United States Patent [19]

Simons et al.

[11] **3,743,007**

[45] **July 3, 1973**

[54] **CONTINUOUS CASTING APPARATUS WITH INTER-CHANGEABLE POURING TUBES**

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[22] Filed: **Oct. 21, 1970**

[21] Appl. No.: **82,750**

[52] **U.S. Cl.** **164/281,** 164/337, 222/548, 222/560

[51] **Int. Cl.** **B22d 11/10**

[58] **Field of Search** 164/136, 281, 337; 222/533, 537, 545, 548, 449, 550, 555, 559, 560, 566, 567, 7, 10, 15, 16, 17, 18

[56] **References Cited**

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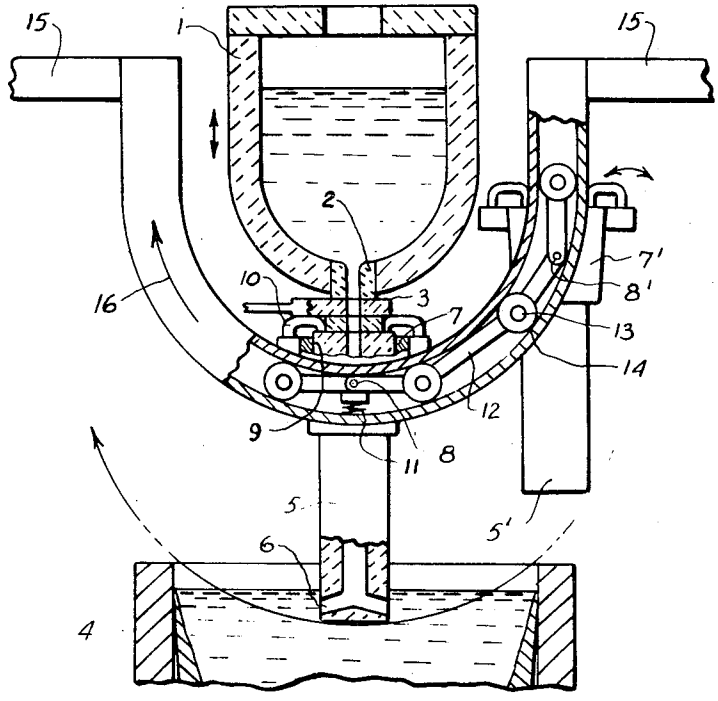
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Assistant Examiner—Larry Martin
Attorney—Werner W. Kleeman

[57] **ABSTRACT**

The outlet of a tundish communicates with the inlet of a continuous-casting mold. Two or more immersible pouring tubes are mounted for movement in a path in such a manner that one pouring tube communicates with the inlet and the outlet, while at least one other pouring tube is in standby position. The last mentioned pouring tube may be moved to operating position and simultaneously the pouring tube previously in operating position is displaced therefrom.

