.

917,257.

Patented Apr. 6, 1909.

3 SHEETS—SHEET 1.

Fig. 2.

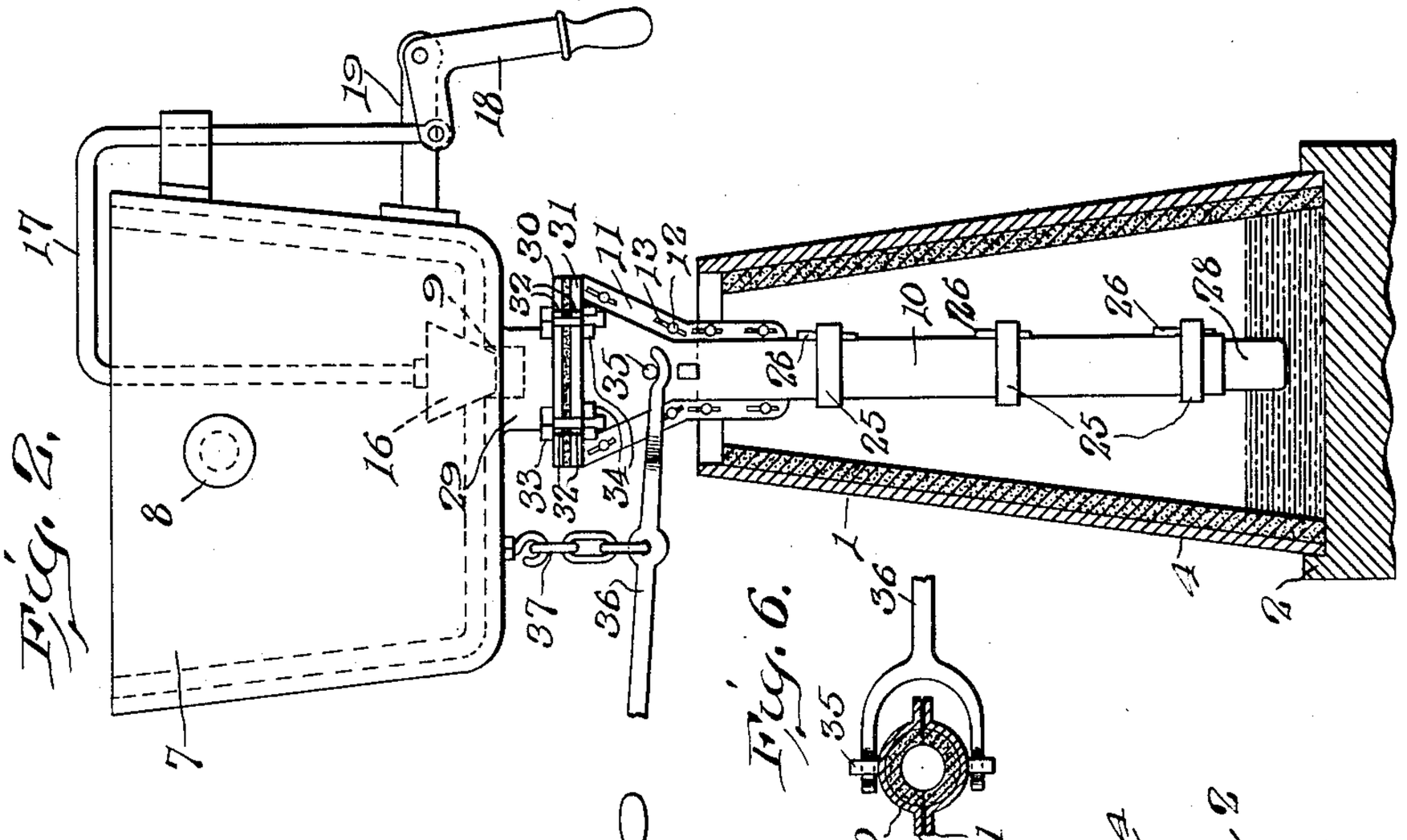
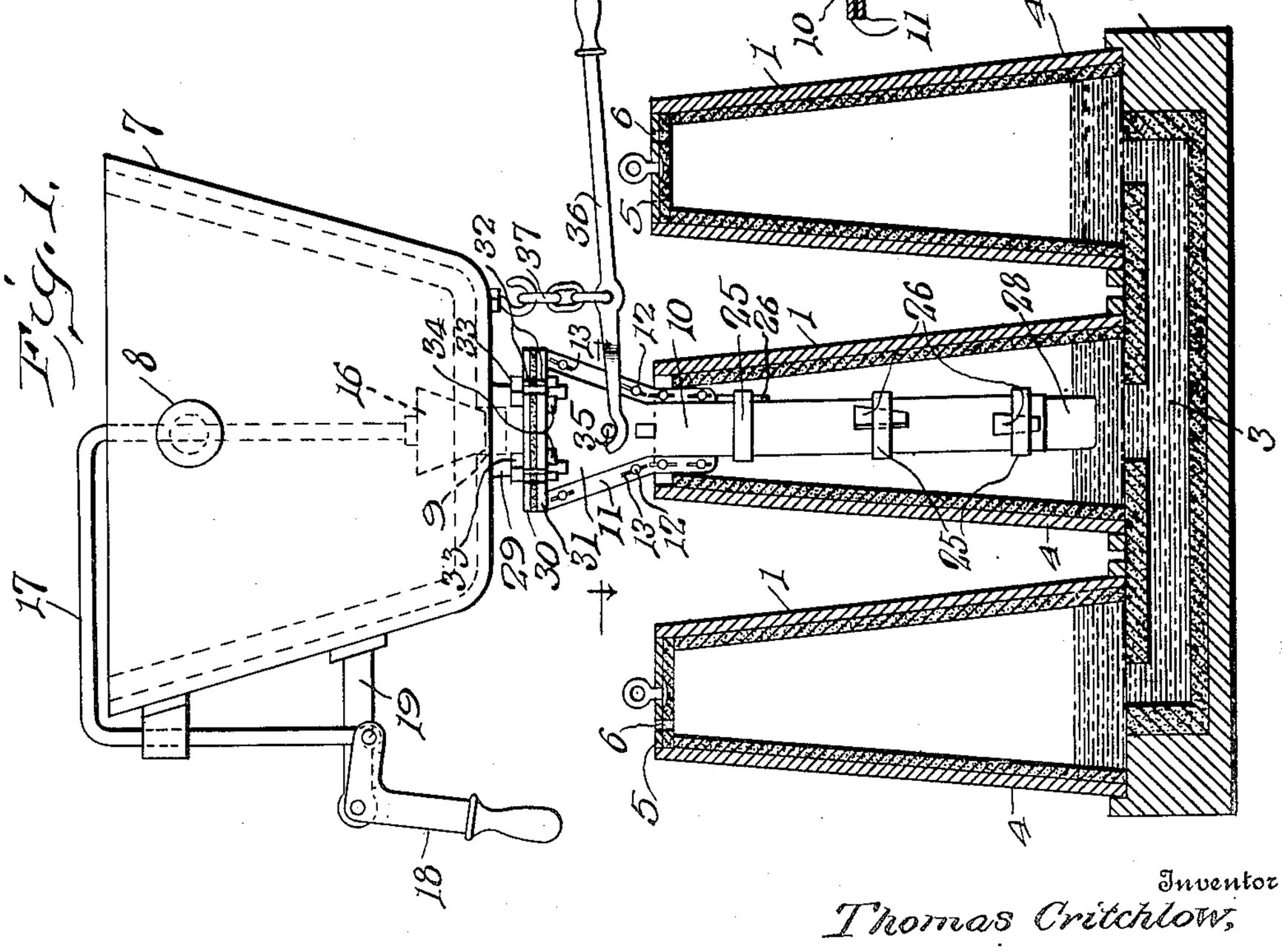


