APPARATUS FOR THE CONTINUOUS CASTING OF METALS

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FIG. 1

INERT GAS

FIG. 2

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26 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus for the continuous casting of metals wherein an intermediate ladle is provided between a casting ladle and a casting mold to transfer molten metal from the former to the latter. The intermediate ladle is swingable about a vertical axis to and from an operative position and is tiltable about a horizontal axis to and from a checking and emptying position.


The present invention relates to an apparatus for the uninterrupted continuous casting of steel or non-ferrous metals in which the pouring of the molten metal into the mold is performed through the intermediary of a ladle.

In the known apparatus of this kind the molten metal must follow a rather long path in moving from the casting ladle to the mold. This factor means that the stream of molten metal is exposed to the atmosphere and thereby to the damaging effects of oxidation for a relatively long period. Furthermore, a highly melting temperature is necessary, with the corresponding increased dissolving of the oxygen in the steel, in order to allow for the longer flow path.

The disadvantages of the present equipment for the uninterrupted continuous casting of steel and non-ferrous metals, wherein the pouring of the molten metal into the mold occurs through the intermediary of a ladle, are overcome according to the invention at least in part by the utilization of at least two casting ladles and two intermediate ladles per line, each of the latter being brought into the casting position alternately by being swung about an axis parallel to that of the stream of metal from the ladle. The intermediate ladles additionally are made capable of tilting with displacement about a horizontal pivot point. In this tilting construction, the path for the movement of the upper periphery of the vessel extends in or below the plane determined by its operative position. By the invention, in addition to avoiding the drawbacks mentioned above, the advantage is gained that the continuity of casting is increased and the opportunities for slag inclusions and reactions with the linings and cover slags is reduced. Furthermore, an improved use of protective gas effects may be efficiently achieved. The latter acts particularly favorably in conjunction with the other advantages if the molten metal has previously been subjected to a vacuum treatment.

In a preferred embodiment of the invention, the filling opening of the mold is placed in direct engagement with the outlet of the intermediate ladle. This serves to improve the above-mentioned advantageous characteristics of the invention. In the same manner, the inventive construction uses a casting ladle having controllable bottom discharge. The intermediate ladle is constructed with such a capacity that, on changing over of the casting ladles, the flow of steel to the mold is entirely maintained to achieve the above-mentioned desirable advantages.

A further feature of the invention is to provide a cover which covers the intermediate ladle in its casting position and remains fixed during all operative positions of the intermediate ladle. The cover has a filling opening and serves to protect the contents of the intermediate ladle against oxidation and against the loss of heat by radiation. The previously mentioned tilting movement of the intermediate ladle can advantageously be arranged, according to an additional feature of the invention, with provision for halting the intermediate ladle in at least three stop positions whereby checking or filling can be carried out without loss of molten metal and the ladle may also be emptied of slag.

More than one intermediate ladle can be provided in the event repair or preventive maintenance is required on a particular intermediate ladle. In this case the intermediate ladles may be pivotally mounted on vertical supports which permit them to be completely removed from the operative position and replaced by another without interrupting the casting operations. An independent guide system is provided for each intermediate ladle support on the same vertical support. Also, the ladles may be interchanged by providing an endless or straight track on which the ladles are movably mounted.

The casting ladles are provided with a single automatically operative cover provided with a heating burner. Individual covers, with corresponding burners for each casting ladle, are eliminated thereby effecting a reduction in total cost of the equipment. The use of a single cover can be achieved in a relatively simple manner if the casting ladles are movable into and out of the operative position by means of track-mounted carriages.

Means are also provided for placing an atmosphere of protective gas around the stream of molten metal flowing from the casting ladle to the intermediate ladle and from the intermediate ladle to the mold.

If the equipment is provided for continuous casting in at least two adjacent parallel lines of molds, this may be effected, according to the invention, by the use of casting ladles which are provided with controllable bottom discharge means to distribute the molten metal into the individual intermediate ladles without the use of an additional distributing means. In this manner, continuous casting operations may be achieved. Furthermore, the intermediate ladles may be constructed for further simultaneous distribution to a plurality of molds.

