Sept. 20, 1966 J. I. GREENBERGER 3,273,208

INTERCHANGEABLE CONTINUOUS CASTING APPARATUS

Filed Sept. 19, 1963 3 Sheets-Sheet 1

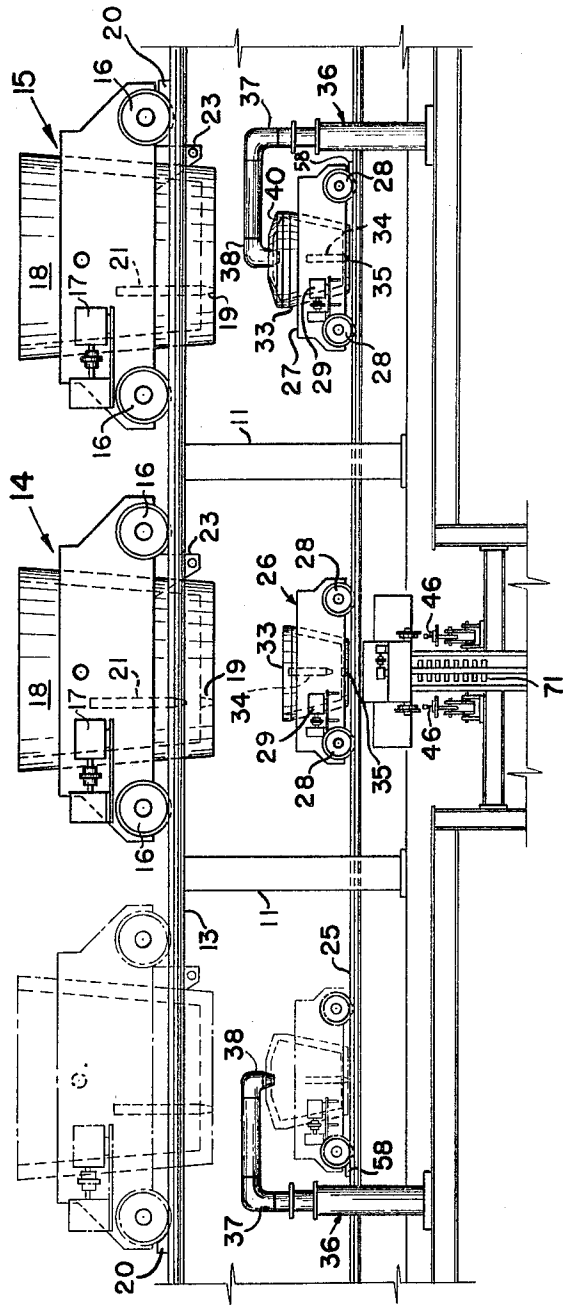


FIG. 1

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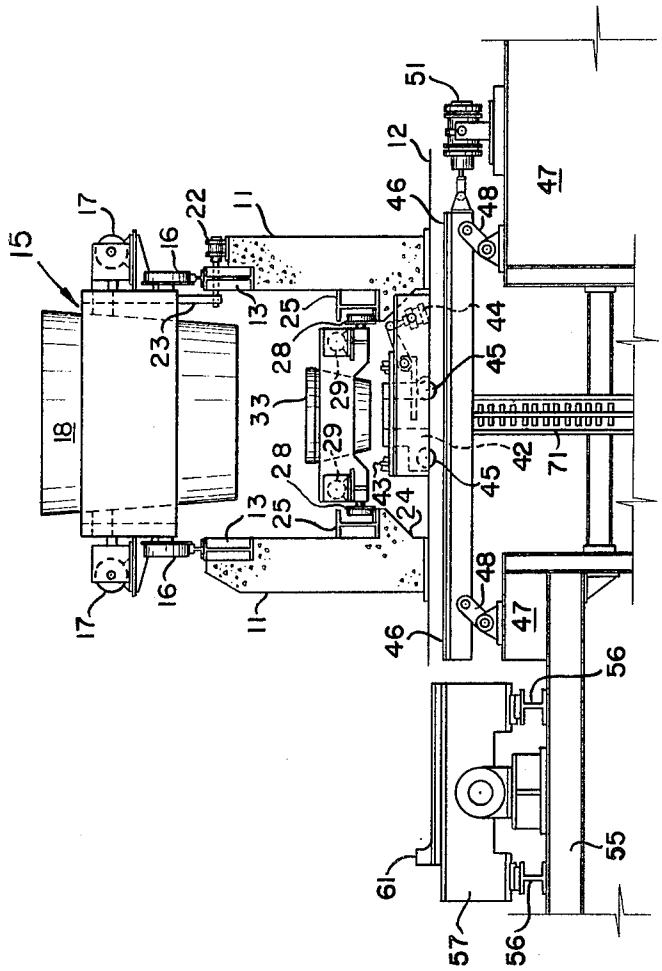