Fig. 6.

Fig. 1.



Witnesses

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3 SHEETS—SHEET 2.

Fig. 5.

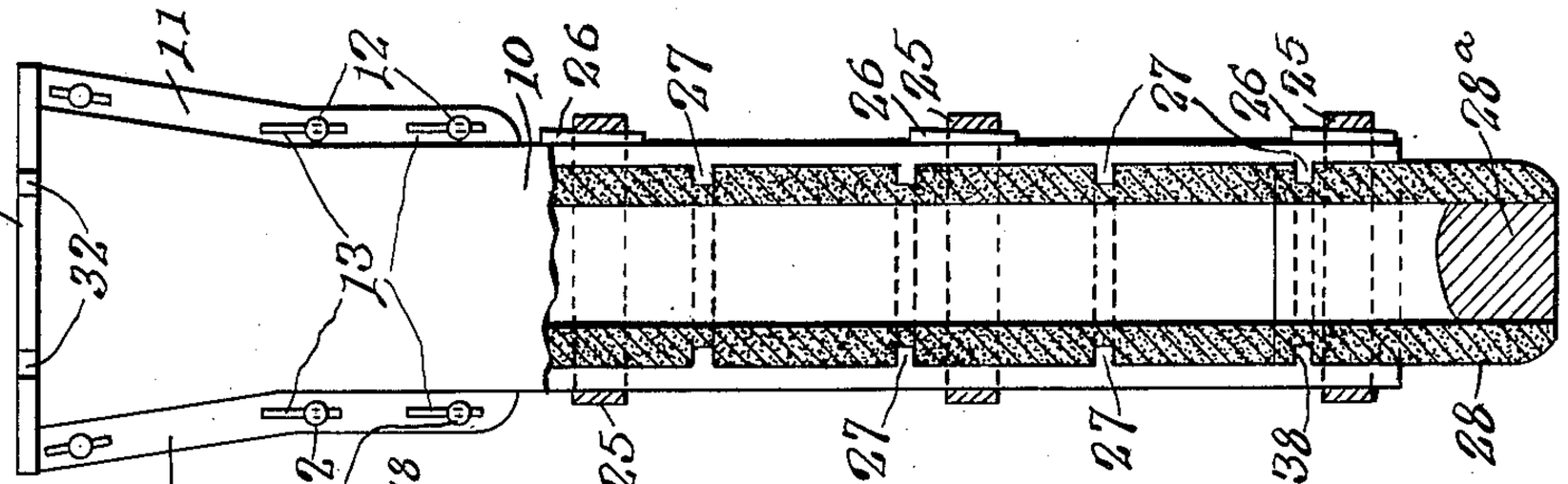


Fig. 4.

