

Nov. 6, 1928.

F. H. MOYER

1,690,750

METHOD OF POURING STEEL

Filed Aug. 20, 1926

2 Sheets-Sheet 1

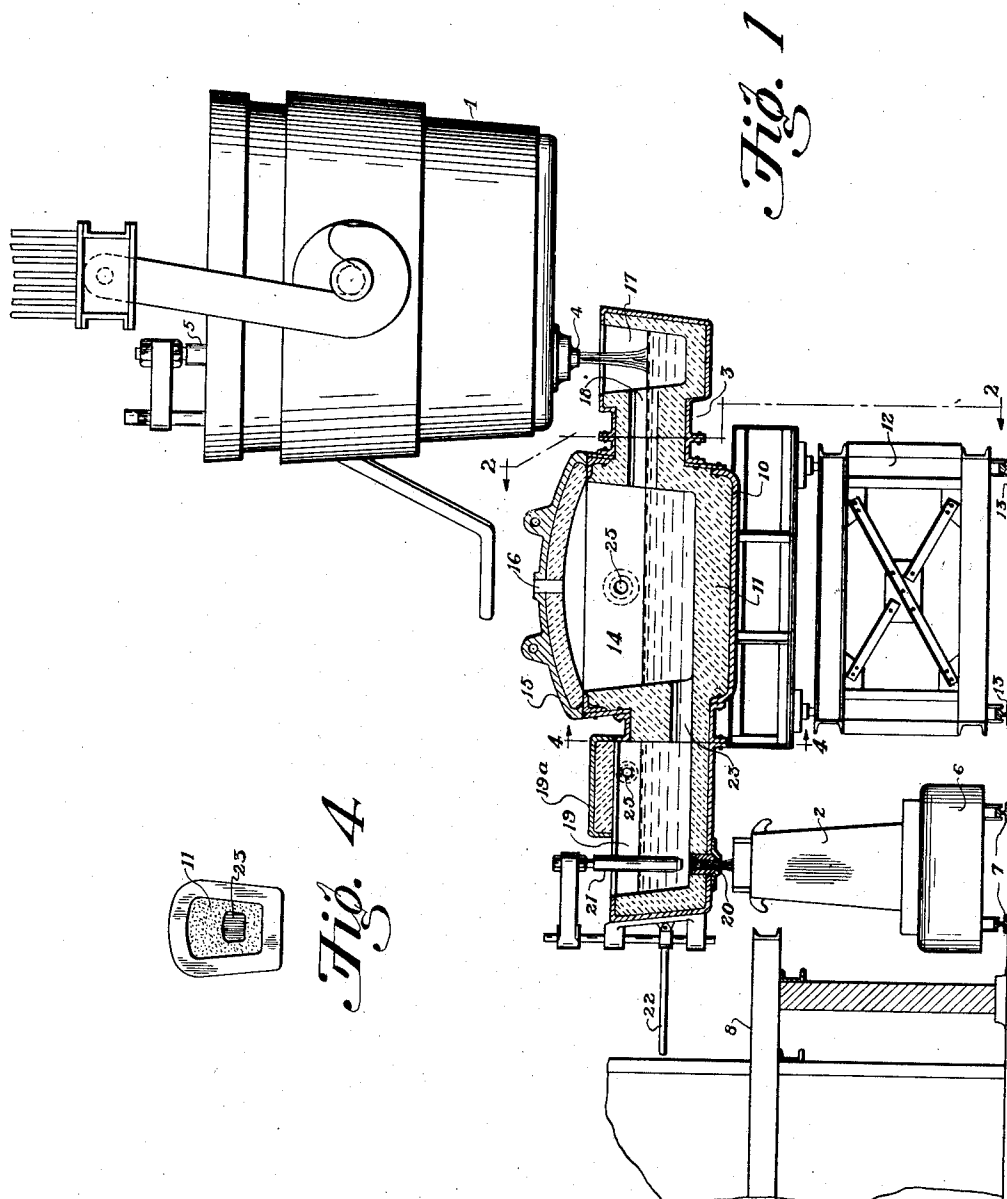


Fig. 4

Fig. 1

Inventor

Fredellia H. Moyer

By *Freese and Bond*

Attorneys

Nov. 6, 1928.

