July 22, 1969 A. MICHELSON 3,456,713

METHOD FOR SUPPLYING MULTIPLE METAL STREAMS TO A CONTINUOUS CASTING MOLD

Filed Sept. 7, 1966 3 Sheets-Sheet 1

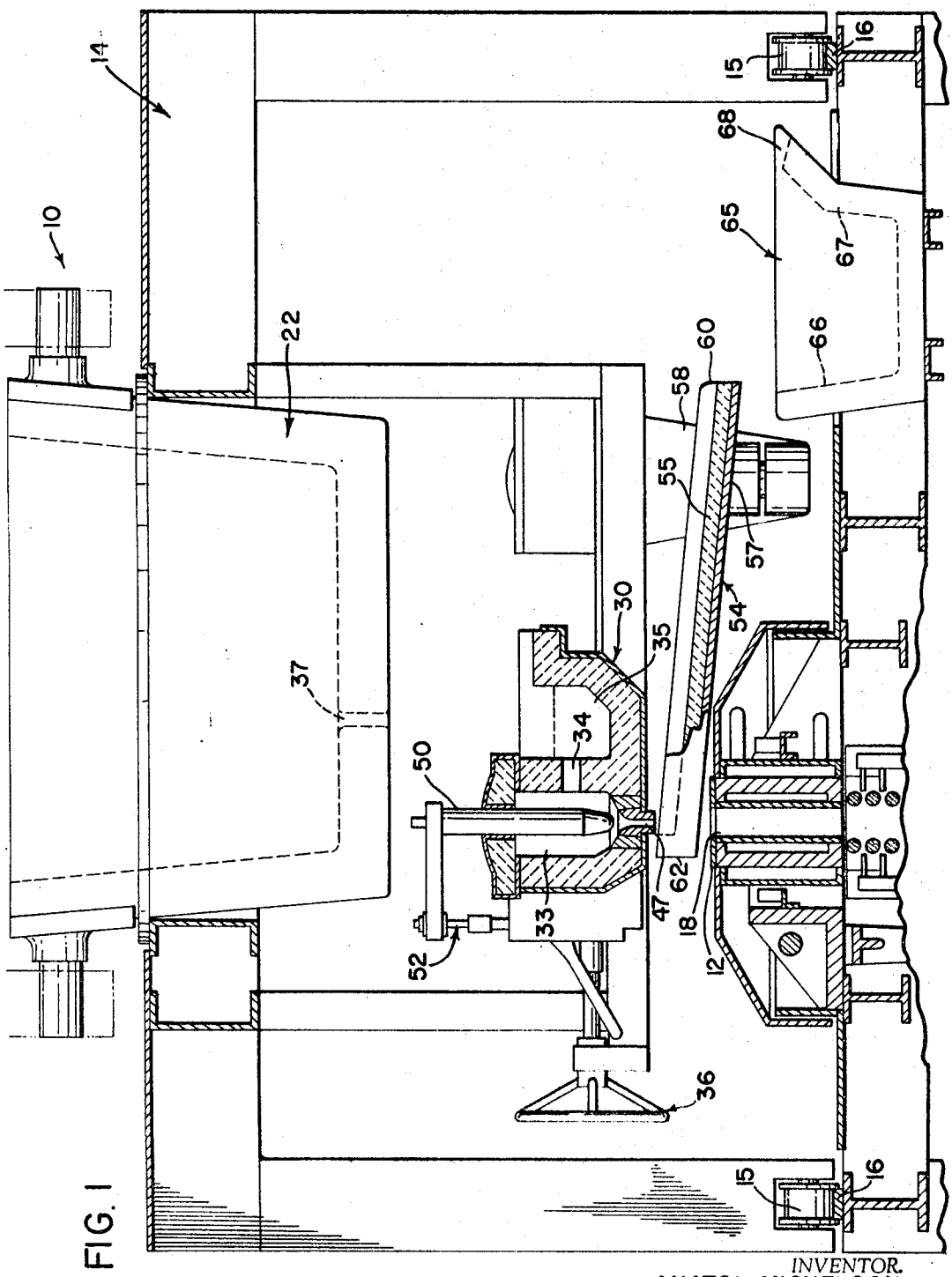