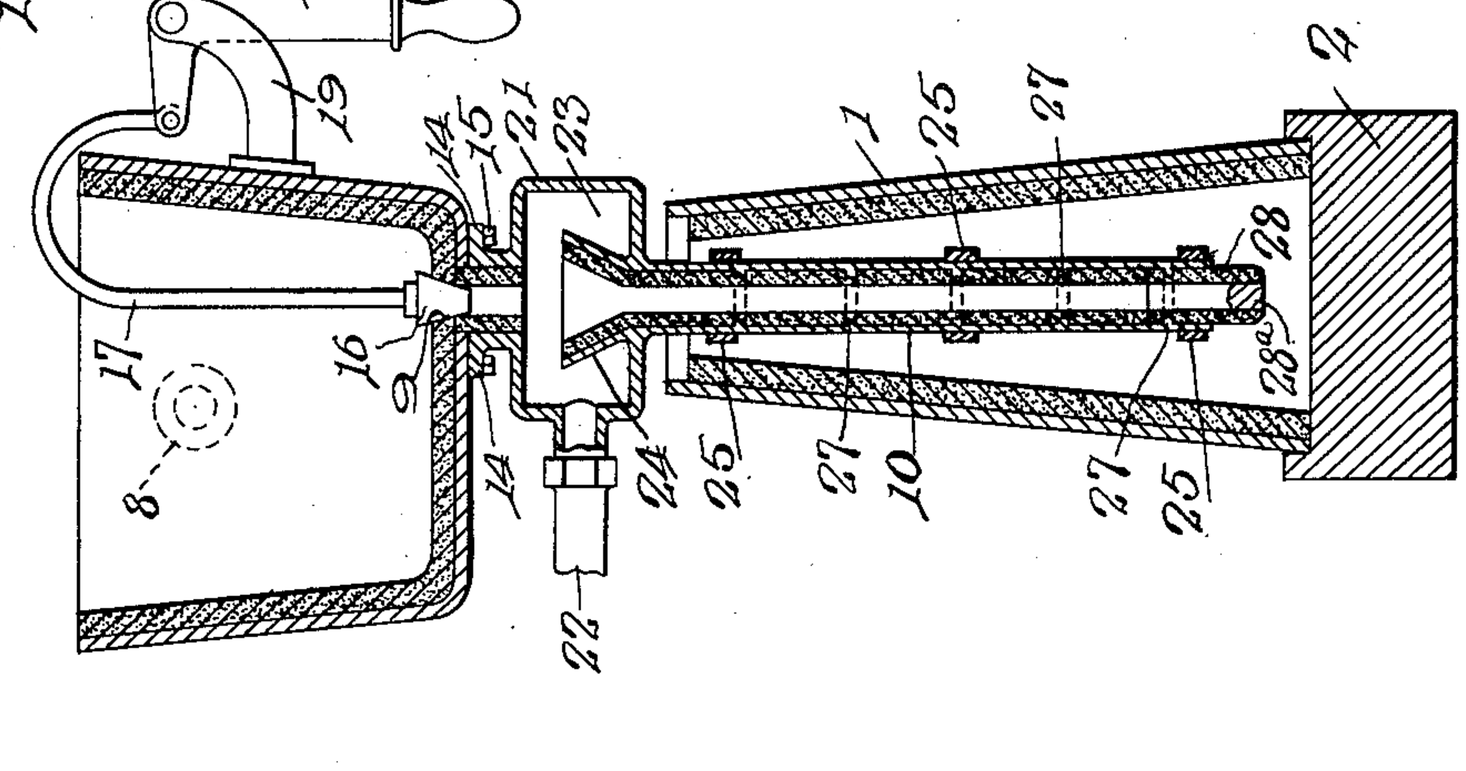
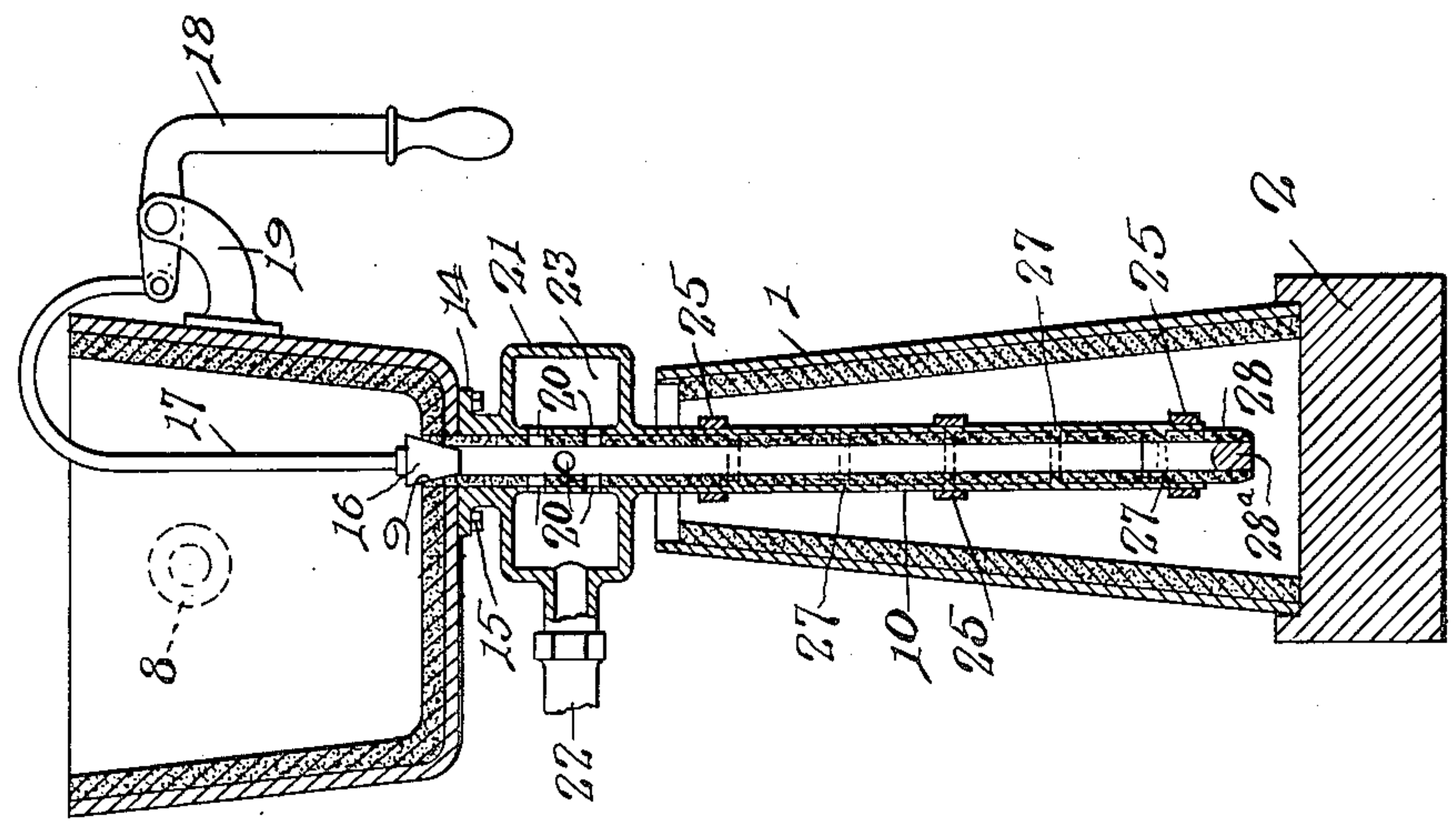


