United States Patent

[11] **3,568,756**

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[21] Appl. No. **757,981**
[22] Filed **Sept. 6, 1968**
[45] Patented **Mar. 9, 1971**

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[32] Priority **Mar. 20, 1968**
[33] **Great Britain**
[31] **13,450**

[54] **TUNDISH HAVING OUTLET NOZZLE COMPRISING A SWIVELLABLE TERMINAL PORTION**
3 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **164/281,** 164/82
[51] **Int. Cl.** **B22d 11/10**
[50] **Field of Search** ..... 164/82, 83, 281, 283; 222/(Inquired); 141/383

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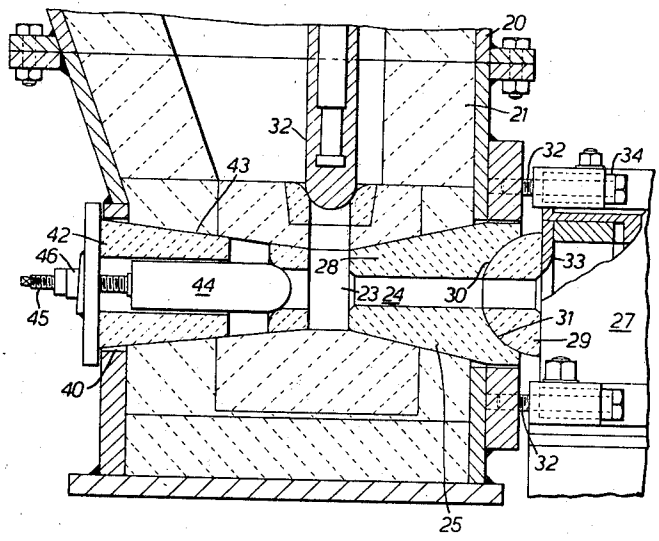
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ABSTRACT: A tundish suitable for receiving molten metal to be cast continuously in a continuous casting mould has an outlet for the molten metal constituted by a nozzle the cross section of the bore of which is less than that of the cavity of the mould and a nonrigid joint is included between the outlet of the tundish and the inlet of the mould in order to permit limited inclination of the longitudinal axes of the mould and the nozzle. The part of the nozzle which defines the outlet therefrom is separate from the remainder of the nozzle and is swivellable to a limited extent with respect to the remainder of the nozzle. The longitudinal axes of the mould and the nozzle may be either substantially vertical or substantially horizontal.



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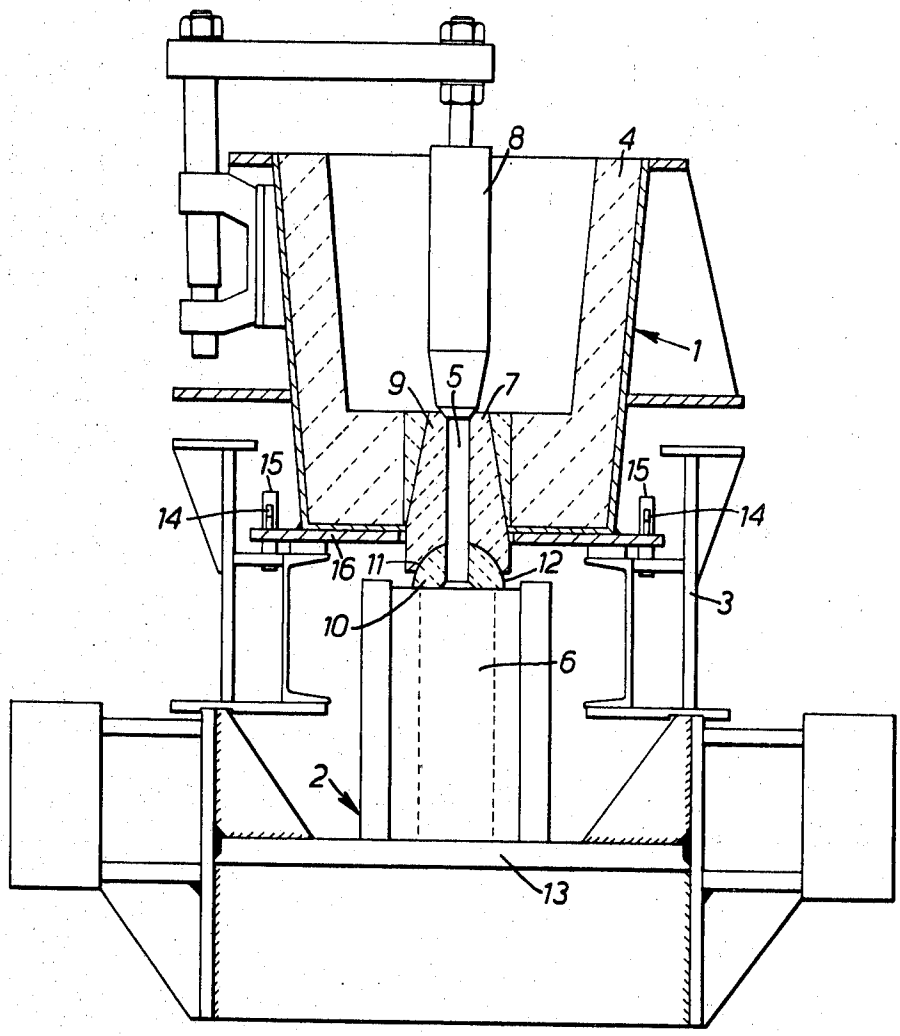