12 Claims, 7 Drawing Figures



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SHEET 1 OF 3

FIG.1

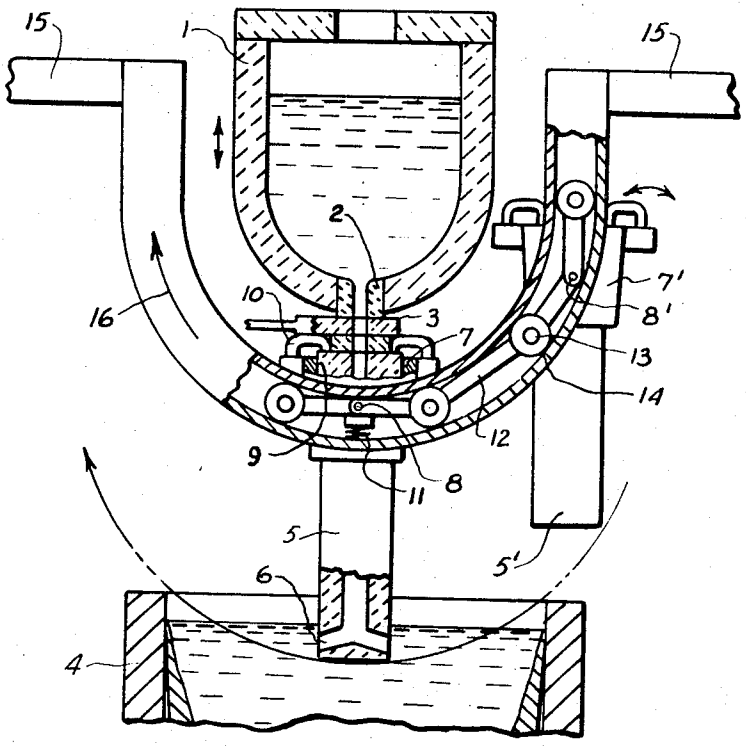
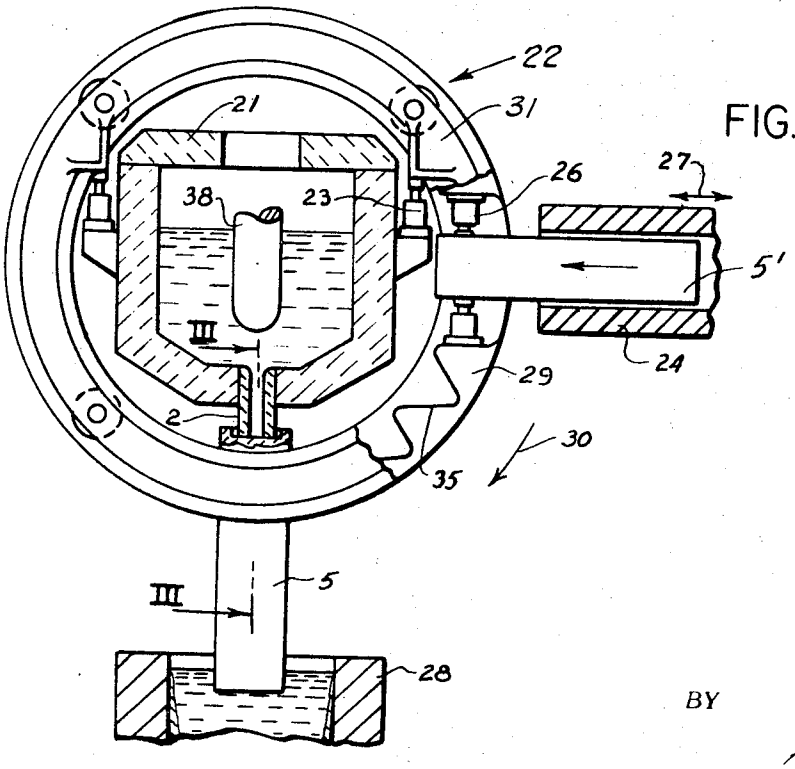


FIG.2



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FIG.3

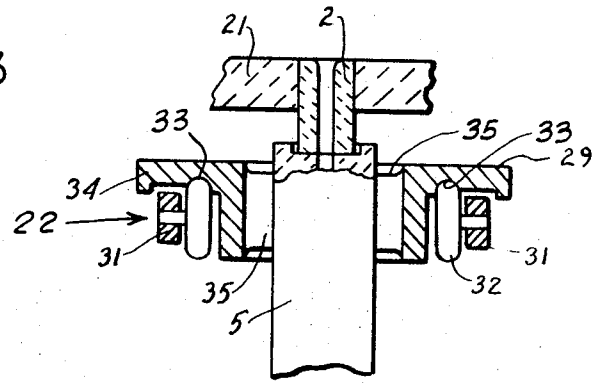
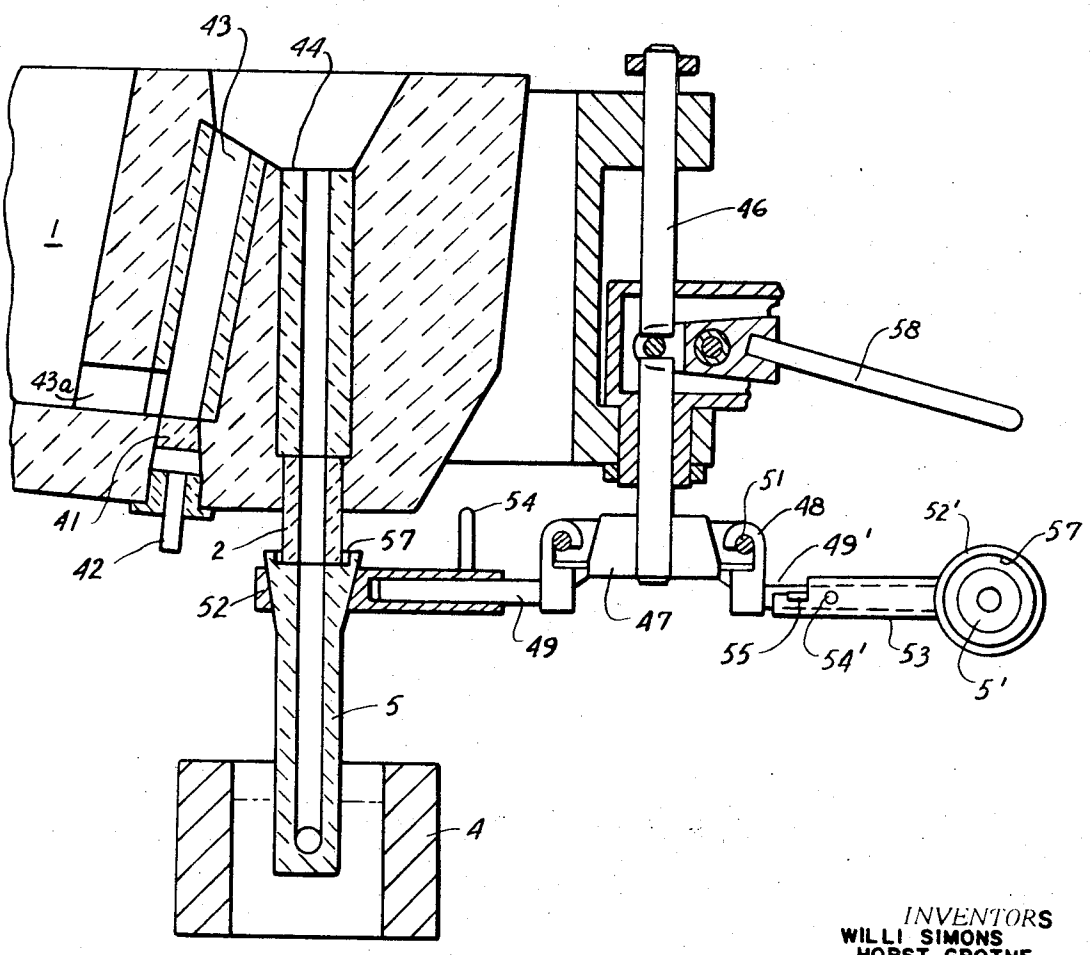