Fig. 3.



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3 SHEETS—SHEET 3.

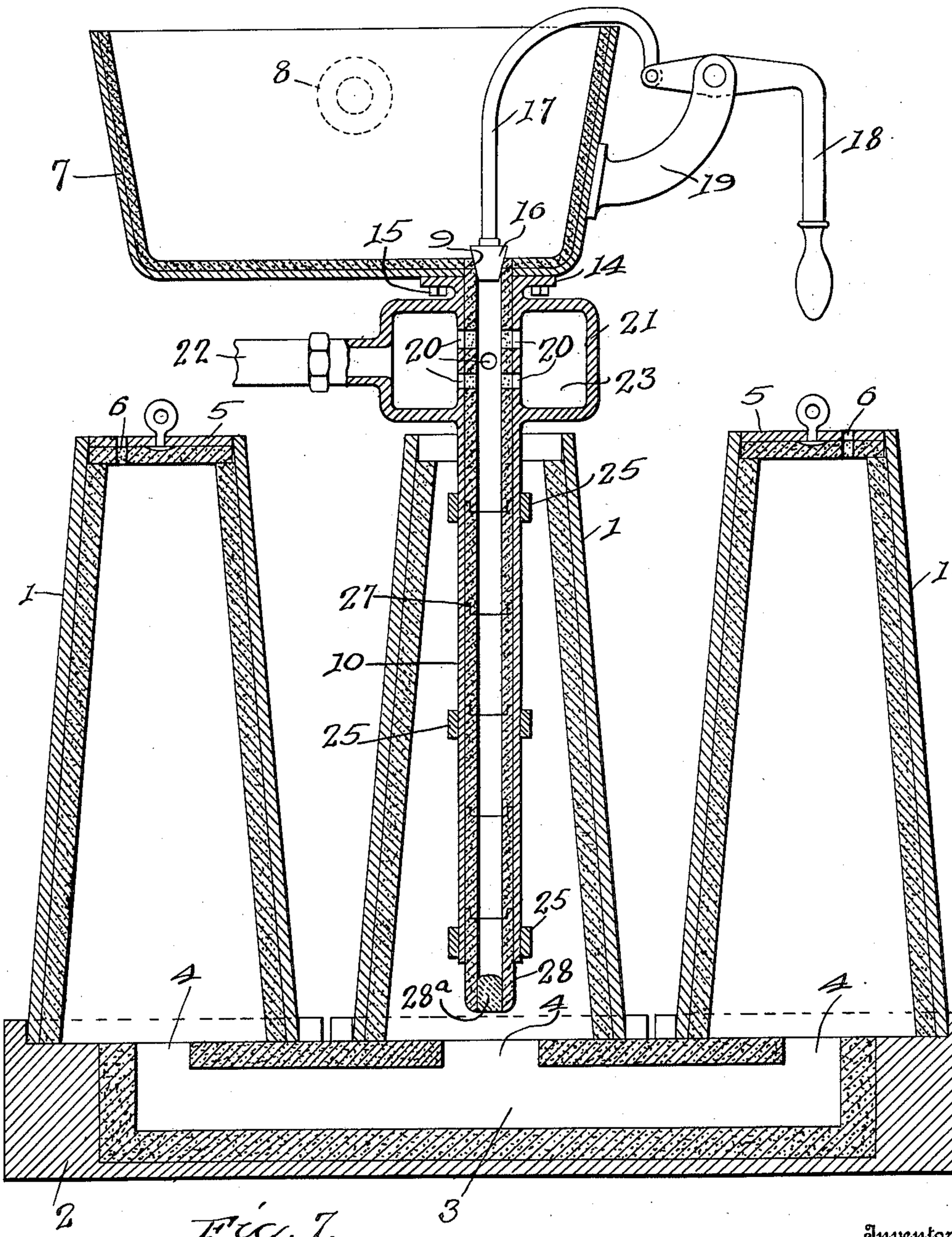

Fig. 7.

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UNITED STATES PATENT OFFICE.

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PROCESS OF AND APPARATUS FOR CASTING METAL.

No. 917,257. Specification of Letters Patent. Patented April 6, 1909.

Application filed June 6, 1908. Serial No. 437,068.

To all whom it may concern:

Be it known that I, THOMAS CRITCHLOW, a citizen of the United States, residing at Jersey City, in the county of Hudson and State of New Jersey, have invented certain new and useful Improvements in Processes of and Apparatus for Casting Metal, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to a process of and an apparatus for casting metal, and is adapted more particularly for the casting of steel ingots.

In casting ingots and articles of a similar character it is desirable that all air should be excluded from the molten metal, as the presence of air in the metal seriously injures the quality of the ingot, or other article that is cast, by forming therein air holes, bubbles and the like. Various apparatus have been designed to exclude the air from the molten metal while the casting is being formed. Among such apparatus are those which vacuumize the molds before the metal is poured into the same. An apparatus of this character has a high degree of efficiency, but is necessarily somewhat complicated in its construction and operation, involving as it does the necessity of constructing and supporting the molds in such a manner that they will be air-tight and also involving the operation of an air-exhausting apparatus in addition to the usual pouring mechanism. Such an apparatus is disclosed in Patent No. 165,068 granted to James Kidd and myself June 29, 1875, and a further development of the idea is shown and described in the applications for patents filed by me March 4, 1908, Ser. Nos. 419,099 and 419,100.

The object of the present invention is to provide a process of and apparatus for casting metal which will exclude the air from the molten metal, thereby providing a casting free from air holes, bubbles and other injurious effects of the air; which will be simple in construction and operation, but will have a high degree of efficiency; which may be applied either to a single mold or a group of molds; and further, which will be provided with means for removing the gases from the molten metal, as well as excluding the air therefrom.

With these objects in view my invention consists in certain combinations and arrangements of parts and in certain novel features of construction to be hereinafter described and then more particularly pointed out in the claims.