FIG. 2

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INTERCHANGEABLE CONTINUOUS CASTING APPARATUS

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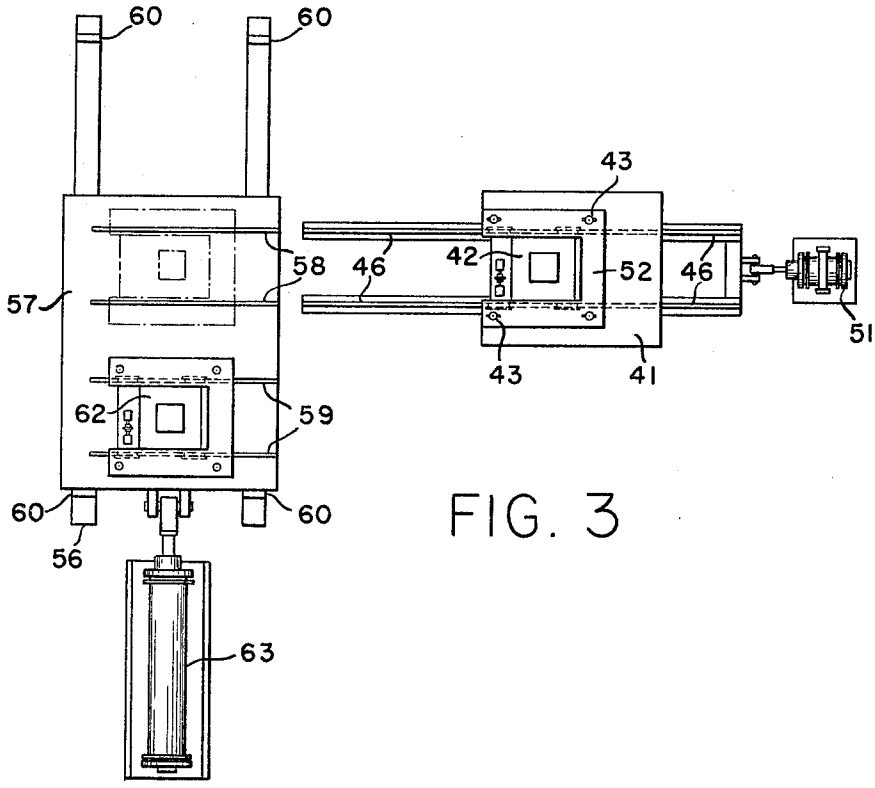


FIG. 3

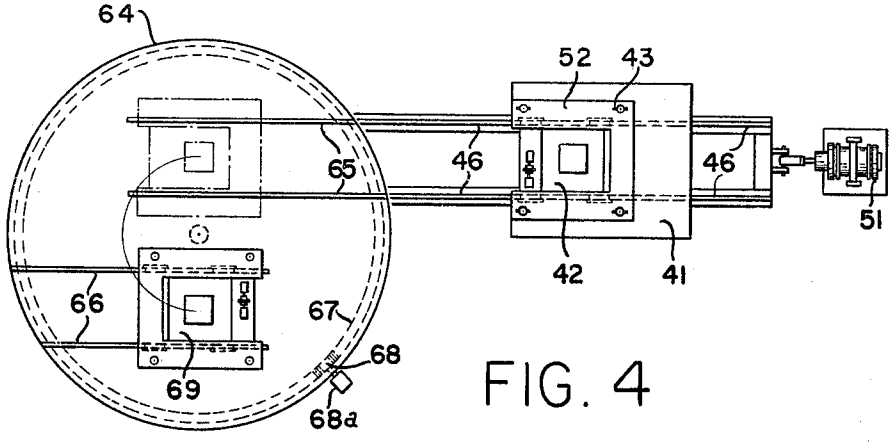


FIG. 4

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United States Patent Office 3,273,208
Patented Sept. 20, 1966

3,273,208
INTERCHANGEABLE CONTINUOUS CASTING APPARATUS

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Filed Sept. 19, 1963, Ser. No. 310,019
13 Claims. (Cl. 22—57.2)

This invention relates to the continuous casting of metallic workpieces and, more particularly, to a continuous casting plant designed to assure maximum production and capable of operating uninterruptedly for relatively long periods.