1,690,750

F. H. MOYER

METHOD OF POURING STEEL

Filed Aug. 20, 1926

2 Sheets-Sheet 2

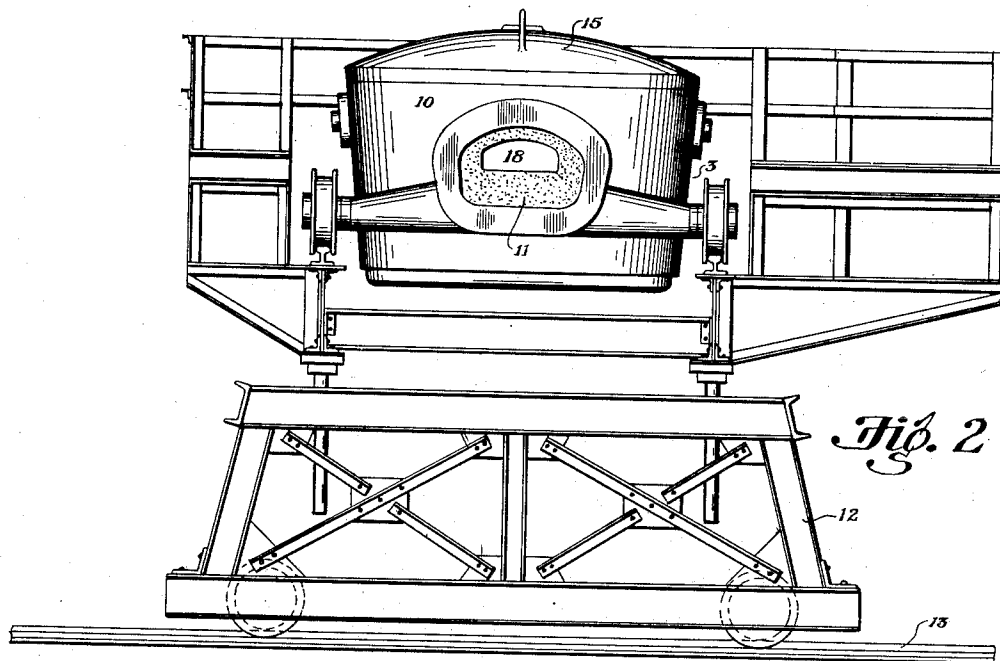
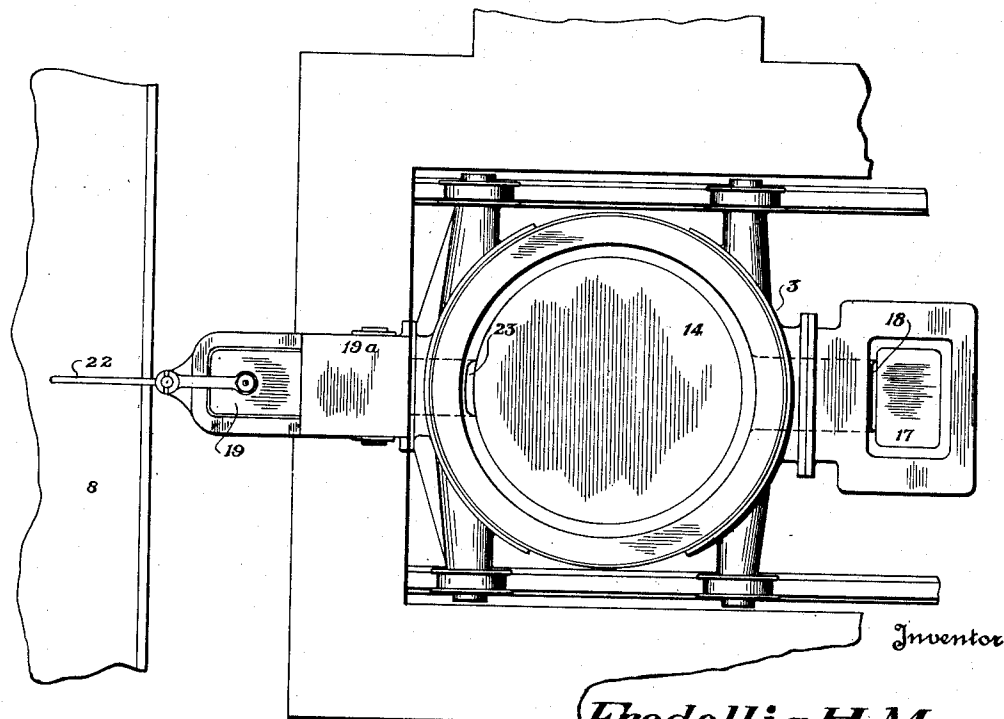