In the accompanying drawings, Figure 1 is a side elevation of an apparatus embodying my invention, showing the same as applied to a group of molds; Fig. 2 is a similar view, showing the apparatus applied to a single mold; Fig. 3 is a vertical, sectional view of an apparatus embodying a modified form of my invention; Fig. 4 is a similar view embodying a further modification of the invention; Fig. 5 is a detail view of the discharge pipe with part of one side broken away; Fig. 6 is a detail view of the adjusting lever for the discharge tube; and Fig. 7 is a vertical sectional view of a modified arrangement of the apparatus embodying the invention.

In the preferred form of apparatus for carrying out my invention I so arrange the discharge nozzle of the ladle that the molten metal from the ladle may be introduced into the mold, first at a point near the bottom of the mold and then at a point near the surface of the metal already within the mold, this point being preferably beneath the said surface, in this manner excluding the air from practically the entire stream of molten metal as it passes from the ladle to the mold, and I so support the ladle that the same can be gradually elevated, thus introducing the metal at a succession of points, but maintaining the point of introduction at all times close to the surface of the metal within the mold.

In Fig. 2 of the drawings I have illustrated the apparatus as applied to a single mold 1, which mold may be of the ordinary construction and may be supported in any suitable manner, while in Fig. 1 I have shown a group comprising a plurality of molds 1, all of which molds are simultaneously filled by the introduction of the metal into one of the same. To this end the molds, which are of ordinary construction, are mounted upon a base 2 and are placed in communication one with the other by means of a conduit 3 formed in said base and connected by means of sprue-holes 4 with the interior of the several molds, whereby a part of the metal poured into any one of said molds will pass through the sprue-hole of that mold and enter the other molds, which are in communication therewith, through their respective sprue-holes. In the present instance,

I have shown the molds so arranged that the metal will be poured into the central mold and I have shown the other molds of the group as provided with closures 5 for the upper ends thereof to prevent the admission of foreign matter to the molds and have provided these closures with vents 6 to permit the escape of any air already in the mold as the molten metal rises therein.