FIG. 1.

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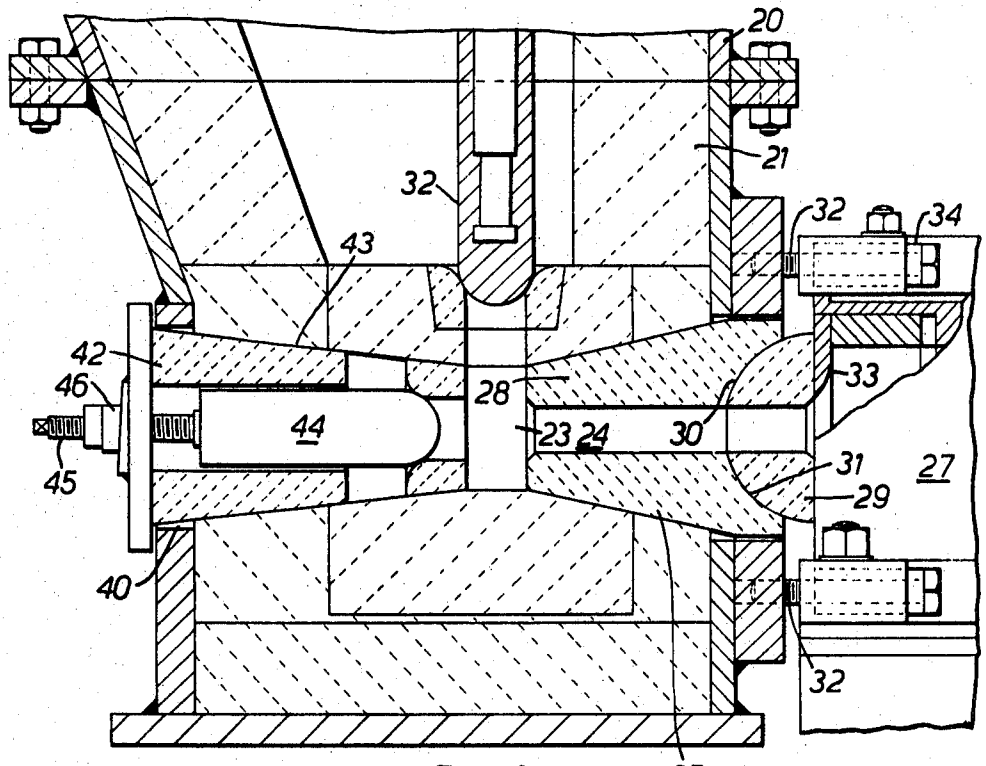


FIG. 2.