By means of the inventive features mentioned above, a substantially reduction in the dimensions in the equipment, in the direction of the flow of the molten metal, can be achieved. Thus, the surface area of molten metal
exposed to the atmosphere is substantially reduced, as compared to the known equipment. This naturally stands in good favor for economy in the protective gas covering, which may be provided within the scope of the invention.

The means by which the foregoing features and other advantages, which will be apparent to those skilled in the art, are accomplished, are set forth in the following specification and claims, and are illustrated in the accompanying drawings, wherein the invention is illustrated in an embodiment by way of example, and in which:

FIG. 1 is a side elevational view, partially in section, of a portion of the structure utilized in the present invention;

FIG. 2 is a vertical sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is a cross-sectional view showing an intermediate ladle with two outlet means, and two casting molds with two corresponding inlets;

FIG. 4 is a view similar to FIG. 3, but showing a single outlet-inlet arrangement, and including a device for protecting the flow of metal therebetween;

FIG. 5 is an exploded perspective view of an intermediate ladle and a carrier assembly for the ladle;

FIG. 5A is an end elevation of the ladle carrier assembly of FIG. 5;

FIG. 6 is a plan view of the structure of FIGS. 5 and 5A shown in an assembled condition;

FIG. 7 is a sectional view through the ladle carrier assembly showing the hydraulic cylinder arrangement for tilting the ladle, taken along line 7—7 of FIG. 6;

FIG. 8 is a diagrammatic view showing the roller track arrangement for permitting tilting movement of an intermediate ladle;

FIG. 9 is a plan view of an embodiment of the present invention for permitting the intermediate ladles to be moved to and from a position above the corresponding casting mold in a horizontal plane and additionally to and from the pouring position in a vertical plane;

FIG. 10 is a view similar to FIG. 9, but showing another embodiment of the present invention;

FIG. 11 is a side elevational view partially in section, showing the entire casting operation, utilizing the structure of the present invention; and

FIG. 12 is a side elevational view, partially in section, of the apparatus of FIG. 11.

Referring specifically to FIG. 1, the reference numeral 1 refers to a casting ladle from which molten metal flows through an intermediate ladle 2 into a casting mold 3 from which an endless metal bar 4 passes. Although only one intermediate ladle 1 is shown, it is understood that more than one can be provided, as will be explained in greater detail later.

Each casting ladle 1 comprises a metal casting 5 and a lining 6 of refractory material, and is provided with a controllable bottom discharge device 7 having a hydraulic ram or cylinder 8 cooperating therewith and fixed with its flange 9 at the bottom of ladle 1, this discharge means 7 being described in greater detail later.

The intermediate ladle 2 is covered in its pouring or casting position, shown in full lines, by a cover 10 which is fixed with respect to ladle 1 and thus remains in the position shown in FIG. 1 regardless of the position of ladle 2. Cover 10 is provided with a channel 11 connected to a conduit 12 for the supply of an inert gas to the area above the molten metal in ladle 2, to reduce oxidation of the metal while ladle 2 is being charged.

A conduit 13 for protection of the stream of molten metal flowing from ladle 2 into the mold 3 is disposed between the discharge opening of ladle 2 and the mold 3, this arrangement being described in detail later.

FIG. 2 shows the controllable bottom discharge device 7 of FIG. 1, in a larger scale and at a right angle to the view of FIG. 1, with an additional protective device for the molten metal being provided. Specifically, control device 7 comprises an outlet orifice 15 of refractory ma-

terial inserted into lining 6. An orifice insert 16, also of refractory material, is inserted in blocks 37 fixed to orifice 15. Disposed at opposite sides of the orifice insert 16 and attached to the bottom wall of ladle 1 are two parallel flanged members 17 which support a plate 20 by means of a plurality of screws 18, nuts 19, and compression springs 21 disposed about the screws.