A ladle 7 is so supported above the mold into which the metal is to be poured that it can be moved vertically and can be conveyed from point to point. To this end, I have provided the ladle 7 with trunnions or lugs 8, by means of which the same can be connected to a traveling crane or derrick. The ladle is provided, preferably in the bottom thereof, with an outlet aperture 9 and has surrounding said outlet aperture and depending therefrom a discharge tube or pipe 10, which tube or pipe is preferably of a length substantially equal to the depth of the mold into which the metal is to be poured. This pipe is preferably lined with fire clay, and, in order that the same may be readily constructed and the fire clay retained in place therein, I have, in the present instance, formed this pipe in two sections, as shown, the upper portion of each section being provided with outwardly extending flanges 11 on the opposite sides thereof, which flanges are adapted to be connected one to the other by means of bolts 12, which are preferably provided with slots in one end thereof to receive the tapered keys 13, by means of which the two flanges are secured one to the other. Those portions of the two halves of the pipe lying below the flanged portions thereof are secured one to the other by means of rings or bands 25 fitting loosely about the same and adapted to be tightly secured thereto by means of tapered keys 26 which are driven between the bands or rings and the sides of the pipe, thus firmly securing the two parts of the pipe together. Each section of the pipe is also preferably provided with inwardly extending, transverse ribs 27 adapted to be embedded in the fire clay lining in the pipe and thus retain that lining in position.

In order that the lower end of the pipe may not be injured by the molten metal in which it is submerged I prefer to provide the same with a fire clay nozzle 28 which fits into the lower end of the pipe and extends some distance below the same. This nozzle is provided near its upper end with an annular groove 38 adapted to engage the lowermost of the transverse ribs 27 which serves to retain the nozzle in position within the discharge pipe. The tube or pipe 10 is, in a large casting apparatus, of considerable length, and, to avoid the necessity of lifting the ladle and its contents to a height sufficient to insert the tube into the mold, it is desirable to make this tube detachable, and, to this end, I have formed the discharge tube 10 in two pieces, the upper portion, 29, of the tube being secured to the ladle about the outlet aperture therein and provided with a flange 30, while the upper end of the lower or body portion of the tube 10 is provided with a corresponding flange 31, which flanges are adapted to be secured one to the other in such a manner that the main portion of the pipe may be readily separated from the ladle. To this end, I have provided the flanges 30 and 31 with slots 32 extending inwardly from the outer edges thereof, the slots in the two flanges being so arranged that they will register when the body portion of the tube 10 is brought into proper relation to the ladle and will be adapted to receive bolts 33 which are secured therein by means of tapered keys 34. In this manner, the discharge tube is rigidly secured to the ladle in such a manner that it can be readily detached therefrom, and, at the same time, the construction is such that the tube may be connected to and disconnected from the ladle without being liable to be injured by rough handling, such as an apparatus of this character usually receives.

To facilitate the handling of the discharge tube 10 when the same is being connected to or disconnected from the ladle I have provided the same with trunnions or lugs 35 and have suspended a lever 36 from the bottom of the ladle by means of a chain 37. This lever has one end bifurcated and adapted to engage the trunnions 35 on opposite sides of the tube 10, thus enabling the tube to be adjusted to bring the slots 32 in the flanges 30 and 31 into registration.

The outlet aperture 9 is controlled by means of a valve 16 having a valve stem or rod 17 extending upwardly and thence outwardly over the edge of the ladle, where it is connected to one end of an operating lever 18 which is pivotally supported upon brackets 19 secured to the adjacent wall of the ladle and so arranged that the movement of said lever about its pivotal axis will move the valve into or out of engagement with its seat in the aperture 9.

When a casting is to be formed, the desired quantity of molten metal is drawn from the converter ladle into the pouring ladle, the valve 16 being closed to prevent the escape of the metal therefrom. The ladle is then conveyed to a point directly above the mold and is connected to the upper end of the pipe 10, the lower end of which is close to the bottom of the mold. With the ladle in this position the valve 16 is opened and the metal allowed to pass through the pipe 10 into the mold. The bottom of the pipe being close to the bottom of the mold, the metal will speedily rise above the lower end of the pipe, thus sealing the same against the admission of air, and it will be apparent that the stream of

metal passing from the ladle to the mold is at all points so inclosed as to exclude the air. As the metal rises in the mold the ladle is moved upwardly, the rate of speed at which the ladle is elevated being so regulated in relation to the discharge of the metal through the pipe 10 that the lower end of that pipe will at all times be beneath or close to the surface of the metal within the mold, thus preventing the air from coming into contact with any material portion of the metal. In this manner the casting formed within the mold is entirely free from air holes, bubbles and other defects which would be caused by the presence of air in the molten metal.