FIG.4



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FIG.5

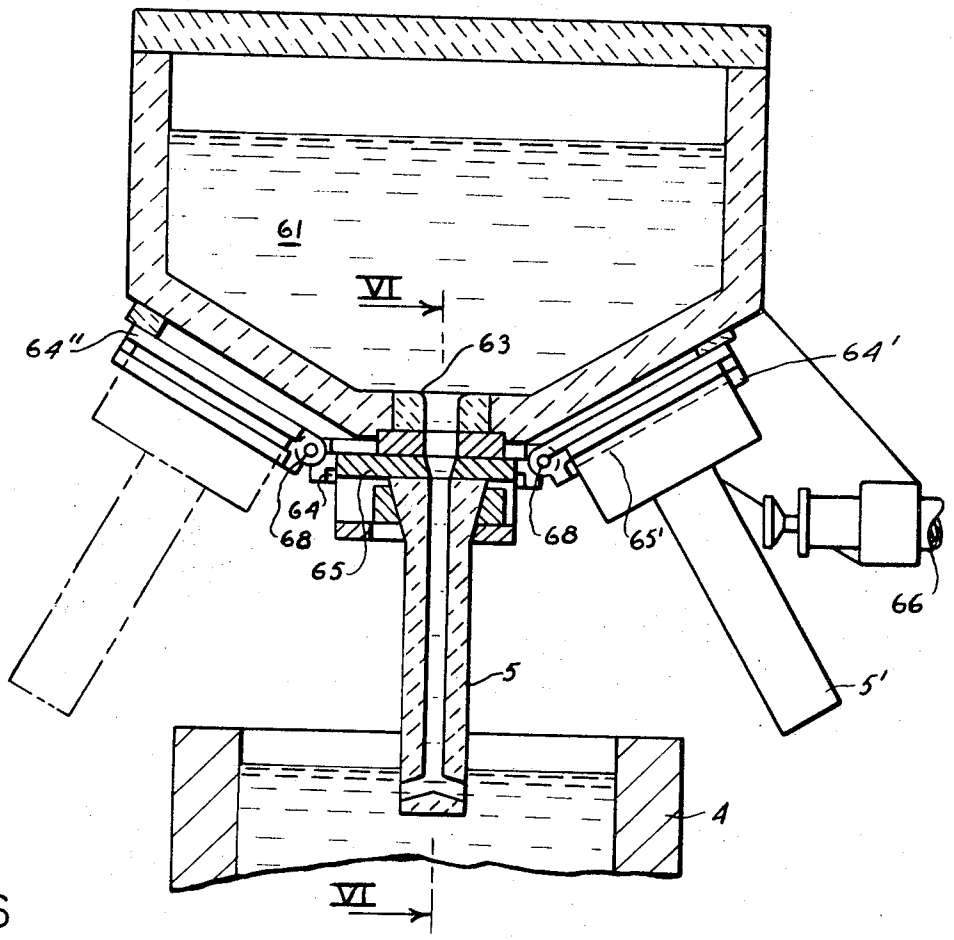


FIG.6

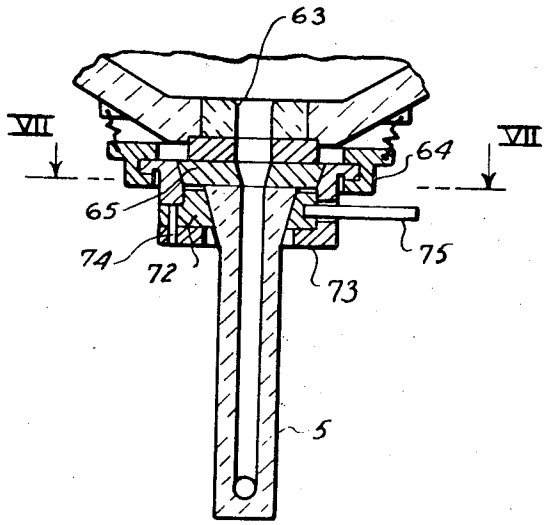
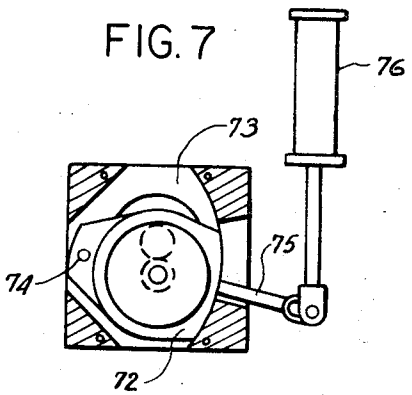


FIG.7



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CONTINUOUS CASTING APPARATUS WITH INTER-CHANGEABLE POURING TUBES

BACKGROUND OF THE INVENTION

The present invention relates to a casting apparatus, and more particularly, to an apparatus for continuous casting. Still more specifically, the invention relates to a continuous casting apparatus for steel, utilizing exchangeable immersible pouring tubes.

It is known in such casting machines to feed molten metal into a tundish, from where it flows into the mold cavity. The metal is supplied to the tundish from a ladle.

In the continuous casting of steel, the molten metal may be poured into the mold by submerging the mold end of the spout into the molten metal both in the mold. This procedure has been found to be very advantageous, particularly in reducing oxidation of the molten steel.

With the trend towards increasing weights per heat and with the introduction of sequential casting, casting times have been prolonged substantially with a consequently greater wear on the pouring tubes.

As a result, signs of erosive destruction of the pouring tube within the bore and in the region of the outlet, are found after relatively short casting times. This is especially prevalent when manganese-alloy steel is cast. Additional erosion is found — when the immersible pouring tubes penetrate through the surface of molten metal in the mold, and when the surface is covered with a layer of casting powder — in the region of contact of the pouring tube with the surface of the molten metal.

It is hardly necessary to emphasize the disadvantageous nature of such erosions. Frequently the pouring tubes will break in the thus-weakened regions with resultant entrainment of contaminants into the liquid core, and oxidation of the steel. Furthermore, the flow pattern of the molten metal becomes changed when such breaks occur — irrespective of whether they are partial or total — and this leads to the conveyance of contaminants into deeper regions of the liquid core.

Desirably, therefore, it should be possible to replace weakened or fractured pouring tubes in a simple and rapid manner, in order to avoid the problems which result from such fracture while at the same time avoiding expensive down-times of the casting apparatus to the maximum extent possible.

