United States Patent

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[72] Inventors Norman T. Mills
Highland;
Charles R. Jackson, Hammond; James W. Halley, Chesterton, Ind.

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[73] Assignee Inland Steel Company
Chicago, Ill.

[54] **CONTINUOUS CASTING APPARATUS**
10 Claims, 14 Drawing Figs.

[52] U.S. Cl. 164/281, 239/598
[51] Int. Cl. B22d 11/10
[50] Field of Search 164/82, 273, 281; 239/598

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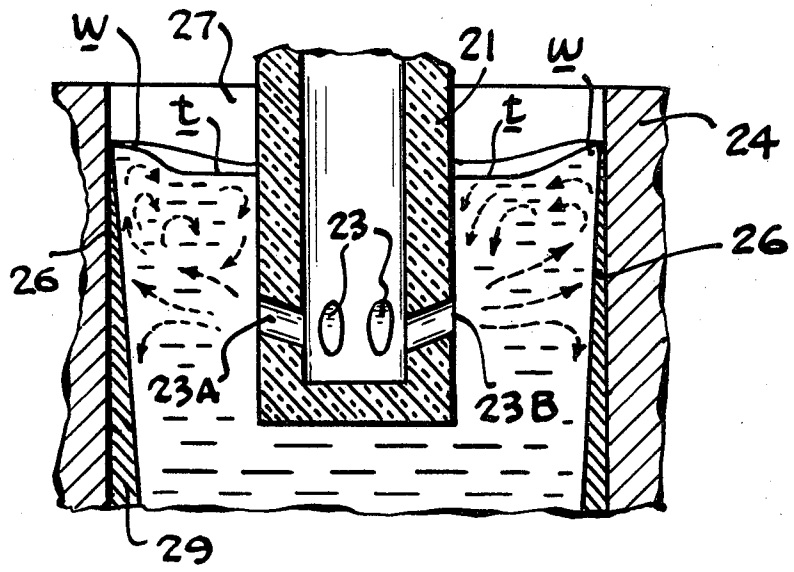
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Primary Examiner—J. Spencer Overholser
Assistant Examiner—R. Spencer Annear
Attorney—Hibben, Noyes & Bicknell

ABSTRACT: A continuous casting process whereby objectionable surface inclusions are substantially eliminated from the continuous casting and wherein molten steel is introduced into a continuous casting mold by an injection means which discharges the molten metal into the mold below the surface of the molten metal pool maintained in the upper end of the mold through controlled streams having an upwardly and outwardly flowing component which contacts the solidifying casting surfaces to wash away objectionable inclusions normally frozen into the casting and concentrates the objectionable inclusions on the surface of the molten metal where they can be readily removed. Injection nozzles adapted for use with rectangular and square continuous casting molds comprise tubular sections having circumferentially spaced lateral discharge openings for introducing the molten metal into the mold so as to uniformly contact those surfaces of the casting from which objectionable inclusions must be substantially excluded.