Fig. 2



Inventor

Fredellia H. Moyer

Fig. 3

By Trease and Bond
Attorneys

UNITED STATES PATENT OFFICE.

FREDELLIA H. MOYER, OF CANTON, OHIO.

METHOD OF POURING STEEL.

Application filed August 20, 1926. Serial No. 130,517.

The invention relates to a new and novel method of pouring steel and the like, provided especially for the purpose of cutting down the stream velocity of the molten metal leaving the ladle nozzle, by a series of intermediate steps which also remove slag, gas and air from the molten metal, pouring clean metal into the mold at minimum velocity and with minimum agitation.

In the present practice of pouring steel or other molten metals into molds it is customary to either pour the metal directly from the ladle nozzle into the mold, or to place between the ladle and mold for the purpose of breaking up or retarding the stream velocity as it enters the mold.

In the first instance, where the pouring box is not used, the high velocity of the stream of molten metal, due to an initial head of some twelve to fifteen feet in the ladle, causes it to splash when it strikes the bottom of the mold, and as the mold is filled, gas, air and slag are entrained and forced into the metal, part of the same remaining in the steel as the ingot solidifies or freezes, remaining throughout the processing of the material and being found as inclusions and defects in the finished product.

A further disadvantage of the above method of pouring is that the molten metal which splashes, as it strikes the bottom of the mold, is thrown against the side walls of the mold, adhering thereto and forming scabs or surface defects in the surface of the ingot being poured. These defects become imbedded in the surface of the steel, when reduced in size in a rolling mill, and must be removed before further processing as they will otherwise appear in the surface of the finished bar or other product.

This operation is very costly as each piece must be inspected and these defects chipped or ground therefrom in order to insure a satisfactory surface in the finished product, as required.

In order to reduce the stream velocity of the molten metal entering the mold, pouring boxes, as above referred to, have been used to receive the molten metal from the ladle nozzle and pour the same into the mold.

Various types of these boxes have been used whereby the depth of the metal is considerably reduced by the regulation of the incoming stream from the ladle into the

pouring box, in order to establish a predetermined relatively low head, a suitable nozzle and stopper mechanism being provided in the pouring box whereby the metal can be teemed or poured into the mold under this low velocity head.

As the pouring of the molten metal from the ladle progresses, the velocity head decreases, while the velocity head in the pouring box remains substantially constant, producing an ideal condition under which to fill the molds.

Such pouring boxes, however, are extremely small in volume as compared with the volume of metal which is to pass there-through in a given time, and furthermore, no means have been provided in these pouring boxes for eliminating gas and slag or for preventing the churning effect of the steel, slag, gas and air due to the velocity of the incoming molten metal; these boxes being so formed that the molten metal together with the slag, gas and air carried therein, is agitated as it is received into the pouring box and poured therefrom.

The small volume of these pouring boxes makes it impossible to maintain a constant flow of metal into and out of the box, as is required in good pouring practice and also makes it impossible to quiet the metal down during its passage through the pouring box into the mold.

Thus the elimination from the steel of gas, slag and entrained air, is not accomplished with these pouring boxes.