SUMMARY OF THE INVENTION

It is, accordingly, an object of the invention to overcome the above disadvantages and to provide the desirable advantages which have been outlined.

More particularly, it is an object of the invention to provide an improved casting apparatus of the type under discussion, which affords these advantages while not being possessed of the listed disadvantages.

Another object of the invention is to provide such an apparatus which permits replacement of a weakened or defective pouring tube with another pouring tube, without requiring any substantial shut-down of the casting apparatus.

A concomitant object of the invention is to provide such an apparatus in which it is possible not only to exchange pouring tubes, but simultaneously components of the flow-regulating device controlling the flow of molten metal out of the tundish.

In pursuance of the above objects, and of others which will become apparent from a perusal of the disclosure following hereafter, the invention resides in an apparatus for continuous casting of steel which, according to one embodiment, comprises a tundish having an outlet and being adapted to accommodate a body of casting material in flowable state. A mold has an inlet and is adapted to receive such material from the tundish. At least two tubular immersible pouring tubes are provided, each adapted to conduct the molten metal, such as steel, from the first receptacle (tundish) into the second receptacle (mold).

According to the invention there is further provided means mounting the pouring tubes for displacement in at least substantial unison between two positions in one of which one of the pouring tubes communicates with the outlet and the other pouring tube is remote therefrom, and in the other of which positions the other pouring tube communicates with the outlet whereas the one pouring tube is remote therefrom.

It will be appreciated that in this manner one immersible pouring tube can be exchanged for another without any need for substantially interrupting the actual casting operation. It is, in fact, possible to automate the exchange operation and the individual steps involved may be made to overlap in time, so as to further shorten the period required for completing the exchange, necessitating an interruption of metal flow into the mold for less than thirty seconds and thus making it possible to carry out the exchange without having to interrupt the continuous casting process.