FIG. 1

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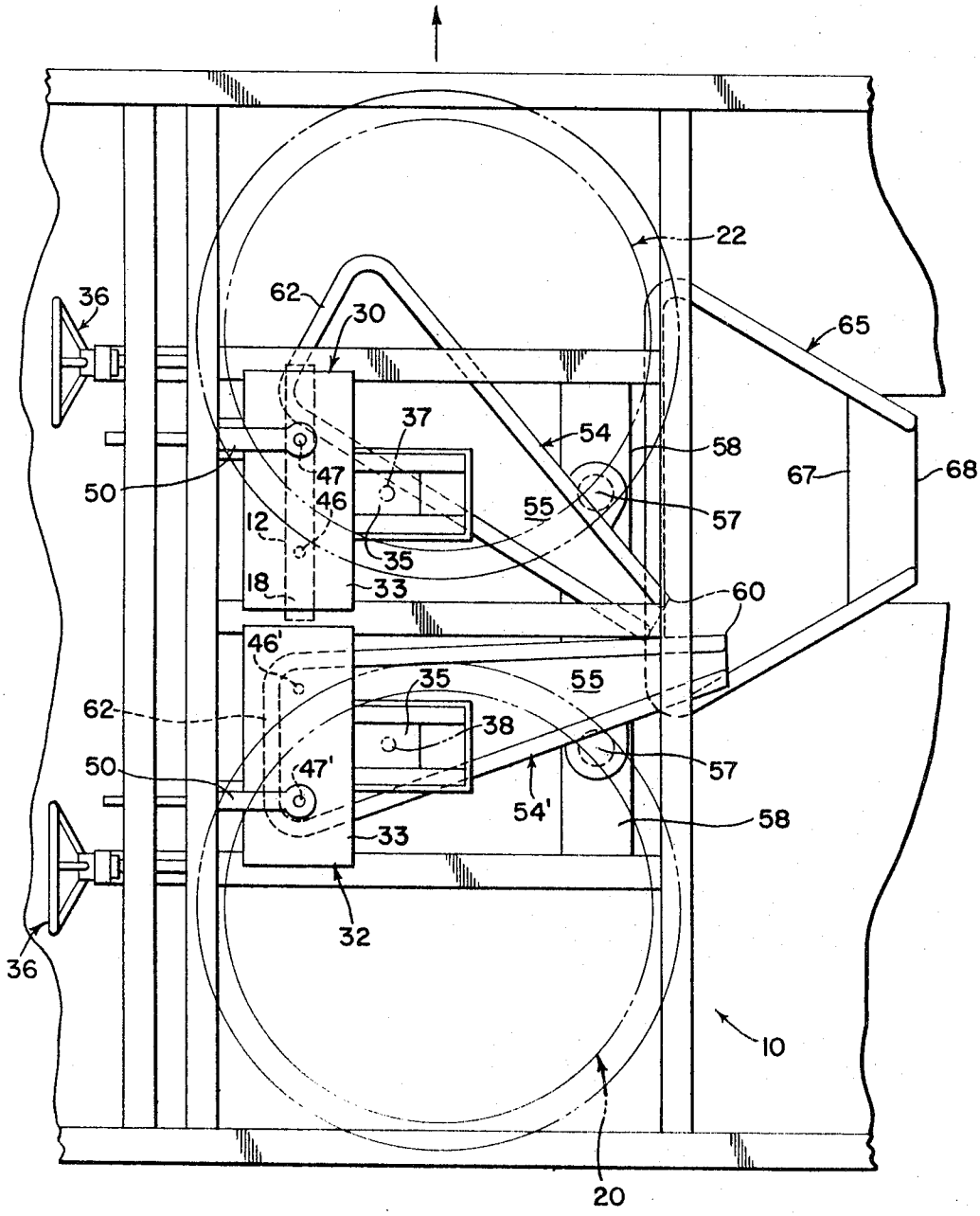
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FIG. 2