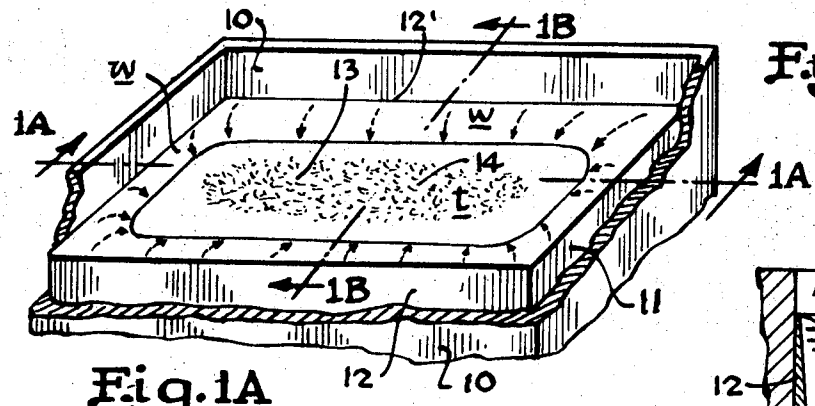


Fig. 1

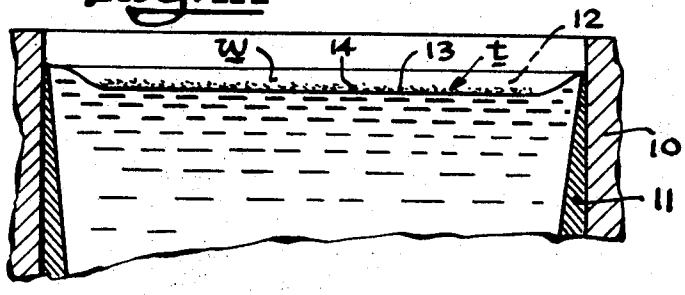


Fig. 1A

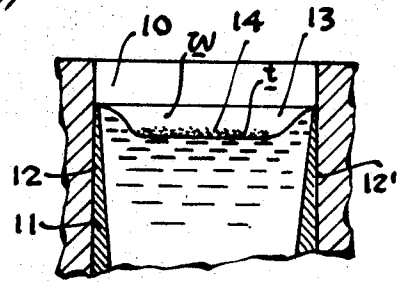


Fig. 1B

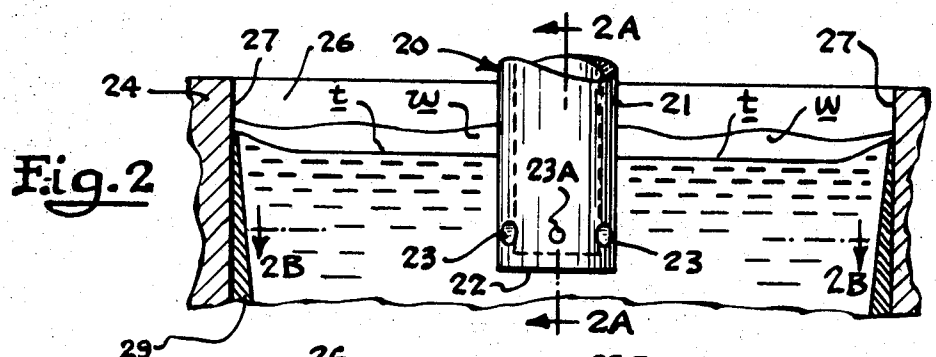


Fig. 2

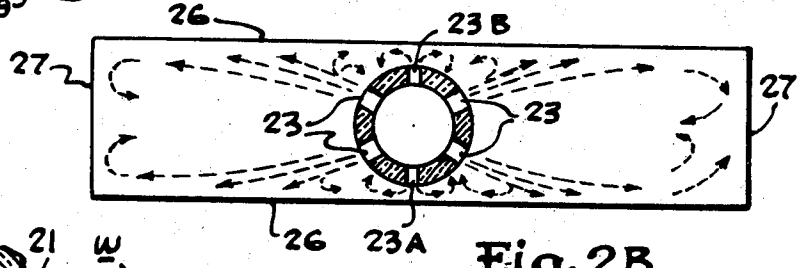


Fig. 2B

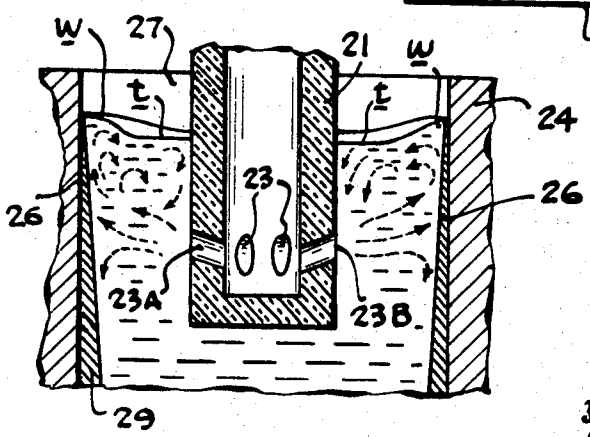


Fig. 2A

Inventors
Norman T. Mills
Charles R. Jackson
James W. Halley
By Hibben, Noyes & Bicknell
Attorneys