Plate 20 is urged upwardly by the compression springs 21, and defines a slot 20a which acts as a guide for a sliding carriage 22. This carriage is connected by a piston rod 23 (FIG. 1) to the hydraulic ram or cylinder 8, and supports an orifice member 23 of refractory material, which is resiliently but firmly held against insert 16. By means of the cylinder 8, the carriage 22 is slideable on plate 20 and serves to selectively and controllably align all or any portion of hole 25 of member 23 with the stationary hole 24 of member 16 according to the quantity of molten metal desired to flow out from ladle 1 into ladle 2.

An additional device for protection of the stream of molten metal flowing out from ladle 1 into ladle 2 may be provided between cover 10 and plate 20. This device is in the form of two metallic cylinders 26 telescoping with respect to each other and secured to cover 10. The space confined by the cylinders is filled with inert gas drawn from ladle 2 through hole 13. Due to these slideable and telescopic mountings, all possible variations in distances between ladle 1, cover 10, plate 20, and their communicating holes, may be accommodated.

FIG. 3 is a cross section through an intermediate ladle 2 adapted for pouring molten metal into two molds 3 at the same time, as shown. Two out flow stones 28 are provided, along with two devices 14 for protection of the molten metal flowing from ladle 2 into the molds 3. Each device 14 comprises an annular body 29 provided with a circular channel 30 connected by a channel 31 to a conduit 32 for supply of an inert gas. Channel 30 is also connected through a plurality of radial channels 33 with the interior of molds 3. Thus an inert, protective atmosphere is maintained in the molds 3 around the molten metal coming from ladle 2.

FIG. 4 depicts an arrangement utilizing a single mold 3 and including a protective device 14 similar to that described in FIG. 3 above, along with an additional protective device 14 in the form of a metallic bellows 27 arranged between mold 3 and protective device 14.

It is emphasized that the bellows 27 may be used instead of cylinders 26 between ladle 1 and cover 10, as described in conjunction with FIG. 2. Conversely, cylinders 26 may be used instead of bellows 27 between mold 3 and protective device 14.

In the event it is desired to replace an intermediate ladle 2 for repair or maintenance without interrupting the flow of molten metal, means can be provided to rotatably support two or more intermediate ladles so that they can easily be moved to and from an operative position. Such an assembly is shown in FIGS. 5–8.

Specifically, a vertical shaft 34 is provided, on which two intermediate ladle carrier assemblies 35 are pivotally mounted. Since carrier assemblies 35 are of the same construction, only one is shown in detail. Each carrier assembly 35 is provided with a horizontal shaft 36 rotatably mounted in two bearing blocks 37 fixed to the interior of the bottom 35a of carrier housing 35a. Two parallel arms 38 are fixed to shaft 36 between blocks 37, the free ends of arms 38 being pivotally connected to the piston rod 40 of a hydraulic cylinder 41 at 39a. The piston rod 42 of a second hydraulic cylinder 41 is axially aligned with an attached to the piston rod 43 of the second unit 41 is pivotally connected to the interior of the upper wall 35b of carrier 35 at 41a, as shown in FIG. 7. The hydraulic cylinders are actuated by any suitable pressurized fluid means.

As shown in FIGS. 5 and 6, shaft 36 projects out through the end wall 35c of carrier 35 and an arm 43 is keyed to the projecting end of shaft 36.
Each carrier 35 is provided with a stud 44 parallel to shaft 36 and projecting from a lug 45 extending from a side of the end wall 35c of carrier 35, arm 46 being pivotally mounted on stud 44.

A ladle support bar 47 is also provided, which has transverse bores 48 extending therethrough, and a short trunnion 49 integrally formed on opposite ends thereof, which trunnions are in axial alignment. The arms 43, 46 are arranged with their free ends extending within a rectangular opening 50 in the bar 47, as best seen in FIGS. 5A and 6, and are connected to the latter by pins 51 extending through the bores 48 of bar 47, and the bores 52 provided at the free ends of arms 43, 46, so that arms 43, 46 may be pivoted with respect to bar 47.