Inasmuch as the molten metal itself contains gases which are injurious to the casting I have provided means for extracting these gases from the stream of metal as it passes from the ladle to the mold. To this end I have provided the discharge pipe 10 with an opening near the ladle 7. This opening, in the form of apparatus shown in Fig. 3, comprises a series of holes 20 formed about the circumference of the pipe. A casing 21 is secured to the pipe 10 surrounding the opening therein and is connected by means of a suction pipe 22 with a suitable suction apparatus, such as an air pump which forms no part of the present invention. The casing 21 thus forms a vacuum chamber 23 about the openings in the pipe 10. The suction exerted, through the openings 20, upon the stream of metal passing through the pipe 10 is such as to extract therefrom all gases and vapors which the molten metal may contain.

In Fig. 4 I have shown a form of apparatus differing slightly from that shown in Fig. 3. In this form of the apparatus the opening in the pipe 10 is formed by cutting away a portion of the pipe within the casing 21 and providing the lower portion of the pipe with a diverging or funnel-shaped mouth 24 extending into the vacuum chamber 23 and adapted to receive the stream of metal from the upper portion of the pipe 10, thus exposing the entire circumference of the stream of metal to the action of the vacuum chamber. If desired, the lower end of the nozzle 28 may be provided with a plug 28^a of some readily fusible material, such as lead, to prevent the entrance of air into the tube 10 prior to the opening of the valve 16.

While I have shown the apparatus for extracting the gases from the molten metal as employed in connection with a single mold, it will be obvious that it can be employed in other arrangements, such, for instance, as the group of molds shown in Fig. 1. It will also be understood that, while I have, in Figs. 3 and 4, shown the tube as permanently secured to the bottom of the ladle, the tube, in this form of the apparatus, may be detachably connected to the ladle in the same manner as is the tube in the form of apparatus shown in Figs. 1 and 2. Thus it will be seen that I have provided a casting apparatus, which, although very simple in its construction, will effectually exclude the air from the molten metal while the casting is being formed, in this manner enabling the metal to be cast free from air holes, bubbles and other defects due to the presence of air therein; and further, that I have provided means for extracting the gases from the stream of molten metal as it passes from the ladle to the mold and thereby further purifying the metal and producing a casting of fine quality. It will also be apparent that, while it is preferable in the operation of the apparatus to so support the ladle that the lower end of the discharge tube will be at all times beneath the surface of the molten metal in the mold, the lower end of this tube may be raised a slight distance above this surface without affecting the quality of the casting inasmuch as the air near the surface of the molten metal will be very highly heated and will not attack the stream of molten metal to any material extent. Consequently, the apparatus can be handled by rough, inexperienced workmen and the character of the casting will not be materially affected if the discharge nozzle of the tube 10 is at times raised above the surface of the metal in the mold.

I wish it to be understood that I do not desire to be limited to the details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

The process involved in the invention may be utilized independently of the apparatus above described and primarily this process consists in introducing the molten metal into the mold at a point near the bottom thereof and then introducing the remainder of the metal, of which the casting is to be formed, into the mold beneath or close to the surface of the metal already in the mold, and, as the metal rises in the mold, to introduce the metal successively at a series of points, each a greater distance from the bottom of the mold than the preceding point, but always maintaining the point of introduction beneath or close to the surface of the metal within the mold. In connection with this part of the process the metal may be treated, as it passes to the mold, to remove therefrom any gases which it may contain, and further, this portion of the process may be utilized on connection with a group of inter-communicating molds, in which all the molds are filled simultaneously. The complete process, embodying all the steps above mentioned, consists in supporting a quantity of molten metal near a group of inter-communicating molds, in drawing off the metal to one of said molds and treating the metal as it is drawn off to extract therefrom any gases which may be contained within the same, and then intro-

ducing the metal so treated into said one of said group of molds near the bottom thereof, whereby a portion of the metal so introduced into said mold will pass into the other molds of said group. Then when the molten metal has risen an appreciable distance in the first-mentioned mold, the remainder of the metal, of which the castings are to be formed, is introduced into said first-mentioned mold, successively, at a series of points, each at a greater distance from the bottom of the mold than the preceding point of introduction, but the point of introduction being at all times beneath or close to the surface of the metal within the mold. In this manner the metal will be introduced into the molds free from gases and the air will be excluded therefrom, thus providing a casting entirely free from the defects caused by the presence of gases and air in the metal.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. An apparatus of the character described comprising a mold, a ladle, and means for introducing metal from said ladle into said mold, first near the bottom thereof and then beneath the surface of the metal within said mold while the remainder of the metal of which the casting is to be formed is being poured.

2. An apparatus of the character described comprising a mold, a ladle, and means for introducing metal from the ladle into the mold, first near the bottom thereof and then successively, at a series of points within said mold, the point of introduction being at all times beneath the surface of the metal within the mold.

3. An apparatus of the character described comprising a mold, and a ladle having a discharge pipe adapted to enter said mold and to extend beneath the surface of the metal therein while the metal is being poured.

4. An apparatus of the character described comprising a mold, and a vertically movable ladle having a discharge pipe adapted to enter said mold and to extend beneath the surface of the metal therein while the metal is being poured.

5. An apparatus of the character described comprising a mold, a ladle having a valve-controlled outlet near the bottom thereof, and a depending tube surrounding said outlet and adapted to enter said mold and to extend beneath the surface of the metal therein while the metal is being poured.