Fig.3

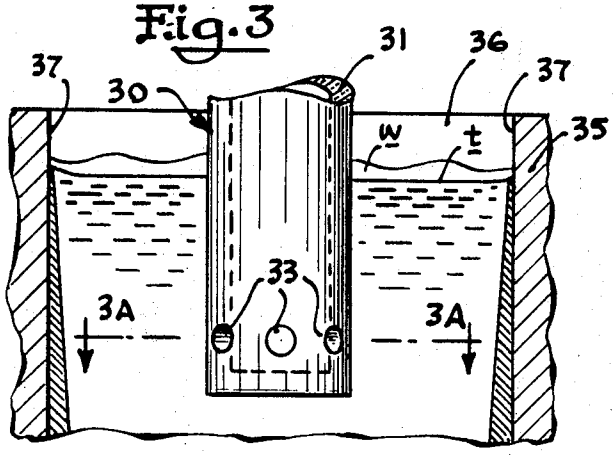
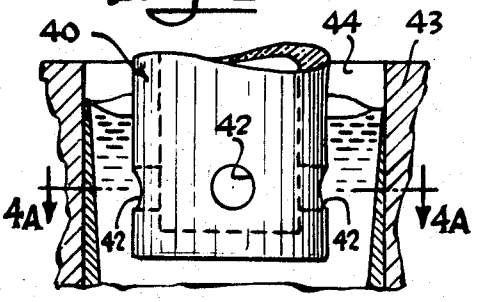