Connecting and disconnecting of the pouring tubes and the outlet of the tundish can be facilitated by making both the pouring tubes and the tundish movable relative to one another, particularly in the direction of metal outflow. To prevent the occurrence of leaks between pouring tube and tundish, and to assure reliable sealing engagement of one with the other independently of possible tolerances in their relative movements, spring means may press the relevant pouring tube towards the outlet of the tundish.

It is desirable that the pouring tube being removed (as defective, weakened, etc.) be withdrawn quickly, to make room for its replacement. To facilitate this the pouring tube may be mounted in or on a guide track which advantageously rises from the level of the tundish outlet. It is particularly advantageous to connect the track with the tundish.

When slabs are cast in the apparatus according to the invention, and when therefore the slab mold has a correspondingly large-dimensioned width, the pouring tubes may be guided in a path — for movement into and out of the mold inlet with their respective lower portions — which is arcuately curved in an upright plane. It is then advantageous to connect the correspondingly curved guide track provided for this purpose, with the frame of another stationary steel structure, and to mount the tundish so that it can be raised and lowered with reference to the mold.

According to a further embodiment of the invention, means can be provided for regulating the outflow of the molten metal through the outlet of the tundish. In conventional manner this can be accomplished by varying the unobstructed cross-sectional area of the outlet. HOwever, according to the invention this means is not necessarily provided on the tundish but instead may be displaceable as a unit with the pouring tube relative to

the outlet. In this manner, all components of the apparatus which are subject to weakening or damage under the afore-described conditions, can be readily replaced to thus further increase the number of sequential casts obtainable with the tundish.

The path in which the pouring tubes move to and from the operating position in which they communicate with the outlet, may be determined by providing the mounting means with arms which are turnable about an upright — usually vertical — axis and which each carry a holding arrangement for holding one of the pouring tubes. It is especially advantageous to mount the arms on a pin or shaft which is journalled on the tundish itself and can also be adjusted to raise and lower the arms with reference to the outlet. The holding arrangements themselves may, however, be turnable with reference to the respective arms and may be arrestable against turning when the longitudinal axis of a pouring tube which they hold has a horizontal or substantially horizontal orientation. This makes it possible to keep the vertical displacement of the tundish within very small limits, or even to avoid it entirely.

If a pouring tube is moved into operating position in cold state, with the term here being used in its relative sense as is obvious when one considers that the inventive apparatus operates with molten metal, deleterious thermal stresses may occur in the fire and heat-resistant material of the pouring tubes. Also, the molten metal, such as steel, may solidify and block their interior passage, especially when the inner diameter is small. To avoid this, the invention also contemplates the provision of preheating means for at least one standby or auxiliary pouring tube, namely the one (or the one next in line) which is to replace the pouring tube currently in operative position.

With the foregoing general objects, features and results in view, as well as certain others which will become apparent from the following explanation, the invention consists in certain novel features of design, construction, mounting and combination of elements, as will be more fully and particularly specified hereafter with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a view in vertical section through one embodiment of the invention;

FIG. 2 is a similar view, but through another embodiment of the invention;

FIG. 3 is a section taken on line III—III of FIG. 2;

FIG. 4 is a view analogous to that of FIG. 1, but showing still a further embodiment of the invention:

FIG. 5 is also a view similar to that of FIG. 1, but of yet an additional embodiment;

FIG. 6 is a section taken on line VI—VI of FIG. 5; and

FIG. 7 is a section taken on line VII—VII of FIG. 6.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Discussing firstly the embodiment of FIG. 1, it will be seen that reference numeral 1 identifies a tundish which can be raised and lowered as indicated by the double-headed arrow. It has an outlet 2 which is provided with a flow-regulating device, here shown as a slide valve 3, by means of which the flow of molten metal, such as steel, — shown within tundish 1 but not identified with a reference numeral — can be varied and stopped as desired. An immersible pouring tube 5, which may also be called an immersible casting nozzle, is in operative position in which it conducts the steel from the outlet 2 of tundish 1 into the (illustrated) casting mold 4 below the surface of the molten steel in the mold.

The purposes of pouring tube 5 have previously been discussed. In addition, its presence protects the steel against oxidation during travel from tundish 1 to mold 4, and the lateral outlets or outlet passages 6 which are immersed below the level of metal in the mold and through which metal can flow out, provide for improved flow patterns in the liquid core.

It can be seen from the drawing that the outlets 6 of pouring tube 5 are located below the surface of the molten steel. In this manner, molten steel can be conveyed into the mold 4 without being affected or contaminated by the ambient air.

A holding element 7 is turnable about the pivot axis 8 and holds the pouring tube 5 which is retained, as shown, by a conically tapering inner surface 9 of the holding or holder element which prevents it from downward movement, and by outwardly pivotable retaining arms 10 which prevent it from upward movement.