The agitating action, above referred to, may be well illustrated by holding a glass under a water faucet and turning the water on full force. It will be seen that there is a great swirling action of water in the glass as it overflows and upon shutting off the water quickly, the glass will not be entirely filled owing to the combined swirling action of the water and the entrained air bubbles forced into the water by the velocity of the incoming water from the faucet. As soon as the water is shut off this action ceases and leaves the glass only partially filled.

The improved process to which this invention pertains may be used in conjunction with the present method of receiving the molten metal from the ladle into which the metal has been tapped directly from the furnace, through the usual tapping spout; or it may be used in conjunction with the

improved slag and gas eliminator disclosed in my application for Letters Patent Serial No. 124,609, filed July 24, 1926, in which latter case the results obtained will produce much cleaner steel than the old method of running the slag and steel directly into the ladle.

The object of the present improvement is to provide a method of pouring steel which will overcome the above mentioned objections present in the ordinary methods of pouring steel.

The above and other objects may be attained by providing a process wherein the molten metal poured from the ladle will be received in one portion of a vessel designed to receive and break the stream velocity of the incoming molten metal and to absorb splash and agitation caused thereby preliminary to passing to an adjacent comparatively large reservoir portion of the vessel.

This reservoir is arranged to receive the partially separated mixture of metal, slag, gas and entrained air, from the receiving portion of the vessel, by passing or overflowing over a dam or weir which is preferably of sufficient width to permit a wide and shallow stream of metal to pass thereover from one portion of the vessel to the next succeeding portion.

As the metal flows over this dam it presents a comparatively large surface area, thereby permitting the mixture of metal, slag, gas and air, of shallow depth, and enlarged area, to become separated on account of the difference in specific gravity of the several materials, the metal being thereby deslagged and de-gasified.

The molten metal being the heaviest will settle to the bottom, the gas and air will be released into the atmosphere and the slag particles will rise to the top and float upon the surface. The top of the dam is spaced above the bottoms of the receiving and reservoir portions of the vessel, precluding further agitation of the metal in the reservoir portion.

This reservoir portion of the vessel is of a considerably enlarged area, thus retarding, changing or slowing down the rate of flow of the metal, and of sufficient depth to produce the desired pressure and potential head for pouring or teeming into molds, as this depth determines the velocity of the stream entering the molds.

The volume of this reservoir is such that during the pouring or teeming the metal will be collected and remain in the reservoir a comparatively long time as compared with the usual pouring box practice. There are two reasons for this, first, having a large volume, for instance one-fifth of the capacity of a ladle containing one hundred tons of molten metal requiring a teeming time of forty-five to sixty minutes; at this rate with

the reservoir containing twenty tons, the metal will require from nine to twelve minutes to pass therethrough, and is so retarded that practically all gas, air and slag, remaining with the metal, separates out leaving the purified metal in the lower portion of the reservoir from which it can be drawn as required.

The second reason is that having a large body or volume of metal from which to draw in teeming, a practically constantly teeming head is maintained, as the volume of metal being withdrawn is small in proportion to the volume in the reservoir portion.

The metal may be poured or teemed directly from the reservoir into the molds but, for reasons which will later appear, it is preferable to withdraw the metal from the large body in the reservoir into another portion or compartment to form a small body of metal from which the metal is teemed or poured, this teeming compartment communicating with the lower portion of the reservoir through a shallow comparatively wide opening to prevent the passage of slag into the teeming compartment.

The improved method may be carried out by means of the apparatus illustrated in the accompanying drawings, in which—

Figure 1 is a longitudinal sectional view of the pouring device by the use of which the improved method is accomplished, showing the same mounted in position to receive molten metal from the ladle and pour the same into an ingot mold;

Fig. 2, a sectional elevation on the line 2—2, Fig. 1;

Fig. 3, a plan view of the same, and

Fig. 4, a section on the line 4—4, Fig. 1.

Similar numerals of reference indicate corresponding parts throughout the drawings.

In carrying out the improved method a pouring device is interposed between the ladle 1 and the mold 2, this pouring device comprising a receptacle indicated generally at 3.