Fig.4



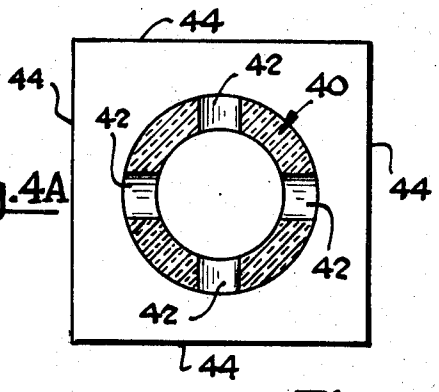


Fig.4A

Fig.3A

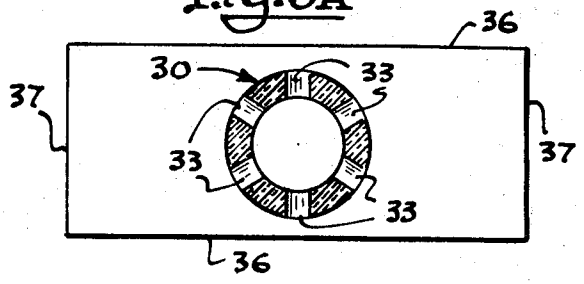


Fig.5

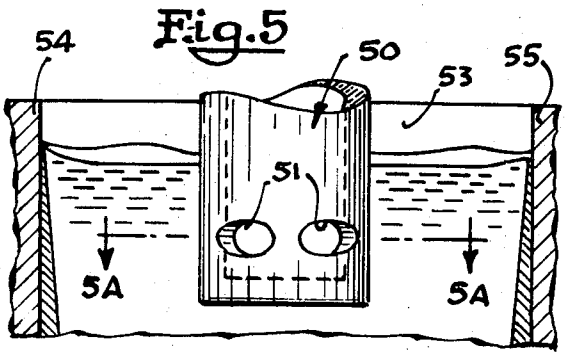


Fig.6

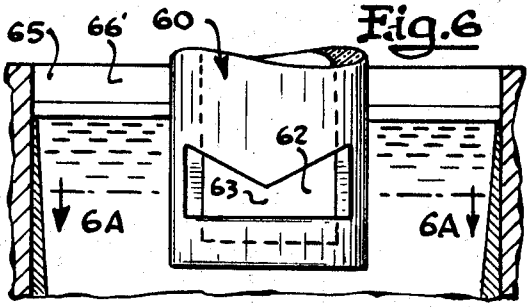


Fig.5A

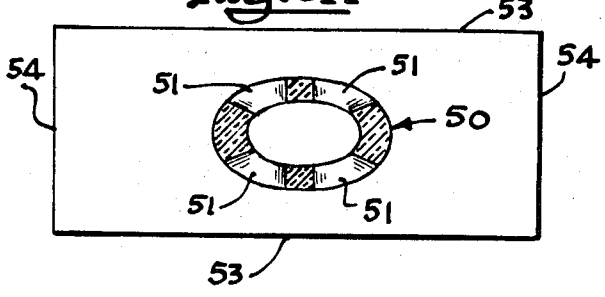
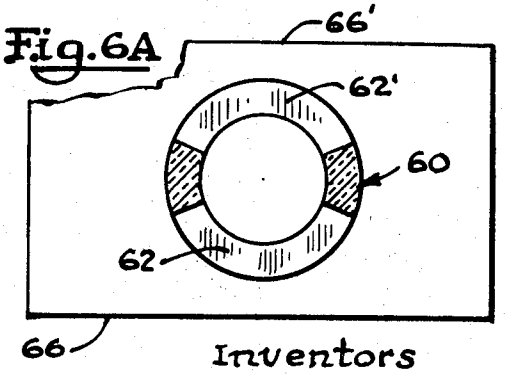


Fig.6A



Inventors
Norman T. Mills
Charles R. Jackson
James W. Halley
By Hibben, Noyes & Bicknell
Attorneys

CONTINUOUS CASTING APPARATUS

The present invention relates generally to an improved continuous casting method and apparatus, and more particularly to an improved method of continuously introducing molten metal into an open ended continuous casting mold and to the submergible injection nozzle used for introducing molten metal into a continuous casting mold.

In the continuous casting of molten metals and particularly molten steel, nonmetallic inclusions, such as aluminum oxide and aluminum silicon oxide, in aluminum killed steels, and gaseous bubbles of carbon oxides in rimmed steels, frequently cause surface defects in the rolled steel sheets because the inclusions and bubbles tend to become trapped in or near the surface portion of the casting adjacent the mold wall. The inclusions and bubbles are particularly objectionable, for example, when entrapped in the wider sides of a rectangular casting, such as a steel slab, where after rolling into thin finished steel sheets, the wider sides form the flat surfaces of the steel sheet. Problems of a generally similar nature are encountered in the continuous casting of steel billets.

Bifurcated submerged injecting nozzles have heretofore been used which direct the incoming molten metal in streams flowing in diametrically opposite directions toward the narrower end walls of a mold having an oblong cross section, but such nozzles do not prevent trapping the oxide and other objectionable inclusions in the wider lateral surfaces of a continuous casting. As a result, the rolled sheets produced from such castings frequently have objectionable streaks and weakened portions along the wider surface thereof which reduce the value and usefulness of the sheet product.

Molten metal has also been introduced into a continuous casting mold through nozzles having a plurality of submerged outlets which are designed to impart to the molten metal within the mold a rotating or circular motion concentric with the longitudinal axis of the injection nozzle and mold to obtain more effective mixing of additives (2,224,414) or to prevent coarse grain crystallization (3,050,793). Such efforts, however, have not recognized nor solved the major problem of preventing the trapping of oxides and other objectionable inclusions near the surface of the casting, particularly along the edges adjacent the corners of a continuous casting having a quadrilateral cross section, and the products made from such castings contain objectionable surface imperfections and are, therefore, less valuable and useful.