It is a well-known fact that for a number of reasons in operating present-day continuous casting plants considerable and frequent unproductive periods of time are experienced. One of the primary reasons for this loss in productivity has reference to the fact that processes presently employed require a discontinuance of the casting operation after the metal in the ladle has been completely poured, until the empty ladle can be removed from the casting position, the dummy bar system inserted and a second ladle, full of molten metal, positioned in its place. In some continuous casting plants, the time necessary to perform the changing of the ladles and preparing for the next casting cycle equals the time it takes to pour the metal from a ladle. This means that the production efficiency of such a plant is about 50% and usually less.

Other production delays are caused by the time needed to effect a changing of used tundishes, worn molds and/or replacement secondary cooling units as well as for changes incident to the change of the size and/or shape of the cast product. According to present general practice, it has been found that replacement of the tundishes is necessary after every casting cycle. With respect to mold maintenance, a mold may remain productive for as many as several hundred casts. However, in comparison with ladle changes, the time necessary to change the tundishes, molds and secondary cooling units is considerably longer, particularly in casting plants employing multiple strands.

It is an object of the present invention to provide a continuous casting plant wherein the ladles can be so changed as to assure more continuous operation of the plant and wherein in no event will ladle changing delay operation of the plant.

It is another object of the present invention to provide an arrangement for quickly changing the tundishes, molds and secondary cooling units of a continuous casting plant whereby the discontinuation of the operation of the plant incident to such changing will be reduced considerably.

It is a further object of the present invention to provide a structure for supporting a number of ladles provided for a common tundish, including means for quickly positioning the ladles successively in operative relationship with the tundish, wherein in moving one ladle out of the pouring position a second or replacement ladle will be automatically positioned in the pouring position.

It is further contemplated by the invention to provide a similar construction for removing molds provided for a common strand from an operative position to an inoperative position and repositioning a second mold unit into the operative position.

It will thus be seen from the following description that by providing a construction whereby the ladles can be shifted without interrupting the continuous operation of the casting plant maximum production, particularly of high tonnage workpieces, can be realized together with a greater yield, since scrap losses incident to cutting off portions from the head and tail portions of the total cast will be reduced. Another inherent advantage in the extended uninterrupted operation of the plant is that greater slab uniformity in dimension and quality will be assured and higher production efficiencies will be obtained.

With respect to the construction which enables the tundishes, molds and secondary cooling unit to be quickly replaced, not only is there a definite advantage in reducing production losses incident to the occasion when these elements require changing and/or replacement, but of equal significance is the advantage that replacement elements designed to cast a different size workpiece can be set up in readiness for quick insertion into casting position with a minimum amount of delay.

These features and advantages as well as others will become more evident when the following description is read along with the accompanying drawings of which:

FIGURE 1 is a schematic elevational view of the upper portion of a continuous casting plant, illustrating a system of ladles, tundishes and molds constructed in accordance with the present invention;

FIGURE 2 is a schematic and elevational view of the plant illustrated in FIGURE 1;

FIGURE 3 is a plan view, in smaller proportion, of the plant illustrated in FIGURES 1 and 2; and

FIGURE 4 is a modification, in certain respects, of the equipment illustrated in FIGURE 3.

With reference, first to FIGURES 1 and 2, there is illustrated a ladle supporting arrangement consisting of a number of spaced-apart columns **11**, the lower end of which is secured to a substructure **12**, the columns serving to support at their upper portions parallel extending rails **13** which are made of a length sufficient to handle three separate ladle cars, two at a time, such as, cars **14** and **15**, illustrated in FIGURE 1. The ladle cars, as shown best in FIGURE 1, include two pairs of wheels **16** which pass along the rails **13**, the wheels of one pair being driven individually by separate motors **17**. The ladle cars carry portable ladles **18** having pouring openings **19** at their lower ends through which the metal is discharged and may be selectively interrupted by means of stoppers **21**. Each ladle car is also provided with a locking arrangement, which is shown only in FIGURE 2, consisting of a piston cylinder assembly **22** carried by one of the columns **11**, the piston of which is adapted to pass into an arm **23** formed at one end of the bottom of the car which has an opening for receiving the end of the piston.