A spring 11 urges the pouring tube holding element 7 with the retained pouring tube 5 towards the outlet 2, pressing the pouring tube 5 thereagainst when the holding element 7 and the pouring tube 5 are in the illustrated operative position where the pouring tube 5 communicates with the inlet of the mold 4 below the surface of the metal. The spring 11 assures proper sealing between pouring tube 5 and outlet 2 even during play in the lifting or descending movement of tundish 1. Such movement, incidentally, can be accomplished with any known means suitable for the purpose and known to those skilled in the art.

In addition to the pouring tube 5 there is provided an other pouring tube, identified with numeral 5'. This other pouring tube is to be rapidly substituted at such time as weakening of pouring tube 5 makes this desirable, or when fracture of pouring tube 5 makes this step imperative.

For this purpose, pouring tube 5' is retained in a holder or holding element 7' which is turnable about a pivot axis 8'; it is shown in FIG. 1 in standby position. The holding elements 7 and 7', and therefore the pouring tubes 5 and 5', are connected by a conveyor chain 12 having runs provided with rollers 13 located at opposite lateral sides of the elements 7 and 7'. A guide arrangement 14 is provided which defines a path in which each chain 12 can travel. As the drawing shows, the path rises upwardly from a level below the outlet 2 of tundish 1.

Reference numeral 15 identifies a portion of a frame or otherwise stationary component of the apparatus, and the guide arrangement 14 — composed of two U-profiled elements of the type shown — is made fast with component 15 at opposite lateral sides of tundish 1. It is emphasized that such rigid connection is possible only when the inlet of the mold is wide so that the lower end of the pouring tube can move into and out of the mold 4 — see the broken-line arrow — without requiring lifting of the guide arrangement 14. Of course, no problem exists if the lower end of the pouring tube does not actually extend into the liquid core.

When the pouring tube 5 is to be replaced with pouring tube 5', the slide valve 3 is first operated to cut off the flow of metal. The tundish 1 is raised to separate outlet 2 from pouring tube 5 and a non-illustrated conventional drive of suitable type, e.g. mechanical or hydraulic, is operated to advance the chain structure and to thereby displace the pouring tubes 5 and 5' in unison in the curved path defined by guide arrangement 14, as indicated by arrow 16. As a result of this, pouring tube 5 moves out of operating position while pouring tube 5' moves to operative position and can be put into communication. This takes place during and without interruption of the casting process, i.e., while there is still liquid molten steel moving through the mold 4. Thereupon the tundish 1 is lowered until outlet 2 sealingly engages pouring tube 5', and the outlet is reopened via slide 3. The defective pouring tube 5 is removed from its holding element 7 and replaced with a new one, so that the replacement action can be repeated when pouring tube 5' requires substitution except that the movement will then be in opposite direction from the direction shown by arrow 16.

In the embodiment of FIGS. 2 and 3, a tundish 21 is connected with an arcuate guide track or track arrangement 22 via cylinder and piston units 23. This permits raising and lowering of track arrangement 22 relative to tundish 21 in the direction of outflow of the molten metal. In operative position the pouring tube 5 is again pressed against outlet 2, but here by the units 23. The tundish 21 itself may be raised and lowered to permit insertion and removal of the lower end of pouring tube 5 in the mold 28. Means for raising and lowering of tundish 21 may be of any known type and are therefore not shown.

As in FIG. 2, a pouring tube 5' is provided for standby purposes. A carriage 29 is movable on rolls 32 in guide track arrangement 22 and is provided with cylinder and piston units 26 which hold the pouring tube 5' in place.

In addition, there is provided a preheating device 24 which is movable in the direction of arrow 27 and which is also shown only in diagrammatic form, being well known to those active in this field and having routine knowledge. The device 24 is associated with and serves for heating of the pouring tube 5'. Of course, if more than one standby pouring tube is provided, more than one device 24 may also be provided, if desired. Its purpose has been discussed earlier, and the device 24 is primarily useful when the pouring tubes are thick-walled and consist, for example, of clay graphite. In this manner, the standby pouring tube (here 5') can be preheated to a desired uniform temperature before it is mounted on carriage 29, or — and in certain circumstances this may be advantageous — the heating can take place while the pouring tube 5' is already connected with the carriage 29.

In this embodiment, exchange of pouring tube 5' for pouring tube 5 is initiated by closing outlet 2 via a stopper or plug 38 which may be manipulated in known manner from outside the tundish 21. Now the units 23 are operated to lower track arrangement 22 in order to separate pouring tube 5 from outlet 2, while at the same time the tundish 21 is raised (together with the track 22) in order to lift the lower end of pouring tube 5 from the mold 28.