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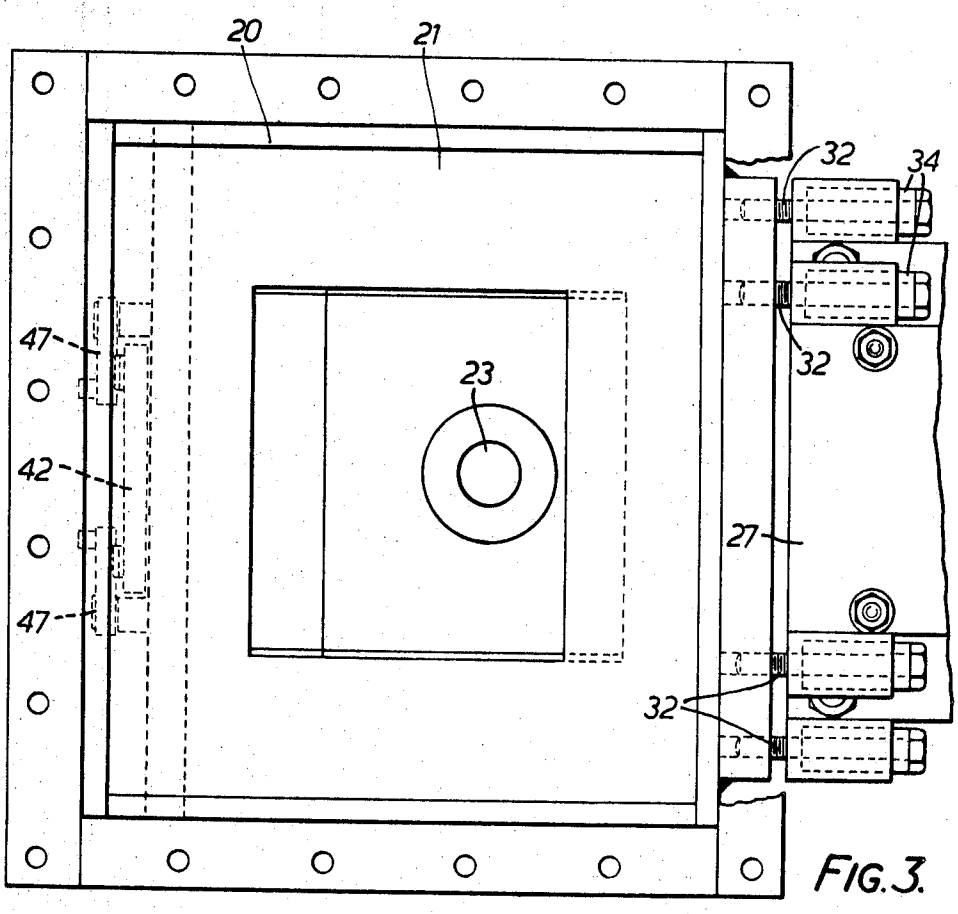


FIG. 3.

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TUNDISH HAVING OUTLET NOZZLE COMPRISING A SWIVELLABLE TERMINAL PORTION

This invention relates to apparatus suitable for use in continuous casting of metal, particularly steel. Continuous casting consists essentially of allowing molten metal stored in a container, usually in the form of a tundish, to flow at a regulated rate through a cavity in the mould. In the mould, generally formed of copper because of its good thermal conductivity properties, the metal is cooled sufficiently for a solid outer skin or shell to be formed which causes the casting leaving the mould cavity to retain the cross-sectional shape of the cavity. By virture of further cooling which takes place outside of the mould, and which in most instances is attained by direct application to the casting of a cooling fluid, the casting solidifies further from the outer skin towards its center.