By this construction and in again referring to FIGURE 1, after the molten metal has been poured from the ladle **18** on the ladle car **14**, the stopper **21** can be lowered into the opening **19** and the motors **17** operated to move the ladle car **14** toward the left to a phantom position where it will come to rest against a stop **20**. Of course, if the ladle car **15** is located on the left of the ladle car **14**, as one views FIGURE 1, the car **14** will move toward the right. Prior thereto, the ladle **18** for the car **15** can be placed on the car **15** by a crane in readiness to take the place of the ladle **18** of the car **14**. Once the car **14** has been removed from its pouring position, the car **15** can be brought into this position in which connection the piston cylinder assembly **22** of the locking device will be operated to correctly position the car in its pouring position. Once this occurs, the stopper **21** of the car **15** can be raised allowing the molten metal to issue therefrom. The time involved in shifting the empty ladle and replacing it with a full ladle will be less than the time required to empty the tundish, so that continuity of pouring will be maintained.

With reference again to FIGURE 2, it will be noted that at the inside of the bases of the columns **11** opposed feet **24** are provided, the upper surfaces of which serve

to support a pair of beams **25** which run parallel to the rails **13** and, as in the case of the rails **13**, are sufficiently long to carry three tundish cars, two at a time. The beams **25** serve as rails for tundish cars **26** and **27** which are similar in construction to the ladle cars **14** and **15** being provided with two pairs of wheels **28**, the wheels of one pair being driven by individual motors **29** shown both in FIGURES 1 and 2. The tundish cars may be maintained in their operative position by the brakes of the motors **29**.

The tundish cars carry tundishes **33** which have the usual stoppers **34**, the lower ends of which are inserted into nozzles **35** located at the bottom of the tundishes **33** when it is desired to prevent the metal from flowing out of the nozzles. Prior to discontinuing the operation of the continuous casting machine to change the tundish **33** of the tundish car **26**, a new or rebuilt tundish **33** and car **27** is positioned on the tracks **25** and preheated preliminary to being inserted into the pouring position. This preheating is accomplished in the instant case by fuel heating devices **36** which, as shown in FIGURE 1, are located on either side of the pouring position of the casting machine. The devices include trunnion-mounted heads **37** to which there are connected fuel nozzles **38** that may be positioned above and inserted into the covers of the tundishes. In order to obtain effective preheating, as shown in FIGURE 1, the tundishes are provided with removable covers **40** which are used during the preheating period.

When it is desired to change the tundish **33** of the car **26**, its motors **29** will be operated to advance the car either to the left or right depending upon whether the replacement tundish is at the left or right as one views FIGURE 1. Assuming the replacement tundish car is in the position shown in FIGURE 1, then the tundish car **26** will be advanced to the left as one views FIGURE 1 and come against stops **58**. Immediately after this has occurred and after the head **37** of the employed heating device **36** has been raised and rotated, so that the cover **40** can be removed, the tundish car **27** is advanced by the operation of its motors **29** and when in the pouring position will be maintained there by the brakes of the motors **29**.

With reference now to the equipment provided for changing the mold, reference will be made first to FIGURE 2. In this respect there is provided a U-shaped supporting platform **41**, shown best in FIGURES 3 and 4, which serves to support a mold **42**, the mold being connected to the platform by a series of bolts **43**. The platform is adapted to be oscillated by an oscillating mechanism **44** which is connected to and carried by the structure of the casting machine. The bottom of the mold is provided with two pair of freely rotatable wheels **45** which are engaged by parallelly arranged rails **46** arranged directly below the mold on either side thereof. The rails are supported by structural members **47** through pivotally connected links **48** which allow the rails **46** to be raised and lowered toward and away from the wheels **45** of the mold. At one end of the rails there is connected thereto a piston cylinder assembly **51** which is also carried by one of the structural members **47** through which means the rails are raised and lowered. FIGURES 1 and 2 show the rails in their lower-most positions out of contact with the wheels of the mold **42**.

With respect to the construction of the supporting platform **41** and the mold **42** reference at this point is made to FIGURE 3, where it will be seen that over the platform is a U-shaped plate **52** wherein the open side of the platform **41** is so arranged that the mold **42**, including the plate **52**, can pass over and through the open side and away from the platform **41**. As previously indicated, the mold is normally secured to the platform **41** by bolts **43** which pass through the plate **52** and which receive at their upper ends wedges which can be quickly removed

from the bolts to free the plate **52** and, hence, the mold **42** for longitudinal movement.