The intermediate ladle 2 is provided with two hook-like members 53 with recesses 54, which engage with the trunnions 49 to mount ladle 2 with respect to bar 47. Ladle 2 has a plate 55 fixed at the outer surface of its wall which abuts against the hemispherical end of a screw 56 extending through a threaded hole in stud 44.

Screw 56 has a square end portion 57 for accommodating a wrench or the like for adjusting the position of ladle 2 with respect to carrier assembly 35.

On operation of hydraulic cylinders 40 and 41, arms 38, shaft 36, and arm 43 rotate, causing intermediate ladle 2 to tilt and translate to the positions A and B shown by phantom lines in FIG. 1. Specifically, when only one cylinder is actuated, the ladle 2 assumes the position A, and when both cylinders are actuated, position B is achieved. Reversing the procedure returns the ladle to its original horizontal position.

Also, if one intermediate ladle 2 is damaged or requires repair, its corresponding carrier assembly 35 may be rotated about shaft 54 from position D1 to position D2 in FIG. 5 to position D3, and vice versa, a second ladle 2 also being movable in a reverse sequence.

An alternate arrangement for effecting the above tilting movement of the intermediate ladle is depicted in FIG. 8. Specifcally, a pair of guide rails 62 and 63 are provided which are supported by external means (not shown) and which provide guiding support for a pair of rollers 64 and 65 disposed on ladle 2. As shown, when ladle 2 assumes positions A and B, roller 64 assumes positions 64a and 64b, respectively, and roller 65 assumes positions 65a and 65b, respectively.

FIG. 9 depicts an arrangement in which the intermediate ladle 2 may be tilted in the manner shown in FIG. 8, i.e., by the rollers and guiding rails, while providing an alternate arrangement for substituting another ladle for a given ladle without interrupting the flow of molten metal. Specifically, a circular endless track is provided which comprises two parallel rails 58, on which two cars or trucks 59a and 59b are adapted to run. Each car or truck comprises a bottom wall 60, a pair of side walls 61, and a plurality of wheels (not shown) which engage rails 58. Each side wall 61 is provided with two guiding rails 62, 63 similar to those shown in FIG. 8.

An intermediate ladle 2 is inserted in each truck or car, each ladle being provided at each side with two rollers 64 and 65, similar to those shown in FIG. 8, rollers 64 running on rails 62, and rollers 65 running on rails 63. Means similar to the hydraulic cylinder units 40, 41 (FIGS. 5–7) are provided to move cars 59 on rails 58 to and from the positions of FIG. 9. For example, the intermediate ladle 2 carried by car 59a, shown in the upper portion of FIG. 9, can be in the waiting position indicated by letter C, while the ladle carried by car 59b, shown in the lower portion of FIG. 9, may be in a waiting position D. Of course, if interchange is necessary, car 59b is removed to position C, while car 59a is moved to position D.

FIG. 10 depicts an arrangement similar to FIG. 9, but utilizing a straight track arrangement rather than an endless track. Particularly, the rails 58 extend from a first waiting position D1 to a second waiting position D2, the casting position C being located between D1 and D2. As in the embodiment of FIG. 9, two cars or trucks 59a and 59b are provided. Assuming that the casting position D2, and car 59b in position C, a substitution of cars and their respective ladles is effected by moving car 59b from position C to position D2, and moving car 59a from position D2 to position C. Therefore, the embodiment of FIG. 10 differs only from that of FIG. 9 by the fact that straight rails are provided instead of circular rails, and two waiting positions are necessary instead of one.

A general description of the above-described apparatus in operation will now be described in connection with FIGS. 11 and 12.

As shown, a framework 81 is provided which forms a support for platform 82 on which is mounted a support structure 83 for a pair of traverse rails 86 forming a support for the movable casting ladles 1a and 1b. These ladles are mounted on a rail-mounted carriage 87 which provides means to alternatively bring the ladles into the operative position, a single cover 88 being provided for the two ladles 1a and 1b, which cover is positioned on the ladle in the casting position (ladle 1a in FIG. 11).

A heating burner 89 may be provided in the cover 88.