It is, therefore, an object of the present invention to provide an improved method and apparatus for continuously casting molten metal in a continuous casting mold which substantially avoids trapping oxides and other objectionable matter in or near the lateral surfaces of a continuous casting, such as in the wider faces of a continuous casting when the mold has an elongated rectangular form.

It is a further object of the present invention to provide an improved submergible injection nozzle for introducing molten metal into a continuous casting mold which reduces the likelihood of entrapping inclusions in the lateral surfaces of a continuous casting, such as in the wider lateral surfaces of the casting when the continuous casting mold has a rectangular shape.

Other objects of the invention will be apparent to those skilled in the art from the following detailed description and claims when read in conjunction with the accompanied drawing wherein:

FIG. 1 is a fragmentary schematic perspective view of the upper section of a continuous casting mold which shows a continuous casting being produced in accordance with the present invention (the axially disposed injection nozzle being omitted for clarity).

FIG. 1A is a vertical sectional view taken along the line 1A–1A of FIG. 1;

FIG. 1B is a vertical sectional view taken along the line 1B–1B of FIG. 1;

FIG. 2 is a fragmentary schematic side elevational view partially in vertical section of an injection nozzle embodying the present invention and which is operatively disposed in a continuous casting mold;

FIG. 2A is a fragmentary schematic vertical sectional view taken along the line 2A–2A of FIG. 2;

FIG. 2B is a schematic horizontal sectional view taken along the line 2B–2B of FIG. 2;

FIG. 3 is a fragmentary schematic side elevational view partially in vertical section of a modified form of injection nozzle operatively disposed in a continuous casting mold;

FIG. 3A is a horizontal sectional view taken along the line 3A–3A of FIG. 3;

FIG. 4 is a fragmentary schematic side elevational view partially in vertical section of a further modified form of injection nozzle operatively disposed in a continuous casting mold;

FIG. 4A is a horizontal sectional view taken along the line 4A–4A of FIG. 4;

FIG. 5 is a fragmentary schematic side elevational view partially in vertical section of a still further modified form of injection nozzle operatively disposed in a continuous casting mold;

FIG. 5A is a horizontal sectional view taken along the line 5A–5A of FIG. 5;

FIG. 6 is a fragmentary schematic side elevational view partially in vertical section of another modified form of injection nozzle operatively disposed in a continuous casting mold; and

FIG. 6A is a horizontal sectional view taken along the line 6A–6A of FIG. 6.

It has been found that the foregoing and other objects of the present invention can be achieved by introducing molten metal into a continuous casting mold in a manner which establishes a novel dynamic fluid flow pattern in the molten metal within the upper end portion of the mold, whereby a plurality of spaced streams of molten metal are directed toward the mold walls and the lateral walls of the solidifying continuous casting so that each of the streams has an outwardly and upwardly flowing component of sufficient velocity to contact and wash the walls of the solidifying casting where the metal is initially solidifying at a very high freezing rate and carry away from the solidifying surfaces the objectionable inclusions. The several upwardly flowing streams of molten metal in which the objectionable inclusions are carried preferably substantially merge to form a substantially uniform front when reaching the upper surface of the molten metal and form a standing wave on the surface of the molten metal adjacent the mold walls and then flow inwardly away from the walls toward the axis of the casting forming a central depressed zone or "trough" between the lateral walls of the mold.