As shown in FIGURE 2, to the left of the rails **46**, there is provided a mold-shifting system which is made up of a supporting beam **55** for supporting a pair of parallel extending beams **56** that serve as guide ways for a shiftable car **57** which is supported and guided on the beams **56**. The beams **56**, as noted in FIGURE 2, are arranged at right angles with respect to the rails **46**. As best shown in FIGURE 3, the mold-shifting car **57** is provided with two pairs of rails **58** and **59** which serve as extensions of the rails **46** when positioned in line with the casting machine. In still referring to FIGURE 3, it will be observed that the mold **43** can be pushed manually over the rails **46** onto the rails **58** where the mold will come to rest against stops **61** shown in FIGURE 2. Once this occurs, the car **57** can be traversed so that the replacement mold **62** carried by the mold transfer car **57** can be positioned in line with the rails **46**. The car, as shown in FIGURE 3, is moved traversely through the agency of a piston cylinder assembly **63** which is connected to one end of the car **57**, the extent of movement being controlled by stops **60**.

FIGURE 4, as previously noted, illustrates a second embodiment of the mold-shifting system. As shown, in place of the longitudinal shiftable car **57**, a rotatable turntable **64** is provided having two pairs of tracks **65** and **66** so arranged that on 180° rotation of the turntable, one or the other of the pairs of tracks will line up with the rails **46**. The turntable **64** is provided with an internally formed gear **67** which meshes with a pinion **68** connected to a motor **68***a*. In this case a replacement mold **69** is set upon the tracks **66**. After the used mold **43** is moved manually onto the turntable, as shown in phantom in FIGURE 4, the turntable will be rotated to place the replacement mold in the phantom position after which it will be manually moved into the casting machine.

There remains one other element illustrated to be commented upon and that has reference to the secondary cooling unit **71** which is shown in FIGURES 1 and 2. While for simplicity the illustration of the present invention has not shown in detail a mechanism for quickly removing the secondary units **61** relative to the mold, it will be appreciated by those skilled in the art that this may very conveniently be done, thereby giving the attendant advantage of being able to considerably reduce downtime incident to changing the secondary unit.

Thus, it will be seen from the above that in providing a shiftable arrangement for the ladle cars whereby two or more cars can be handled at once, uninterrupted operation of the casting plant is assured as far as the changing of the ladles is concerned. Thus, the period of uninterrupted operation is limited to the life of the tundish nozzles, mold or secondary cooling unit, primarily the former. In this respect the present invention will considerably eliminate the time loss incident to replacing these elements by providing a system whereby the used elements can be quickly removed and immediately replaced by other elements.

In accordance with the provisions of the patent statutes, I have explained the principle and operation of my invention and have illustrated and described what I consider to represent the best embodiment thereof. However, I desire to have it understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. In combination with a continuous casting machine employing a ladle and a mold, said mold being vertically movable relative to said ladle during operation of said machine,

a first means for supporting the mold in a pouring position,

a second means for supporting two molds in such a manner that the molds can be selectively positioned

in said pouring position when said vertical movement of said mold is interrupted, and

means for bringing at least a part of the second supporting means into a supporting position with one of the molds when in the pouring position when said vertical movement of said mold is interrupted, thereby to allow the transfer of a mold from a supporting position with said first supporting means to a supporting position with said second supporting means.

2. In combination with a continuous casting machine employing a ladle, mold and tundish,

means for supporting two ladles in such a manner that the ladlies can be selectively positioned in a common pouring position,

means for moving the ladles into and out of the pouring positions,

means for supporting two tundishes in such a manner that the tundishes can be selectively positioned in the pouring position,

means for moving the tundishes into and out of the pouring position,

means for supporting a mold in such a manner that the mold can be moved from a casting position to a position remote therefrom,

a mold transfer car located remote from the casting position of the mold for supporting at least two molds, and

means for positioning the car so as to receive a mold from the casting machine, and to position a second mold in position for insertion into the casting machine.

3. In combination with a continuous casting machine, according to claim 2, wherein,

wheels are secured to said mold,

rails engage with said wheels, and

means for moving said rails into and out of engagement with said wheels whereby said mold in the casting position can be moved away from said casting position.