The molten metal contained in ladle 1a flows through the controllable outlets 7 (shown in FIGS. 1 and 2) in the bottom of the ladle, through an inlet opening 13 in the cover 10 of the intermediate ladle 2. Ladle 2 can be swung out of the operative casting position C shown in the drawings, about a vertical axis parallel to that of the stream of metal from the ladle, in the event the ladle needs replacement, by means described in FIGS. 5–7, 9, or 10. As an addition to, or alternative to, the above-mentioned movement of the intermediate ladle, it may also be mounted to tilt about a horizontal pivot point by utilizing the piston-cylinder units 40 and 41 of FIGS. 5–7, or by the arrangement of FIG. 8. During the tilting movement, the path of movement of the upper periphery of the intermediate ladle is arranged to be in or below a plane determined by the operative casting position, and the ladle is moved from the operative position C to a checking or filling position A and to an emptying position B. In the latter position the residue of the casting metal is emptied into a slag ladle 100.

The molten metal flows through outlet 28 of the intermediate ladle 2 directly into an adjacent filling opening 104 of the mold, which is supported on the platform 2. It being understood that one of the devices described above for protection of the flow of molten metal from the air may be utilized.

A secondary cooling element 117 and a driving roller frame 119 are mounted on a second platform 118 which is attached to the supporting frame 81 beneath platform 82. The cast metal 120 which has solidified during passage through the cooling element 117 is bent by the device 121 and passes through a chute 122 to the entry end of the straightening rollers 123 and is separated by the cutting device 124.

FIG. 12 is an enlarged vertical section perpendicular to FIG. 11 and illustrates a two-line casting arrangement, with identical components being utilized in each operation.

Specifically, the intermediate ladles 2′ and 2″ are mounted on carrier assemblies 35′ and 35″ which are in turn pivotally mounted on vertical pivot means 34′ and 34″, respectively. As discussed in detail earlier, these pivot carrier assemblies make it possible to quickly and easily remove the ladles from the operative position in the event repair or maintenance is required.

Also, additional carrying assemblies carrying additional or substitute intermediate ladles 2′ and 2″ are pivotally mounted on pivot means 34′ and 34″.

It is apparent from the above that the avoidance of
exposed stretches of molten metal is achieved due to the substantially reduced vertical separation of the cooperating components. Also, the other advantages discussed in detail above are made possible by the continuity of the casting process achieved by the rapid interchangeability of the casting ladles and the intermediate ladles.

Of course, the variations of the specific construction and arrangement of this type apparatus herein disclosed can be made by those skilled in the art without departing from the invention as defined in the appended claims.

What has been described is:

1. An apparatus for the continuous casting of molten steel or non-ferrous metals, comprising at least one casting ladle, a casting mold spaced from said casting ladle, at least one intermediate ladle, first mounting means mounting said intermediate ladle for movement in a first plane to and from a position whereby said intermediate ladle extends between said casting mold and said casting ladle, and a second mounting means mounting said intermediate ladle for movement in a second plane relative to said casting mold and said casting ladle.

2. The apparatus of claim 1, wherein there are two intermediate ladles provided, said first mounting means permitting selective movement of said ladles to and from said position.

3. The apparatus of claim 2, wherein said first mounting means comprises a track, and a pair of vehicles mounted on said track for movement to and from said position on each of said ladles being carried by a corresponding vehicle.

4. The apparatus of claim 3, wherein said said track is straight.

5. The apparatus of claim 3, wherein said track is straight.

6. The apparatus of claim 2, wherein said first mounting means comprises a vertical shaft, and a carrier member for each intermediate ladle, said carrier member being mounted for swinging movement about said shaft.

7. The apparatus of claim 6, wherein said second mounting means comprises a hydraulic cylinder assembly carried by said carrier member, and means operatively connecting said intermediate ladle to said hydraulic cylinder assembly.

8. The apparatus of claim 1, wherein said second mounting means comprises a pair of tracks, and a pair of vehicles mounted on said intermediate ladle and engaging said tracks.