The ladle is adapted to receive the molten metal either directly from the furnace in the usual manner, or from the slag and gas eliminator disclosed in my co-pending application above referred to, and may be provided with the usual pouring nozzle 4 and stopper mechanism 5 for controlling the same.

The ingot mold 2 may be of the usual construction and carried upon a car 6 mounted upon tracks 7 located adjacent to the usual pouring platform 8, all of which may be of usual and well known construction as adapted to present pouring practice.

The pouring device may comprise the steel shell 10 lined with suitable refractory material 11 and carried upon a car 12 mounted on tracks, 13, located parallel to the tracks 7. The vessel 3 may comprise the large central

reservoir 14 covered as by the lid 15 provided with the central gas outlet 16; the receiving compartment 17 communicating with one side of the reservoir through the wide neck 18 spaced above the bottoms of both of said compartments and forming a dam between the same; and the pouring compartment 19 which may be closed upon its top by the cover 19^a and is provided with the pouring nozzle 20 controlled by a stopper 21 arranged to be operated as by the lever 22 extended across the pouring platform in a position to be accessible to workmen thereon.

The lower portion of the pouring compartment communicates with the lower portion of the body of metal in the reservoir through the reduced opening 23, permitting the molten metal to pass from the bottom of the reservoir into the pouring compartment, and its rate of flow to be speeded up in passing through the opening 23.

The receiving compartment 17 is of sufficient volume to receive and break the velocity of the molten metal received from the nozzle of the ladle, the splash and churning or boiling action of the ladle stream being absorbed in this compartment as the molten metal is received therein from the ladle.

The metal is thus considerably quieted before it reaches the receiving compartment, and when the same is filled to the height of the dam the molten metal passes through the opening 18 in a thin sheet of relatively great width and length as compared to thickness at a very much reduced velocity due to the width of the opening 18.

As this opening is of some considerable length also the molten metal passing thereover in a thin sheet is given a chance to rid itself of the gas and entrained air bubbles which rise to the surface and escape in the atmosphere, the slag also coming to the surface of the molten metal as it flows into the reservoir compartment 14.

Since this reservoir is of relatively large area and shallow depth and the metal passes quietly into the same, from the receiving compartment, the action of the molten mass of metal is further retarded therein.

The stopper 21 in the teeming or pouring compartment remains closed during the time that the reservoir is being filled, permitting the incoming molten metal to rise, in both the reservoir and pouring compartment, to the desired level, preferably two or three inches above the bottom of the neck 18, between the receiving compartment and reservoir. During this period of filling of the reservoir and pouring compartment, gas will continue to rise to the surface in the reservoir and slag will rise to the surface in both the reservoir and pouring compartment until the metal rises above the top of the opening 23, after which the slag will be retained on the surface of the metal in the reservoir

only, excepting such slag which has already passed into the pouring compartment and formed a blanket on the top of the metal therein. Inlets 25 may be provided in the reservoir and pouring compartment both, for the purpose of introducing a suitable agent, to form a non-oxidizing atmosphere over all exposed surfaces. Since the level of the molten mass is kept below the top of the neck 18, the receiving compartment 17 will also receive the benefit of this non-oxidizing atmosphere, and in order to conserve heat of the metal and prevent oxidizing a cover may be provided for the receiving compartment also.

When the reservoir and pouring compartment have been filled to the desired level, above mentioned, the stopper 21 is opened and the metal is teemed into the molds in the usual manner. No further slag can enter the pouring compartment from the reservoir, only clean metal, free of gas, slag and air passing through the teeming nozzle 20 into the molds.

As the last ingots are poured it will be necessary to watch the operation carefully and when the slag remaining in the reservoir starts to pass into the pouring compartment the stopper 21 should be closed and the slag drained into a slag pot or other suitable receptacle in usual manner so that only clean metal will be poured into the molds.

This improved method is especially adapted for the making of steels where internal and surface cleanliness are of the highest importance; and it will not only improve the above qualities of the steel, but will also materially increase the yield over present practice, due to the elimination of gases and slag from the steel, the uniformity of pouring and the minimizing of the splash and churning of the steel in the molds.