4. In combination with a continuous casting machine, according to claim 2, wherein

said mold in the casting position is detachably connected to a mold-carrying means, and

said carrying means having an open side for permitting a mold, when detached from said carrying means, to move away from said carrying means.

5. In combination with a continuous casting machine, according to claim 4, including

means connected to and for oscillating said mold-carrying means, thereby to oscillate said mold during the casting operation.

6. In combination with a continuous casting machine employing a ladle and a pair of molds,

means for supporting one of said molds belows the ladle so that it can be moved ultimately into a pouring position for receipt of molten metal and to a position remote therefrom,

a mold transfer car located in said remote position having mold supporting areas for supporting at least two molds in which said areas are positionable alternately relative to said supporting means, and

means for positioning said car so that one of its supporting areas will receive one of the molds from the casting machine and said other supporting area will position the other mold for movement into said casting machine.

7. In combination with a continuous casting machine employing a mold, a pair of tundishes and a pair of ladles arranged in a superimposed relationship,

means for supporting said ladles in such a manner that the ladles can be selectively positioned in a common pouring position above a tundish,

means for supporting the tundishes in such a manner that the tundishes can be selectively positioned in the common pouring position above the mold,

means for moving the ladle into and out of the pouring position wherein the ladle is changed so as to maintain a sufficient volume of molten metal in the tundish in the pouring position, whereby a continuous flow of metal from a tundish is assured during the interchange of an empty ladle for a full ladle,

a support structure for the said ladle supporting means and said tundish supporting means, the construction being such that said ladles and tundishes are maintained in a spaced vertical superimposed relationship and allowed to move unrestrictedly relative to each other and in a direction normal to the axis of said support structure,

said tundish being arranged below one of the ladles and above the mold and being smaller than either of the ladles so that both ladles cannot be simultaneously located in the pouring position over the tundish,

said tundish having a cover, and

an opening in said cover of relatively small size in comparison with the cover through which molten metal is fed from the ladle.

8. In combination with a continuous casting machine, according to claim 7, including

means for preventing the ladles from moving when positioned in the pouring position.

9. In combination with a continuous casting machine employing a mold, a pair of tundishes, and a pair of ladles arranged in a superimposed relationship,

means for supporting said ladles in such a manner that the ladles can be selectively positioned in a common pouring position above a tundish,

means for supporting two tundishes in such a manner that the tundishes can be selectively positioned in the common pouring position above the mold,

means for moving the ladles into and out of the pouring position wherein the ladles are changed so as to maintain a sufficient volume of molten metal in one of the tundishes in the pouring position, whereby a continuous flow of metal from said tundish is assured during the interchange of an empty ladle for a full ladle, and

a support structure for the said ladle supporting means and said tundish supporting means, the construction being such that said ladles and tundishes are maintained in a spaced vertical superimposed relationship and allowed to move unrestrictedly relative to each other and in a direction normal to the axis of said support structure.

10. In combination with a continuous casting machine, according to claim 9, including

means for preventing the ladles from moving when positioned in the pouring position, and

means for preventing the tundishes from moving when positioned in the pouring position.

11. In combination with a continuous casting machine, according to claim 9, including

tundish preheating means arranged to heat the tundish when in a position away from the pouring position.

12. In combination with a continuous casting machine, according to claim 9, in which

said means for supporting said ladles and tundishes are sufficiently long to support three ladles and tundishes, whereby a replacement tundish and ladle can be positioned on either side of a ladle and tundish in the pouring positions, and

tundish preheating means are arranged on both sides of said pouring position to preheat a replacement tundish which may be located on either side thereof.

13. In combination with a continuous casting machine employing at least a pair of molds, a pair of tundishes and a pair of ladles arranged in a superimposed relationship,

means for supporting said ladles in such a manner that the ladles can be selectively positioned in a common pouring position above a tundish,

means for supporting said tundishes in such a manner that the tundishes can be selectively positioned in the common pouring position above the mold,

means for moving the ladles into and out of the pouring position wherein the ladles are changed so as to maintain a sufficient volume of molten metal in one of the tundishes in the pouring position, whereby a continuous flow of metal from said tundish is assured during the interchange of an empty ladle for a full ladle,

a mold transfer car located in a remote position for supporting at least two molds, and

means for positioning the car so as to receive one of the molds from the casting position and to position said other mold in position for insertion into the casting position.

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