Once this is done, carriage 29 is advanced in direction of arrow 30 through 90° by suitable non-illustrated mechanical, hydraulic or other means. The units 23 now lift the track arrangement to sealingly press pouring tube 5' against outlet 2, and it is parenthetically pointed out that suitable dimensioning of the units 23 makes it possible to preselect this pressure so that the units 23 can additionally act as hydraulic springs. Now the ladle 21 together with track 22 is lowered until pouring tube 5' is immersed in the liquid core of mold 28 to the desired depth below the surface of the molten steel, whereupon plug 38 is removed and metal flows again to the mold. Of course, if the inlet is wide, or if the pouring tube does not extend into the metal bath, raising and lowering of the tundish 21 and of the track arrangement 22 is not necessary, although the movement of track arrangement 22 alone is still needed.

Details of the track arrangement 22 are shown in the sectional view of FIG. 3 where it will be seen that two stationary track ring portions 31 are each provided with four rollers or wheels 32 which serve to retain and guide carriage 29 in guides 33. The carriage 29 is composed of two angle-profiled rings 34, connected by ribs 35 which not only serve to provide carriage 29 with the requisite strength and stability, but also support the units 26 for the pouring tubes 5, 5'.

Coming to the embodiment of FIG. 4, it will be seen that tundish 1 is again provided with an outlet 2 which can be flow-controlled. A porous element 41 is arranged below a riser conduit 43, and gas is supplied through a pipe 42 so that it must pass through element 41 before it can enter riser conduit 43. The latter communicates above element 41 with the interior of tundish 1 via a port 43*a* to receive molten steel which becomes admixed with the incoming gas and is transported thereby to an overflow edge of riser conduit 43 from where it enters the pipe 44 which conveys it to the outlet 2.

In this embodiment a rotatable shaft or pin 46 is mounted and journalled on tundish 1 laterally offset and in upright — generally in vertical — orientation. A hub 47 is secured to its lower end portion and carries two pivot arms 49, 49' which are pivotable about bolts or shafts 51. Each of the arms 49, 49' carries a pouring tube holder 52, 52' respectively, for which purpose the tubular sections 53 are provided. Manual grips 54 make it possible to rotate the sections 53, and thus the holders 52, 52' and their associated immersible pouring tubes 5 and 5', rotate on the arms 49, 49' about horizontal axes defined by the latter. Abutments or arresting means 55 make it possible to arrest the arms 49, 49' when the axis of the respectively carried pouring tube 5, 5' is horizontally oriented.

It will be appreciated that turning of shaft 46 causes the pouring tubes 5, 5' to travel in a circular path which is coordinated with outlet 2. An upper recess 57 in the respective pouring tube 5, 5' cooperates with the outlet 2 for sealing engagement. A lever 58 permits the shaft 46 to be raised and lowered axially of itself so that the respective pouring tube can be separated from outlet 2.

When the pouring tube 5 is to be replaced, the supply of gas through riser conduit 43 is throttled; for obvious reasons it should not be stopped completely. The lever 58 is then operated by lifting it, to lower shaft 46 and pouring tube 5, whereupon a handle 54 is used to pivot pouring tube 5 to horizontal orientation. Now the hub 47 is turned about the axis defined by shaft 46, removing pouring tube 5 in the circular path and replacing it with pouring tube 5' which is pivoted to vertical orien-

tation and connected with outlet 2, whereupon the original gas supply to riser conduit 43 is restored.

Naturally, the shaft 46 could also be journalled in another component of the apparatus, rather than in the tundish 1. Moreover, two of them may be provided and so arranged with their respectively associated elements that the damaged pouring tube is removed in one arcuate path while the replacement pouring tube is supplied on another arcuate path.

Coming, finally, to the embodiment of FIGS. 5 to 7, it will be seen that here the pouring tubes 5 and 5' can be displaced in unison with respective flow-regulating devices for the outlet 63 of a tundish 61.

Reference numeral 64 identifies a guide which supports pouring tube 5 in operative position, together with an apertured sliding plate 65. A similar plate 65' and the standby pouring tube 5' are in standby position, held in a guide 64' which is pivotably connected with guide 64 as shown.

As FIGS. 6 and 7 show, pouring tube 5 is mounted in a plate 72 which is pivotable on guides 73 about a pivot shaft or axis 74, with reference to plate 65. The purpose of this arrangement, in which movement of plate 72 is caused by means of a laterally mounted cylinder and piston unit 76 which can be coupled to a transmission lever 75, is to permit regulating the flow of steel through the outlet 63.

When the unit consisting of plate 65 and pouring tube 5 is to be replaced, plate 72 is pivoted to close outlet 63. Now the tundish 61 is raised, and the guides 64' and 64'' are swung downwardly about the pivot axes 68 that they move to positions in which they are horizontally aligned with guide 64. A cylinder and piston unit 66 pushes the pouring tube 5' and plate 65' from guide 64' into guide 64, and simultaneously displaces pouring tube 5 and plate 65 from guide 64 into guide 64''. Thereafter the guides 64' and 64'' are swung upwardly to the positions shown in FIG. 5 (with the new position of pouring tube 5 shown in broken lines). Now the tundish 61 is lowered, and the flow of metal through the outlet is restored.