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FIG. 3

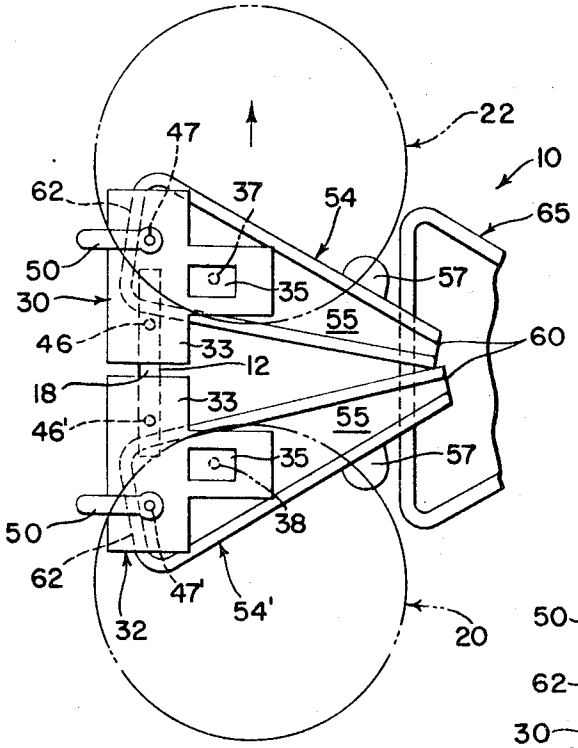
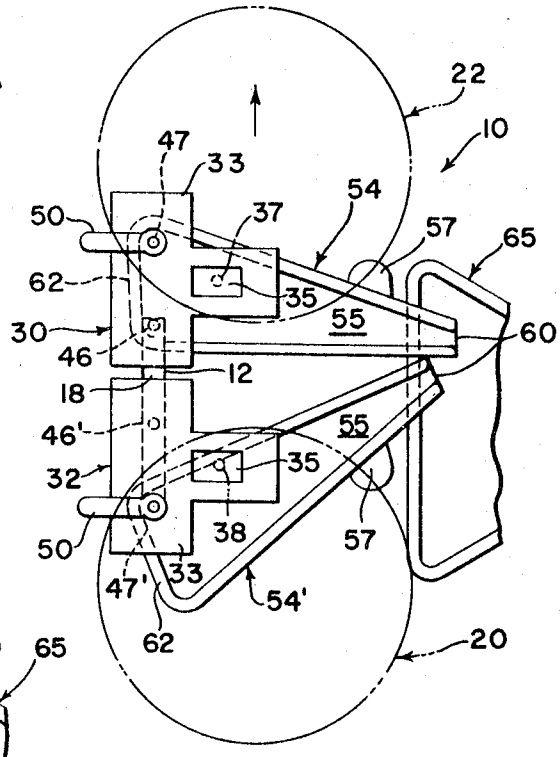


FIG. 4



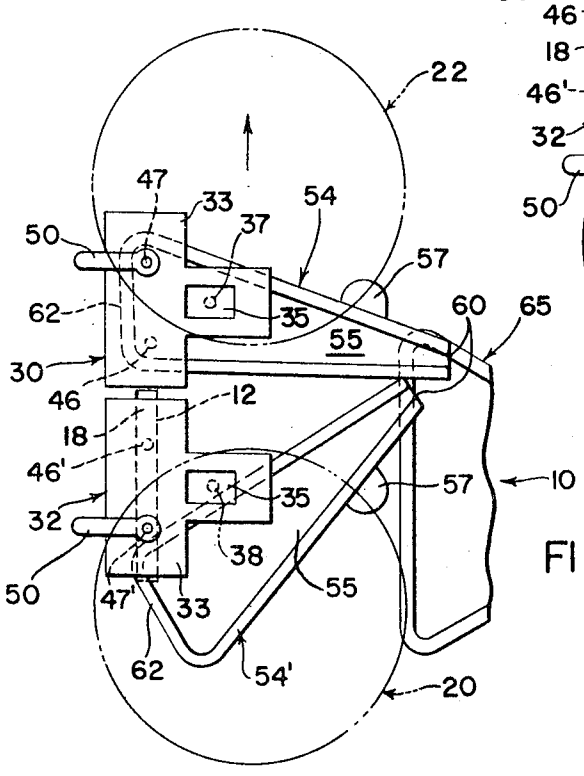


FIG. 5

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United States Patent Office 3,456,713
Patented July 22, 1969