FIG. 1 of the drawing schematically shows the flow pattern which is ideally established in the pool of molten metal maintained in the upper end portion of a continuous casting mold **10** and continuous casting **11** in accordance with the present invention and which effects removal from the initially solidifying walls of the casting the objectionable inclusions and irregularities which normally are frozen into the lateral surface of the continuous casting and thereby facilitates forming continuous castings having substantially smooth blemish-free lateral surfaces, particularly in the wider lateral surfaces **12**, **12'** of a rectangular casting which corresponds to the exposed flat surfaces of a rolled steel sheet formed therefrom. The objectionable inclusions which are swept away from the rapidly freezing face of the continuous casting collect on the surface of the central depressed zone or "trough" *t* formed in the upper molten metal surface **13** of the casting where they agglomerate to form a slag **14**. Because of the low density of the agglomerated slag **14**, the slag floats on the surface of the molten metal and is not incorporated in the casting. The slag that accumulates in the center of the mold can be removed by skimming or can be dissolved in a fluid artificial slag which can be provided on the surface of the molten metal.

To establish the desired novel dynamic fluid flow pattern in the pool or head of molten metal maintained in the upper end portion of a continuous casting mold in contact with the solidi-

fying metal, it is important that the inflowing molten metal enter the continuous casting mold below the surface of the pool or head of molten metal in such a manner that a plurality of streams of molten metal are formed which are angularly spaced at the point of introduction into the mold and are symmetrically disposed with respect to the transverse axes of said mold so that the flow of molten metal uniformly contacts and is substantially uniformly distributed over at least two of the solidifying lateral wall surfaces of the continuous casting before the streams reach the upper surface of molten metal and travel with sufficient dynamic energy that a substantial proportion of each of the streams on contacting the surface of the solidifying casting will flow upwardly along the solidifying casting surfaces and when reaching the upper surface of the molten metal the substantially uniform front of flowing metal will turn inwardly away from the walls to form the axially depressed zone or trough *t*. The foregoing continuous, uniform upwardly and inwardly flow of molten metal produces a pronounced "standing wave" of "roll" on the surface of the molten steel, as indicated at *w* which extends from the mold walls inwardly at the upper end of the casting, forming the relatively elongated axial depression or "trough" *t*, in the upper surface of the molten metal between the lateral walls of the casting generally in accordance with the idealized flow pattern shown diagrammatically in FIGS. 1, 1A and 1B of the drawing. Most of the objectionable "inclusions" carried upwardly and inwardly by the flowing molten metal from the solidifying casting surfaces are concentrated in the upper surface of the trough *t*.

In carrying out the continuous casting process of the present invention, it has been found that highly satisfactory results are obtained by introducing molten metal into a continuous casting mold through a tubular injection nozzle or "snorkel" having the discharge outlets provided in the lateral wall surface adjacent the lower axial end of the nozzle in the form of a plurality of lateral discharge openings symmetrically arranged with respect to a transverse axis of the nozzle which discharges the molten metal below the surface of the molten metal in the upper end of the casting in a plurality of streams which radiate outwardly toward the lateral walls of the casting and which have a substantial upwardly flowing component with sufficient energy that a substantial portion of the molten metal in each stream flows upwardly, preferably spread uniformly along the walls of the solidifying casting and mold walls, then inwardly to form the desired axial depression of "trough" in the upper surface of the molten metal, as previously described.

The injection nozzle which has been found best suited for transferring the molten metal from a supply source to the interior of a rectangular or oblong continuous casting mold is a cylindrical submergible injection nozzle having an even number of discharge openings or passages formed in the lateral surface of the injection nozzle adapted to extend below the surface of the head of molten metal in the upper end portion of the continuous casting mold and forms an even number of streams of molten metal which permit evenly distributing the flowing molten metal over the lateral surfaces of the upper walls of the mold and/or casting. The streams issue from the injection nozzle with a sufficient velocity that a substantial proportion of each of the streams will contact one or more walls of the casting below the upper surfaces of the molten metal, and establish the herein described uniform flow pattern which is evidenced by the "roll" formed on the metal surface around the edges of the mold, and which ideally provides equal energy distribution over the lateral surface of the mold and casting, as shown in FIGS. 1–1B.