6. An apparatus of the character described comprising a vertically movable ladle having a valve-controlled outlet near the bottom thereof and a depending tube surrounding said outlet and adapted to enter said mold and extending beneath the surface of the metal therein when the metal is being poured.

7. An apparatus of the character described comprising a mold, a ladle, a discharge pipe for said ladle adapted to enter said mold and having an opening in the wall thereof, a casing secured to said pipe and extending about said opening to form a chamber, and a suction pipe connected with said chamber.

8. An apparatus of the character described comprising a mold, a vertically movable ladle, a discharge pipe for said ladle adapted to enter said mold and having an opening in the wall thereof between said ladle and said mold, a casing secured to said pipe and extending about said opening to form a chamber, and a suction pipe connected with said chamber.

9. An apparatus of the character described comprising a mold, a ladle, a discharge pipe for said ladle adapted to enter said mold, a casing secured to said pipe and forming a chamber surrounding the same, a portion of said discharge pipe lying within said chamber, being cut away, and a suction pipe connected with said chamber.

10. An apparatus of the character described comprising a base having a conduit therein, a plurality of molds supported on said base and connected with said conduit, a vertically movable ladle supported above one of said molds, a discharge pipe for said ladle adapted to enter said mold and extend beneath the surface of the metal therein when the mold is being filled, and a valve controlling the flow of metal through said discharge pipe.

11. A process of casting metal consisting in first introducing a portion of the metal into a mold through the upper portion of said mold and then introducing the remainder of the metal, of which the casting is to be formed, beneath the surface of the metal in the mold.

12. A process of casting metal consisting in first introducing a portion of the metal into the mold above the bottom thereof and then introducing the remainder of the metal, of which the casting is to be formed, beneath the surface of the metal within the mold.

13. A process of casting metal consisting in first introducing a portion of metal into the mold above the bottom thereof and then introducing the remainder of the metal, of which the casting is to be formed, successively at a series of points within said mold, the point of introduction being at all times beneath the surface of the metal in the mold.

14. A process of casting metal consisting in first treating the metal to extract the gases therefrom, then introducing a portion of the metal into the mold above the bottom thereof, and then introducing the remaining metal, of which the casting is to be formed, beneath the surface of the metal within the mold.

15. A process of casting metal consisting

in first treating the metal to extract the gases therefrom, then introducing a portion of the metal into the mold near the bottom thereof, and then introducing the remaining metal, of which the casting is to be formed, successively at a series of points within the mold, the point of introduction being at all times beneath the surface of the metal in the mold.

16. A process of casting metal consisting in supporting a quantity of molten metal near the mold, drawing off said metal to said mold, treating the metal as it is drawn off to extract the gases therefrom, then introducing a portion of the metal so treated into said mold near the bottom thereof and then introducing the remaining metal, of which the casting is to be formed, beneath the surface of the metal within said mold.

17. A process of casting metal consisting in supporting a quantity of molten metal near the mold, drawing off said metal to said mold, treating the metal as it is drawn off to extract the gases therefrom, then introducing a portion of the metal so treated into said mold near the bottom thereof and then introducing the remaining metal, of which the casting is to be formed, successively at a series of points within said mold, the point of introduction being at all times beneath the surface of the metal in the mold.

18. A process of casting metal consisting in first introducing the metal into one of a group of inter-communicating molds near the bottom thereof, whereby all of said molds are poured simultaneously, and then introducing a portion of the remainder of the metal, of which the castings are to be formed, into said first-mentioned mold successively at a series of points within said first-mentioned mold, the point of introduction being at all times beneath the surface of the metal in said mold.

19. A process of casting metal consisting in supporting a quantity of metal near a group of inter-communicating molds, drawing off the metal to one of the molds of said group, treating the metal as it is drawn off to extract the gases therefrom, then introducing a portion of the metal into said mold near the bottom thereof, whereby all of said molds are poured simultaneously, and then introducing the remainder of the metal, of which the castings are to be formed, into said first-mentioned mold beneath the surface of the metal within the same.

20. A process of casting metal consisting in supporting a quantity of metal near a group of inter-communicating molds, drawing off the metal to one of the molds of said group, treating the metal as it is drawn off to extract the gases therefrom, then introducing a portion of the metal into said mold near the bottom thereof, whereby all of said molds are poured simultaneously, and then introducing the remainder of the metal, of which the castings are to be formed, into said first-mentioned mold successively at a series of points within said first-mentioned mold, the point of introduction being at all times beneath the surface of the metal in said mold.

21. A process of casting metal consisting of supporting a quantity of molten metal near a mold, drawing off said metal at a point below the surface thereof and conveying the same to said mold through an air-tight conduit and introducing a portion thereof into the bottom of said mold and then introducing the remainder of the metal, of which the casting is to be formed, into said mold beneath the surface of the metal within the same.

22. A process of casting metal consisting in first treating the metal to extract the gases therefrom, then introducing a portion of the metal into the mold near the bottom thereof, and then introducing the remaining metal, of which the casting is to be formed, close to the surface of the metal within the mold.

In testimony whereof, I affix my signature in presence of two witnesses.

THOMAS CRITCHLOW.

Witnesses:
ELZA F. MCKEE,
EDWARD L. REED.