This method of pouring steel will be effective for sheet bars in the minimizing of the cause of blisters in the finished sheets; and also in steels known to the trade as high grade steels for forging and other uses where a clean steel is required.

Hot tops may be used upon the molds as in common practice or if desired they may be eliminated, a very good quality of ingot being produced in the mold with this method, without the use of hot tops.

Although ideal results are obtained by this method by passing the molten metal through three communicating compartments, in the pouring vessel, it should be understood that the objects of the invention may be accomplished by providing only two compartments or even by providing only a single compartment of sufficient area to quiet the molten metal and permit degasification between the receiving and pouring ends of the compartment. Attention is also called to the fact that the pouring vessel may be

provided with one or more pouring nozzles arranged to simultaneously pour into a like number of molds at one setting.

The apparatus disclosed in this application for carrying out the herein described method is described and claimed in a copending application, filed August 17, 1926, Serial No. 129,806.

I claim:—

- 10 1. The method of pouring molten metal which consists in pouring and receiving the metal in an oxidizing atmosphere, de-gasifying the metal in a non-oxidizing atmosphere, and then teeming the metal in an oxidizing atmosphere.
- 15 2. The method of pouring molten metal which consists in pouring and receiving the metal, de-slagging the metal, and then teeming the metal, the body of metal having the same potential head throughout the receiving de-slagging and teeming operations.
- 20 3. The method of pouring the molten metal which consists in pouring and receiving the metal in an oxidizing atmosphere, changing the rate of flow of metal in a non-oxidizing atmosphere, and then teeming the metal in an oxidizing atmosphere.
- 25 4. The method of pouring molten metal which consists in pouring and receiving the metal in an oxidizing atmosphere, changing the rate of flow of metal in a non-oxidizing atmosphere, and then teeming the metal in an oxidizing atmosphere, the body of metal having the same potential head throughout the receiving, change of rate of flow and teeming operations.
- 30 5. The method of purifying molten metal which consists in pouring and receiving the metal, passing the metal in a thin sheet of relatively great width and length as compared to thickness, and then teeming the metal, the body of metal having the same potential head throughout the receiving, passing and teeming operations.
- 35 6. The method of purifying molten metal which consists in pouring and receiving the metal, overflowing the metal in a thin sheet of relatively great width and length as compared to thickness, changing the rate of flow of the metal, and then teeming the metal, the body of metal having the same potential head throughout the receiving, overflowing, change of rate of flow and teeming operations.
- 40 7. The method of purifying molten metal which consists in pouring and receiving the metal, overflowing the metal in a thin sheet of relatively great width and length as compared to thickness, slowing down the rate of flow of the metal, speeding up the rate of flow of the metal, and then teeming the metal, the body of metal having the same potential head throughout the receiving, overflowing, slowing down, speeding up and teeming operations.
- 45 8. The method of purifying molten metal which consists in pouring and receiving the metal, overflowing the metal in a thin sheet of relatively great width and length as compared to thickness, slowing down the rate of flow of the metal, and then withdrawing the metal from the lower portion of the body of metal, the body of metal having the same potential head throughout the receiving, overflowing, slowing down and withdrawing operations.
- 50 9. The method of purifying molten metal which consists in pouring and receiving the metal, overflowing the metal in a thin sheet of relatively great width and length as compared to thickness, slowing down the rate of flow of the metal, speeding up the rate of flow of the metal, and then teeming the metal from a lower portion of the body of metal, the body of metal having the same potential head throughout the receiving, overflowing, slowing down, speeding up and teeming operations.
- 55 10. The method of purifying molten metal which consists in pouring and receiving the metal, passing the metal in a thin sheet of relatively great width and length as compared to thickness, collecting the metal in a large body, and then teeming the metal, the metal having the same potential head throughout the receiving, passing, collecting and teeming operations.
- 60 11. The method of pouring molten metal which consists in passing the metal in a thin sheet of relatively great width and length as compared to thickness, collecting the metal in a large body, withdrawing the metal from a lower portion of the body, and then teeming the metal, the metal having the same potential head throughout the passing, collecting, withdrawing and teeming operations.
- 65 12. The method of pouring molten metal which consists in passing the metal in a thin sheet of relatively great width and length as compared to thickness, collecting the metal in a large body, withdrawing the metal from a lower portion of the large body to a small body of metal, and then teeming the metal from a lower portion of the small body, the metal having the same potential head throughout the passing, collecting, withdrawing and teeming operations.
13. The method of pouring molten metal which consists in pouring and receiving the metal, overflowing the metal in a thin sheet of relatively great width and length as compared to thickness, collecting the metal in a large body, withdrawing the metal from below the surface of the large body, and then teeming the metal, the metal having the same potential head throughout the receiving, overflowing, collecting, withdrawing and teeming operations.