The size and form of the injection nozzle and the size, form and circumferential arrangement of the lateral discharge openings in the nozzle can be varied without departing from the inventive concept of the present invention with the only limitation being that the injection nozzle must establish in the molten metal of the upper portion of the mold a dynamic flow pattern of the type herein described. And, although not essential to this invention, the energy delivered in an upward direction by the portion of the stream flowing upwardly adjacent to the solidifying casting can be increased by inclining the nozzle openings upwardly from the horizontal plane when the nozzle is disposed with its longitudinal axis parallel to the longitudinal axis of the mold and casting. The metal streams which flow from these inclined discharge openings will have a definite upward angle of inclination from the horizontal. With a nozzle having discharge openings inclined upwardly from the horizontal, however, it is important that the upwardly inclined streams of molten metal originating at about the axis of the mold contact the lateral walls of the solidifying casting before contacting the upper surface of the molten metal in the mold.

When forming a continuous casting having a rectangular cross section with a large length and small width, i.e. a so-called "slab," where it is of paramount importance to avoid surface imperfections in the wide faces of the slab, best results can be obtained if the molten metal injection nozzle is positioned with respect to the walls of the mold so that no molten metal streams flow directly toward the narrow walls of the rectangular mold. The nozzle should also be positioned so that the molten metal streams wash as much of the wide face as possible, while maintaining as much as possible uniform flow conditions across each of the wide faces of the mold. To maintain uniform molten metal fluid flow conditions across the wide face of a rectangular or slab mold, it is helpful, but not necessary, to make the cross-sectional area of each molten metal stream proportional to the distance each stream must travel before contacting and washing the solidifying face of the casting in order to equalize the distribution of the kinetic energy of the flowing metal over the surface of the wider lateral walls of the mold.

While the angular spacing of the discharge openings about the lateral surface of the nozzle is normally equal where a cylindrical nozzle having a plurality of circular openings is used for casting a rectangular slab in which the wider mold wall is about 4.5 times longer than the narrower mold wall, the circumferential spacings of the discharge openings of the nozzle do not have to be equal when the mold size is appreciably different in order to effect an even distribution of the fluid or kinetic energy of the liquid metal flowing from the nozzle. Thus, in a nozzle for use with a continuous casting mold having dimensions substantially different from an 8"×37" mold, the spacing of the discharge openings can be angularly spaced more or less than 60° from the adjacent openings, depending on the dimensions of the mold. Also, an additional even number of nozzle discharge openings over the standard six openings normally preferred with an 8"×37" mold can be used, since the latter maintains the desired symmetrical or equal distribution of the metal within the mold. For example, a nozzle with 8 or 10 or more circular openings can be used to wash the wide faces more effectively in a mold having a length to width ratio substantially greater than 4.5 to 1, or, conversely, a nozzle with four circular or two specially-shaped openings can be used to wash the faces effectively in a mold having a length to width ratio substantially less than 4.5 to 1.

The discharge openings in the lateral surface of the injection nozzle are preferably circular in form to minimize the frictional resistance to the flow of molten metal for an opening of a given cross-sectional area. However, all the openings do not have to be the same size and discharge openings having oval or elongated cross sections can be used, if it is desirable to have the streams of metal spread or fanned out, as shown in FIGS. 5 and 6 of the drawing.

The injection nozzle **20** shown in FIGS. 2, 2A and 2B of the drawing specifically illustrates a preferred embodiment of the present invention, and the nozzle **20** comprises a suitable refractory cylindrical tubular section **21** having its extreme lower end closed and its upper end connected with a reservoir of molten metal, such as a conventional tundish (not shown) which has a conventional valve means for cutting off the flow of molten metal to the injection nozzle. Lateral discharge passages or openings **23**, **23A** and **23B** are provided adjacent