3,456,713

METHOD FOR SUPPLYING MULTIPLE METAL STREAMS TO A CONTINUOUS CASTING MOLD

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Filed Sept. 7, 1966, Ser. No. 577,658
Int. Cl. B22d 11/10
U.S. Cl. 164—82 3 Claims

ABSTRACT OF THE DISCLOSURE

A method of continuously discharging two streams of molten metal into the mold of a continuous casting machine. The method comprises utilizing two ladles each associated with nozzle means for providing two separate streams from each. One of the ladles is positioned above the mold and its contents supplied to the mold in two streams. As it begins to empty, it is shifted laterally so that only one of its streams is conducted to the mold. Simultaneously, the other ladle is brought into position so that one of its streams is conducted to the mold. As flow from the first ladle terminates, both ladles are shifted so that both of the streams from the second ladle are conducted to the mold.

This invention pertains to the art of continuous casting and more particularly to the casting of separate heats or ladles of molten metal without interruption from one heat to the next.

The invention will be described with particular reference to the casting of wide slabs where more than one stream of molten metal is directed into the mold simultaneously, however, it should be appreciated that it is equally applicable to the casting of other shapes, such as ovals, rounds, squares or the like.

Heretofore, so-called uninterrupted continuous casting has involved the use of several ladles in which one ladle is pouring as a fresh one is brought up and pouring is begun from it as the metal from the first is being exhausted. By recycling ladles in this manner, the flow of metal to the mold may continue substantially without interruption. The ladles are not poured directly into the mold but instead are tapped into an intermediate refractory vessel or tundish from which the molten metal is then conveyed to the mold. To achieve a quick interchange of ladles, it has been proposed in the past to support the ladles on carriages traveling on an elevated trackway above the pouring floor. The ladles can be lifted out or lowered onto the carriages by means of an overhead crane. In one prior art arrangement, a pair of tundishes and trough members, one associated with each ladle, is pivoted on a column which extends parallel to the casting axis. Molten metal is supplied substantially without interruption to the mold by turning the tundishes and trough members in a manner synchronized with the expiration of molten metal from one ladle and the initial pouring from the other.

However, such prior art apparatus is unsuitable for uninterrupted continuous casting of wide slab ingots. In casting wide, rectangular slabs, for example, approximately 5 feet wide by 6 inches thick, at least two streams of molten metal spaced a considerable distance apart are

used to supply the mold requirements for metal. The rotational prior art arrangement would cause the parallel metal streams to move through an arc which is wholly inconsistent with the geometry of the slab mold and would therefore be unworkable.

Moreover, with at least two streams feeding the mold, prior art trough members cannot avoid feeding the contaminated and cold metal initially to the mold or prevent dripping when the tundish is moved away from the mold.

The present invention accomplishes the pouring of at least two streams of molten metal at the same time, synchronizing the movement of troughs, tundishes and ladles so that substantially uninterrupted slab casting is achieved.

In accordance with the invention there is provided a mold adapted to receive molten metal in at least two pouring locations. A pair of tundishes, each having two pouring nozzles, are movable longitudinally above the mold so as to intersect with the two pouring locations. The spacing of the tundish nozzles is so related to the mold dimensions and pouring locations that movement of the tundishes relative to the mold brings about a displacement of one nozzle of one tundish beyond the mold side wall as a nozzle of the other tundish is moved above the mold. The shifting of the tundishes is synchronized with the depletion of metal from a pouring ladle supplying one of the tundishes and the start of pouring from another ladle supplying the other tundish so that the supply of the parallel streams of molten metal to the mold is not substantially interrupted.

The main object is to provide a method and apparatus for casting wide slab ingots substantially without interruption.

Another object is to provide a method of shifting a pair of tundishes in rectilinear fashion so as to achieve continuous flow at two parallel mold pouring locations.

Still another object is to provide a continuous casting pouring method and apparatus in which half of the equipment is inactive most of the time enabling repairs to be made without interruption of the casting cycle.