While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims.

We claim as our invention: 1. Apparatus for pouring molten metal into the mold of a continuous casting machine, comprising a tundish having an outlet having a passage therethrough, means for controlling the flow of metal through said outlet passage, a first immersible pouring tube having a passage aligned with said outlet passage and extending from said outlet passage to a level below the surface of the molten metal in the mold to conduct metal from said tundish into said mold, a replacement immersible pouring tube, and means for simultaneously supporting and guiding said first immersible pouring tube and said replacement immersible pouring tube at least during the time that said first immersible pouring tube is to be exchanged by said replacement immersible pouring tube, said supporting and guiding means controlling the movement of said pouring tubes along a path such as said pouring tubes are moved, said first immersible pouring tube is moved out of alignment with said outlet passage and said replacement immersible pouring tube is moved into alignment therewith, said supporting and guiding means for said immersible pouring tubes including means for permitting removal and replacement of any one of said immersible pouring tubes from said supporting and guiding means while the other immersible pouring tube is in position beneath said outlet passage.

2. Apparatus according to claim 1, further including means for carrying out relative movement between said pouring tubes and said tundish in the vertical direction.

3. Apparatus according to claim 2, wherein each pouring tube is yieldably held against said outlet passage by a spring.

4. Apparatus according to claim 1, wherein the path defined by said supporting and guiding means is circular.

5. Apparatus according to claim 1, wherein said supporting and guiding means is connected to the tundish.

6. Apparatus according to claim 1, wherein said supporting and guiding means is attached to a fixed structural framework and the tundish can be raised and lowered relative thereto.

7. Apparatus according to claim 1, wherein each pouring tube and said means for controlling the flow of metal are both held together as a unit against said outlet passage when each said pouring tube is in alignment with said outlet passage and are moved thereto or displaced therefrom as a unit.

8. Apparatus according to claim 1, including means for preheating said replacement pouring tube.

9. Apparatus for pouring molten metal into the mold of a continuous casting machine, comprising a tundish having an outlet having a passage therethrough, means for controlling the flow of metal through said outlet passage, a first immersible pouring tube having a passage aligned with said outlet passage and extending from said outlet passage to a level below the surface of the molten metal in the mold to conduct metal from said tundish into said mold, a replacement immersible pouring tube, and means for supporting said first immersible pouring tube and said replacement immersible pouring tube and guiding the movement of said pouring tubes along a path such that as said pouring tubes are moved, said first immersible pouring tube is moved out of alignment with said outlet passage and said replacement immersible pouring tube is moved into alignment therewith, said path defined by said supporting and guiding means being circular, said supporting and guiding means extending upwardly from below said outlet passage.

10. Apparatus for pouring molten metal into the mold of a continuous casting machine, comprising a tundish having an outlet having a passage therethrough, means for controlling the flow of metal through said outlet passage, a first immersible pouring tube having a passage aligned with said outlet passage and extending from said outlet passage to a level below the surface of the molten metal in the mold to conduct metal from said tundish into said mold, a replacement immersible pouring tube, and means for supporting said first immersible pouring tube and said replacement immersible pouring tube and guiding the movement of said pouring tubes along a path such that as said pouring tubes are moved, said first immersible pouring tube is moved out of alignment with said outlet passage and said replacement immersible pouring tube is moved into alignment therewith, said supporting and guiding means including a vertical shaft, a pair of arms pivotally mounted on said shaft, and a pouring tube holder mounted on each

of said arms, and wherein the said path is defined by rotation of said vertical shaft.

11. Apparatus according to claim **10,** wherein the shaft is mounted on said tundish and is vertically adjustable with respect thereto.

12. Apparatus according to claim **10,** wherein said pouring tube holders are rotatable on said arms and include means to arrest the rotation thereof when the pouring tube axis is swung to a horizontal position.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,743,007 Dated July 3, 1973

Inventor(s) Willi Simons et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Page 1, left-hand column, paragraph [73] Assignees:
read "Concast AB" as --Concast AG--

Page 1, left-hand column, after paragraph [73]
insert --Priorities October 30, 1969
Switzerland
16169/69 and
November 13, 1969
Germany
P 19 57 037.7--

Page 1, in the "Abstract", line 5,
delete "inlet and the"

Column 1, line 15, read "mold" , second occurrence, should read -- lower --;
Column 1, line 16, read "spout" as --pouring tube--
Column 2, line 66, read "HOwever" as --However--
Column 6, line 7, read "ladle" as --tundish--

Signed and sealed this 26th day of March 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334