9. The apparatus of claim 1, wherein said casting ladle is provided with a controllable bottom discharge opening.

10. The apparatus of claim 1, further comprising a cover having a heating burner therein to cover the casting ladle.

11. The apparatus of claim 1, further comprising means for placing an atmosphere of protective gas around the exposed portion of molten metal passing between said casting ladle and said intermediate ladle, and between said intermediate ladle and said mold.

12. The apparatus of claim 1, in which the casting is performed in at least two adjacent lines, each line comprising at least one mold and one intermediate ladle, a common casting ladle said casting ladle and said intermediate ladles being provided with controllable bottom discharge means by which the distribution of the molten metal to the individual intermediate ladles and molds, respectively, is achieved.

13. The apparatus of claim 12, in which means are provided in the bottom of each of said intermediate ladles for the distribution of molten metal to several molds in a single operation.

14. The apparatus of claim 12, wherein means are provided for placing an atmosphere of protective gas around the exposed portion of molten metal passing between said casting ladles and said intermediate ladles, and between said intermediate ladles and said mold.

15. An apparatus for the continuous casting of molten steel or non-ferrous metals, comprising at least one mold, a frame extending over said mold, a first platform on said frame, track means and vertical pivot means mounted on said platform, a carriage movably mounted on said track means, at least two casting ladles mounted on said carriage, at least one intermediate ladle mounted on said vertical pivot means for pouring the molten metal from said casting ladles to said mold, means for moving said carriage and said casting ladles to alternately take up an operative pouring position, means for swinging said intermediate ladles into an operative position about the vertical pivot means the axis of which is parallel with that of the molten stream from each of said intermediate ladles, means for tilting displacing said intermediate ladles, the path of said tilting displacement of the upper periphery of the intermediate ladle lying below a plane determined by the upper periphery of said intermediate ladle in its operative position.

16. The apparatus of claim 15, in which an outlet of said intermediate ladle engages directly with a filling opening of said mold, said mold being supported on a second platform mounted on said frame below said first platform.

17. The apparatus of claim 15, in which the casting ladles are provided with controllable bottom discharge openings.

18. The apparatus of claim 15, in which the capacity of the intermediate ladles is such that on changeover of the casting ladles the flow of molten metal to the mold is maintained.

19. The apparatus of claim 15, further comprising a cover having a filling opening therein for each of said intermediate ladles, said cover remaining fixed in all operative positions of said intermediate ladles.

20. The apparatus of claim 15, further comprising means for halting the tilting displacement of the intermediate ladles in at least three positions.

21. The apparatus of claim 15, in which each intermediate ladle is independently pivotally mounted on said vertical pivot means.

22. The apparatus of claim 15, in which a single cover having a heating burner therein is provided to cover the casting ladle in the operative position.

23. The apparatus of claim 15, in which the casting is performed in at least two adjacent lines, each said line comprising at least one mold and one intermediate ladle, a common casting ladle said casting ladle and said intermediate ladles being provided with controllable bottom discharge means by which the distribution of the molten metal to the individual intermediate ladles and molds, respectively, is achieved.

24. The apparatus of claim 15, in which means are provided in the bottom of each of said intermediate ladles for the distribution of molten metal to several molds in a single operation.

25. The apparatus of claim 15, wherein means are provided for placing an atmosphere of protective gas around the exposed portion of molten metal passing between said casting ladles and said intermediate ladles, and between said intermediate ladles and said mold.

26. An apparatus for the uninterrupted casting of steel or non-ferrous metals, said apparatus comprising a frame, mold means fixedly mounted on said frame, a platform mounted on said frame above said mold means, track means on said platform, a carriage movably mounted on said track means, at least two adjacent casting ladles mounted on said said carriage, at least two intermediate ladles pivotally mounted on said platform for horizontal movement about an axis parallel with that of the stream of molten metal, means for alternately positioning said casting ladles and said intermediate ladles in an operative pouring position, means for discharging said molten metal from the bottom of said casting ladle to said intermediate ladles, and means for discharging said
molten metal from the bottom of said intermediate ladle directly into said mold means.

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