These and other objects will be more fully appreciated by referring to the following description and drawings wherein:

FIGURE 1 is a partially sectioned side elevational view of pouring apparatus in accordance with the preferred embodiment of the invention;

FIGURE 2 is a top view of the pouring apparatus in FIGURE 1 showing the position thereof when the molten metal is being supplied to the mold entirely by one of the ladles and tundishes;

FIGURE 3 is a schematic view showing an intermediate pouring position of the apparatus in FIGURE 1 in which molten metal is being supplied in part by both ladles and both tundishes during the transition;

FIGURE 4 is a schematic view similar to that in FIGURE 3 showing the position of the ladles as the pouring responsibility is shifted from one ladle to the other; and

FIGURE 5 is another schematic view showing the position of the ladles after the transition is completed.

Referring to the drawings wherein the showings are for the purpose of illustrating a preferred embodiment of the invention only and not for the purpose of limiting same, FIGURES 1 and 2 show a pouring apparatus 10

positioned over a slab mold **12**. The pouring apparatus **10** moves longitudinally relative to the mold **12** on a carriage **14** having rollers **15** mounted on rails **16**. The mold **12** has a casting cavity **18**, the long axis of which is generally parallel to rails **16**. Two bottom pour ladles **20**, **22** are transported by the carriage **14** and can be lifted into and out of position by an overhead crane.

Two tundishes **30**, **32** each include a covered pouring chamber **33** communicating through a port **34** with a chamber **35**. The chamber **35** of each tundish **30**, **32** projects laterally below each ladle spout **37**, **38** while the pouring chambers **33** extend longitudinally above the mold cavity **18**. According to the invention, at least two pouring nozzles **46**, **47**, **46'**, **47'** project from each pouring chamber **33** at laterally spaced pouring locations although for particularly wide slabs more may be needed. In addition to longitudinal movement on carriage **14**, each tundish **30**, **32** is adjustable laterally of the mold by traversing mechanisms indicated generally at **36**. The outside nozzles **47** and **47'** only of each tundish both have stoppers **50** projecting through the refractory cover of the pouring chamber **33** and include operating mechanisms, generally indicated at **52**, for imparting vertical movement thereto so as to shut off flow through the nozzles **47**, **47'** when desired.

Associated with each tundish **30**, **32** is a trough **54**, **54'** having a refractory lining **55**. Each trough is pivoted at **57** to a bracket **58** mounted beneath the carriage **14**. As shown in FIGURE 1, each trough **54**, **54'** is movable between the tundishes and the top of the mold **12**. Each trough is inclined downwardly so that the end **60** swings in an arc above a refractory vessel **65** and is roughly triangular in shape having an end **62** sufficiently wide to span the distance between sets of nozzles **46**, **47**, **46'**, **47'**. The vessel **65** is wider at the back wall **66** than at the front wall **67** where pouring lip **68** is located so as to accommodate the sweep of the trough ends **60**.

A more complete understanding of the method of operation in accordance with the invention may be had by referring to the following description. Briefly, the method involves pouring until one ladle is nearly empty and then bring up a fresh ladle and continuing to pour it by shifting the apparatus **10** relative to the mold. When flow diminishes from the first ladle, the mold requirements are supplied by the fresh ladle. Thus, by recycling fresh ladles and shifting the pouring apparatus **10** back and forth, uninterrupted casting is obtained from a plurality of ladles. Starting with the cycle as shown in FIGURE 2, ladle **22** is full of molten metal and is positioned on the carriage **14** over the mold **12**. The pouring spout **37** of ladle **22** is discharging directly into the chamber **35** of the tundish **30**. The transversing mechanism **36** has previously been adjusted to position the tundishes **30**, **32** in line with the mold cavity **18**. At this time the ladle **20** may not be in position, but rather is being prepared at some other remote location and will be brought up when ladle **22** approaches an empty condition. During casting, the troughs **54**, **54'** are pivoted out of the way of the two nozzles which are pouring, i.e., in FIGURE 2 trough **54** is swung to the right providing a clear path for the nozzles **46**, **47**. If desired, troughs **54**, **54'** may be swung into position under both nozzles **46**, **47** or **46'**, **47'** to conduct the first portion of metal into vessel **65** if it is felt that contamination is likely at the start of casting.