It is desirable for reasons of safety to the operators of the continuous casting apparatus and to obtain maximum yield that molten metal stored in the container flows into the mould and that none flows out to waste between the container and the mould. Furthermore the metallurgical qualities of the casting are improved if the flow of metal from the container to the mould takes place in the absence of air, such an arrangement being known as sealed pouring.

According to a first aspect of the present invention, apparatus for continuous casting of metal comprises a tundish for receiving molten metal to be cast, a continuous casting mould, means defining a passage connecting the tundish with the inlet of the mould said means being sealed to the tundish and the mould to prevent ingress of air and egress of molten metal between the tundish and the mould and means for heating said passage prior to casting.

By providing a sealed passage along which the metal flows between the tundish and the mould, the desiderata mentioned above are attached. It is however, essential that the passage is dried and thoroughly heated before the molten metal flows therealong and to this end means for heating the passage prior to casting, and which preferably takes the form of an electric heater, are provided.

According to a second aspect of the invention, apparatus suitable for continuous casting of metal comprises a tundish for receiving molten metal to be cast, the outlet from the tundish for the molten metal being constituted by a nozzle, a continuous casting mould having a mould cavity of greater cross-sectional area than that of the bore of the nozzle and with the mould arranged such that the part of the mould defining the inlet thereto is in sealed relation with the part of the nozzle defining the outlet therefrom to prevent ingress of air and egress of molten metal between the nozzle and the mould.

It is essential in continuous casting apparatus that the molten metal only solidifies in the mould cavity and not in the passage between the tundish and the mould. It is convenient for this passage to be constituted by the bore of a nozzle and by ensuring that the cross-sectional area of the passage is considerably less than that of the mould two advantages accrue. These advantages are that the heat loss from the molten metal in the passage is reduced and the rate of flow of molten metal through the passage is increased and therefore it is unlikely that solidification of the metal in the passage will occur.

It is preferable to include a nonrigid joint between the outlet of the tundish and the inlet of the mould in order to permit limited inclination of the longitudinal axes of the nozzle and the mould and thereby ensure flow of metal into the mould at the same time ensuring that the outlet of the tundish and the inlet of the mould are in sealing relation with one another. The part of the nozzle which defines the outlet therefrom is conveniently separate from the remainder of the nozzle and is swivellable to a limited extent with respect to the remainder of the nozzle.

To enable the end portion of the nozzle to be swivellable to a limited extent with respect to the remainder of the nozzle, the two parts of the nozzle are conveniently provided with

coacting surfaces each of which form a part of the surface of a sphere. The coacting surface on one of the parts of the nozzle forms a socket for receiving a convex surface on the other part of the nozzle. The coacting surfaces enable the outer part of the nozzle to be rotated to a limited extent relative to the stationary remainder of the nozzle so that their longitudinal axes are mutually inclined while the coacting surfaces remain in contact with one another.

Means are provided which bias the coacting surfaces of the nozzle into abutting sealed relation.

The axes of the mould and the nozzle may be arranged substantially vertical so that the casting leaves the mould in a substantially vertical direction. The axes of the mould and the nozzle may also be arranged to be substantially horizontal in which case the tundish may have an upwardly facing opening to receive the molten metal and a narrow throat extending downwardly from the base of the inner wall of the tundish to the inner end of the nozzle. A vertically displaceable stopper rod may be associated with the throat to stop and start the flow of molten metal from the tundish to he mould. Preferably an aperture is provided in an outer sidewall of the tundish opposite the nozzle with a passage extending from the aperture to the inner end of the nozzle. The longitudinal axis of the passageway is aligned with that of the nozzle so that a heater may be inserted into the passage to preheat the passage and nozzle prior to casting. During casting the aperture is closed with a removable refractory plug. The plug may be removed in an emergency to drain metal from the tundish through the aperture if a blockage occurs in the mould and there is a likelihood that the molten metal will otherwise freeze in the tundish.

In order that the invention may be more readily understood it will now be described, by way of example only, with reference to the accompanying drawings in which:

FIG. 1 is an elevation, partly in section of a tundish and mould with the longitudinal axis of the mould cavity arranged vertically;

FIG. 2 is a sectional side elevation of a tundish and mould with the longitudinal axis of the mould cavity arranged horizontal; and

FIG. 3 is a plan view of the arrangement shown in FIG. 2.