8. The method of purifying molten metal which consists in pouring and receiving the metal, overflowing the metal in a thin sheet of relatively great width and length as compared to thickness, slowing down the rate of flow of the metal, and then withdrawing the metal from the lower portion of the body of metal, the body of metal having the same potential head throughout the receiving, overflowing, slowing down and withdrawing operations.

9. The method of purifying molten metal which consists in pouring and receiving the metal, overflowing the metal in a thin sheet of relatively great width and length as compared to thickness, slowing down the rate of flow of the metal, speeding up the rate of flow of the metal, and then teeming the metal from a lower portion of the body of metal, the body of metal having the same potential head throughout the receiving, overflowing, slowing down, speeding up and teeming operations.

10. The method of purifying molten metal which consists in pouring and receiving the metal, passing the metal in a thin sheet of relatively great width and length as compared to thickness, collecting the metal in a large body, and then teeming the metal, the metal having the same potential head throughout the receiving, passing, collecting and teeming operations.

11. The method of pouring molten metal which consists in passing the metal in a thin sheet of relatively great width and length as compared to thickness, collecting the metal in a large body, withdrawing the metal from a lower portion of the body, and then teeming the metal, the metal having the same potential head throughout the passing, collecting, withdrawing and teeming operations.

12. The method of pouring molten metal which consists in passing the metal in a thin sheet of relatively great width and length as compared to thickness, collecting the metal in a large body, withdrawing the metal from a lower portion of the large body to a small body of metal, and then teeming the metal from a lower portion of the small body, the metal having the same potential head throughout the passing, collecting, withdrawing and teeming operations.

13. The method of pouring molten metal which consists in pouring and receiving the metal, overflowing the metal in a thin sheet of relatively great width and length as compared to thickness, collecting the metal in a large body, withdrawing the metal from below the surface of the large body, and then teeming the metal, the metal having the same potential head throughout the receiving, overflowing, collecting, withdrawing and teeming operations.

14. The method of pouring molten metal which consists in pouring and receiving the metal, overflowing the metal in a thin sheet of relatively great width and length as compared to thickness, collecting the metal in a large body, withdrawing the metal from below the surface of the large body to a small body of metal, and then teeming the metal from below the surface of the small body, the metal having the same potential head throughout the receiving, overflowing, collecting, withdrawing and teeming operations.

15. The method of pouring molten metal which consists in pouring and receiving the metal, de-gasifying the metal, and then teeming the metal, the body of metal having the same potential head throughout the receiving, de-gasifying and teeming operations.

16. The method of pouring molten metal

which consists in pouring and receiving the metal, de-gasifying and de-slugging the metal and then teeming the metal, the body of metal having the same potential head throughout the receiving, de-gasifying, de-slugging and teeming operations.

17. The method of conveying molten metal from a ladle to a mold which consists in collecting the metal from the ladle in a large body, permitting the gases to escape from the metal, skimming the slag from the metal, withdrawing the metal from below the surface of the large body to a small body, and then teeming the metal, the metal having the same potential head throughout the collecting, escaping, skimming, withdrawing and teeming operations.

In testimony that I claim the above, I have hereunto subscribed my name.

FREDELLIA H. MOYER.