As casting proceeds and the metal held by originally full ladle **22** begins to run out, a fresh ladle **20** is brought up and put in position over tundish **32**. Before flow through nozzles **46**, **47** has diminished appreciably, however, the carriage **14** is slowly started to move bringing the inside nozzle **46'** of tundish **32** closer to the mold cavity **18** while moving the outside nozzle **47** of tundish **30** an equal distance toward the opposite side of the mold. Due to the spacing between nozzles, nozzle **46'** will have been moved to within the boundary of the mold cavity **18** by the time nozzle **47** is leaving at the opposite side. Before stopper **50** shuts off flow from nozzle **47**, pouring commences from the fresh ladle **20** into tundish **32** and nozzle **46'**. This transition period can best be visualized by referring to the diagrams in FIGURES 3–5. Referring to FIGURE 3, pouring is now taking place from both ladles **20**, **22**. At this time, all of the metal flowing into tundish **30** from ladle **22** is diverted to nozzle **46** which has taken up the position formerly occupied by nozzle **47** and likewise, all the metal flowing into tundish **32** from ladle **20** is diverted through nozzle **46'** which has taken up the position formerly occupied by nozzle **46**. Both nozzles **47**, **47'** are now idle. Pouring and shifting of carriage **14** continues without interruption until flow through nozzle **46** is in danger of being diminished or the metal contaminated by slag impurities from the emptying ladle **22**. In FIGURE 4 the carriage **14** has been shifted to the point where nozzle **46** is about to move outside the mold cavity **18** while at the same time, nozzle **47'** is moving within it. As nozzle **46** moves beyond the mold cavity, trough **54** is positioned under it to divert the metal and slag flow from the emptying ladle **22** into vessel **65**; while simultaneously, the stopper **50** for nozzle **47'** is opened to permit full parallel flow into the mold **12** from both nozzles **46'**, **47'**. In FIGURE 5, movement of the carriage **14** has continued until the nozzle **46'** takes up the position originally occupied by the nozzle **47** and nozzle **47'** that position first occupied by nozzle **46**. As may be appreciated from the above, the process continues by bringing a fresh ladle to replace the empty one and moving the carriage **14** in the opposite direction thus supplying metal at both pouring locations of the mold in substantially uninterrupted fashion.

Having thus described a preferred embodiment of the invention and its method of operation, it will be appreciated that various modifications and changes may be made by those skilled in the art without departing from the spirit of the invention as defined by the appended claims except insofar as they are limited by the prior art.

Having thus described my invention, I claim:

1. A method of discharging ladles of molten metal sequentially into the mold of a continuous casting machine without interruption comprising the steps of:

providing a first substantially full ladle having nozzle means associated therewith for conducting molten metal from said first ladle in first and second parallel streams;

positioning said first ladle and its associated nozzle means above said mold and conducting the molten metal from said first ladle to said mold in said first and second parallel streams;

providing a second substantially full ladle having nozzle means associated therewith for conducting molten metal from the said second ladle in third and fourth parallel streams;

prior to termination of flow from said first ladle, shifting said first ladle and its associated nozzle means laterally so only said second stream is in position to conduct molten metal to said mold and, substantially simultaneously, bringing said second ladle and its associated nozzle means to a position above said mold and conducting molten metal to said mold from said second ladle in said third stream;

continuing to supply molten metal to said mold from both of said ladles from said second and third streams respectively; and,

as flow from said first ladle begins to diminish, shifting both said ladles and their associated nozzle means laterally to a position wherein only said second ladle and its nozzle means is in position above said mold, and conducting metal from said second ladle to said mold in said third and fourth streams.

2. The method as defined in claim **1** including the step of stopping said first stream as said first ladle and its associated nozzle means are shifted laterally.

3. The method as defined in claim 1 including the step of starting flow of said fourth stream prior to the time said second ladle and its associated nozzle means is in position above said mold.

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U.S. Cl. X.R.

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