Referring to FIG. 1, a tundish 1 arranged to receive molten metal to be cast continuously in a continuous casting mould 2 is supported on a rigid frame 3. The tundish is lined with a refractory material 4 and a passageway 5 extends from the base of the inner wall of the tundish to the inlet of the mould cavity 6. The mould 2 is positioned beneath the tundish with the longitudinal axis of the mould cavity vertical and the passage 5 is defined by a nozzle 7 of refractory material.

The nozzle extends from the outlet of the tundish to the inlet of the mould cavity so that molten metal flows from the tundish to the mould in the absence of air. A vertically displaceable stopper rod 8 in the tundish has its lower end associated with the upper end of the nozzle in order to control the flow of molten metal from the tundish into the nozzle.

The nozzle comprises two parts 9 and 10 and to enable one part of the nozzle to be swivellable to a limited extent with respect to the other part of the nozzle, the two parts of the nozzle are provided with coacting surfaces 11 and 12 respectively each of which forms a part of the surface of a sphere. The coacting surface on the part 9 of the nozzle is of concave form and serves as a socket for receiving the coacting surface of convex form on part 10 of the nozzle. The coacting surfaces enable the two parts of the nozzle to be inclined slightly relative to each other while the coacting surfaces remain in contact with one another. This arrangement ensures that the metal flows from the tundish to the mould through a sealed passageway while enabling the tundish and the mould to be assembled with the longitudinal axes of the outlet of the tundish and the inlet to the mould slightly out of alignment.

In order to prevent leakage between the coacting surfaces 11 and 12 the mould is rigidly secured to a framework 13 while the tundish may be raised or lowered slightly with

respect to the framework 13 and is biased downwardly towards the framework 13 by means of cotters 14 projecting through slots in pegs 15 extending through openings in a support plate 16 for the tundish. In this way the coacting surfaces are biassed together in abutting relation and this prevents leakage therebetween.

Prior to introducing molten metal into the tundish the tundish and the passage 5 are dried and preheated by a gas burner extending to the tundish through the upper open end.

Referring now to FIGS. 2 and 3 a metal tundish 20 has an inner lining 21 of refractory material, such as fire clay, which defines the inner wall of the tundish. A narrow throat 23 extends downwardly from the base of the inner wall of the tundish and is in communication with the bore 24 of a nozzle 25 projecting outwardly from a sidewall of the tundish. The axis of the bore of the nozzle is substantially horizontal as also is the axis of the cavity of a continuous casting mould 27 which is sealed to the nozzle. The nozzle is of refractory material and is in two parts, namely a fixed part 28 mounted in the tundish and a part 29, which forms the outer end of the nozzle and which is swivellable with respect to the part 28. The part 28 of the nozzle has a concave surface 30 which is part of the surface of a sphere and which coacts with a similar convex surface 31 on the part 29 of the nozzle. The two parts of the nozzle may be arranged with their longitudinal axes inclined one relative to the other by a limited amount but with the coacting surfaces 30 and 31 remaining in contact with one another.

The tundish has an upwardly facing opening to receive molten metal and a vertically displaceable stopper rod 32 associated with the throat to control the flow of molten metal from the tundish. The mould 27 is secured to the tundish 1 by means of a plurality of bolts 32 which are spaced apart around the projecting end of the nozzle and the end of the nozzle abuts against an annular plate 33 which may be of graphite or silicon nitride and which defines the inlet to the mould. A spring 34 is provided around each of the bolts 32 to engage with the head of the bolt and a part of the mould to bias the mould and the tundish together and thereby clamp the coacting surfaces of the nozzle together in sealed relation. The springs 34 provide a degree of resilience which keeps the mould and the tundish biassed together when differential expansion occurs between the mould and the tundish when the apparatus is in use.

The cross-sectional area of the bore of the nozzle 24 is considerably less than the cross-sectional area of the mould cavity so that molten metal flowing from the tundish to the mould passes through the nozzle at a higher rate than would be the case if the cross section of the bore of the nozzle and the cavity of the mould were comparable. The heat loss from the bore of the nozzle is also reduced due to the relatively small cross section of the bore and both the fast rate of flow of the metal through the bore and its small cross-sectional area prevent metal solidifying in the bore and hence blocking it. An aperture 40 is provided in the sidewall of the tundish opposite the nozzle 25 and a passageway 41 extends into the tundish from the aperture to the throat 23. The axis of the passageway 41 is substantially horizontal and is aligned with the axis of the nozzle. A removable refractory plug 42 is fitted into the aperture 40 and part way into the passageway to prevent leakage therethrough when metal is contained in the tundish. The plug has a tapered outer surface which engages with a correspondingly tapered surface 43 defining part of the length of the passageway. A horizontally displaceable stopper rod 44 has a threaded portion 45 which projects through the plug to the outside of the tundish and engages with a nut 46 mounted on the outside of the plug so that the stopper rod can be advanced into engagement with a part of the passageway 41 which is of reduced cross section to prevent leakage of molten metal through this passageway. The plug is retained in the aperture by quick release locking means 47.

Prior to casting the plug 40 and the stopper rod 44 is removed and a heater inserted into the passageway 41 and the bore of the nozzle 24 to dry and pre-heat them. After the plug has been replaced, the molten steel to be cast is poured into the tundish through the upwardly facing opening and the stopper rod 32 is raised slightly to enable molten metal to flow through the throat 23 and the nozzle 24 to the mould. The mould is continuously cooled and further cooling means in the form of nozzles (not shown) are positioned adjacent the outlet end of the mould so that cooling fluid can be directed on to the casting leaving the mould. Means (not shown) are provided for withdrawing the casting continuously from the mould and tundish may be reciprocated in a direction parallel to tee axis of the mould in order to prevent sticking of the metal to the mould.

I claim:

1. In apparatus adapted for use in the continuous casting of steel, which apparatus comprises a tundish for receiving molten metal to be cast, said tundish having a vertically disposed outlet defined by thermoinsulating material, a narrow throat defined by thermoinsulating material connecting said outlet with the inlet of a substantially horizontal tubular nozzle projecting laterally outward from one of a pair of opposite sidewalls of the tundish; a continuous casting mould secured to said wall of the tundish with the longitudinal axis of the mould cavity substantially horizontal, the cross-sectional area of the cavity being greater than that of the nozzle bore, and said mould comprising an apertured silicon nitride plate constituting the inlet of the mould; means biassing said plate into engagement with the outlet of the nozzle so that the bore of the nozzle is in sealed relation with the mould cavity to prevent ingress or air and egress of metal between the nozzle and the mould; and means for admitting a heater to said throat, said means comprising an aperture defined by the sidewall of the tundish opposite to that from which the nozzle projects, a passage defined by thermoinsulating material extending from said aperture to said throat with the longitudinal axis of the passage aligned with the axis of the bore of the nozzle, the cross-sectional dimensions of the aperture and passage being large enough to permit a heater to be passed therethrough into said narrow throat, a removable sealing plug fitted into said aperture and a passage, and quick release locking means on said tundish for securing said plug in position, the improvement according to which said nozzle comprises two parts, one of which constitutes the inlet of the nozzle and extends to the sidewall of the tundish and the other of which constitutes the outlet of the nozzle, said two parts of the nozzle having coacting part-spherical surfaces, which permit the longitudinal axes of the bore of the two parts of the nozzle to have limited inclination relative to each other while the surfaces remain in contact with one another.

2. Apparatus as claimed in claim 1 in which the coacting surface on the part of the nozzle defining the outlet therefrom is of convex form and the coacting surface on the remainder of the nozzle is of concave form.

3. Apparatus as claimed in claim 1 in which said nozzle is of refractory material.