the closed lower end wall **22** of the nozzle **20** and comprise six cylindrical passages which have their midpoints lying in a common plane extending transversely of the nozzle **20** and which are equally spaced about the circumference of the nozzle (i.e. spaced 60° apart for use with a mold **24** having a length to width ratio of about 4.5 to 1) with the midpoint of each opening spaced axially about 2.5 inches from the lower end wall **22** of the nozzle **20**. Each of the discharge openings **23**, **23A** and **23B** has its axis inclined upwardly at an angle of about 10° from the horizontal plane when the nozzle **20** is operatively disposed in the mold **24** so that the axis of each of the discharge openings intersects the longitudinal axis of the nozzle **20** at a point below the midpoint of the discharge openings. It will thus be evident that the molten metal flowing from each of the openings **23**, **23A** and **23B** will form a stream having an upward inclination relative to the horizontal. The nozzle **20** is preferably immersed in the head of molten metal which is maintained within the upper end of the open ended continuous casting mold **24** so that the lateral discharge openings **23**, **23A** and **23B** are between about 3 and about 12 inches below the upper surface of the molten metal midway between the wide faces **26** and narrow end faces **27** with the axes of the openings **23A** and **23B** in a plane perpendicular to the planes of the wide mold faces **26** in the manner shown in FIG. **2B**. The openings **23A** and **23B** are of equal size and have about half the cross-sectional area of the remaining openings **23** so that the streams of molten metal which travel a greater distance have a larger cross-sectional area.

When the nozzle **20** having the larger openings **23** with a diameter of about 1.25 inches is used as shown in FIG. **2** in the continuous casting mold **24** with its narrow faces having a length of about 8 inches and the wide faces having a length of about 37 inches and operated to form a continuous casting **29** at a casting rate of 80 inches per minute, the molten metal flows from each of the openings **23** at a velocity of about 7 ft. per second. When the casting rate is reduced to 40 inches per minute, the molten metal flows from the discharge openings at a velocity of about 3.5 ft. per second. If it is assumed that the minimum acceptable casting rate in the above described apparatus and nozzle **20** is 20 inches per minute, the minimum acceptable velocity of the molten metal as it leaves the openings **23** will be not less than about 1 foot per second.

The flow pattern of the molten metal within the interior of the mold **24** and the casting **29** which is established by the nozzle **20** under the first specified operating conditions is best shown in FIGS. **2A** and **2B**, and the "standing wave" or "roll" (*w*) which surrounds the axial "trough" (*t*) is best shown in FIGS. **2** and **2A** of the drawing. The fluid flow pattern established in the molten metal within the mold **24** and casting **29** is generally similar to the idealized pattern shown in FIGS. **1**, **1A** and **1B**, and the objectionable inclusions commonly present in the mold are effectively concentrated on the surface of the molten metal in the axial "trough," so that inclusions which normally cause surface steelmaking defects are substantially eliminated, particularly from the wider lateral faces of the rectangular continuous casting.

The modified form of injection nozzle **30** shown in FIGS. **3** and **3A** of the drawing comprises a cylindrical tubular section **31**, of a suitable refractory material, having its lower end closed and its upper end connected with a conventional tundish (not shown) which is provided with a conventional valve means for controlling the flow of molten metal to the injection nozzle **30**. The lateral discharge passages or openings **33** comprise six equally spaced, equal diameter radially extending cylindrical passages. The axes of the openings **33** are disposed in a single plane extending transversely of the nozzle **30** and are spaced axially about 2.5 inches from the lower end wall of the nozzle **30**. In use, the nozzle **30** is preferably immersed in the molten metal within the upper end of the continuous casting mold **35** so that the lateral discharge openings **33** are about 2 to 6 inches below the surface of the metal and are directed toward the mold walls in the manner best shown in FIG. **3A**. Thus, the nozzle **30** is placed midway between the wide faces **36** and narrow faces **37** of the mold **35** with four of the openings **33** symmetrically and obliquely disposed with respect to the wide faces **36** and two of the openings **33** disposed with their axes perpendicular to the wide faces **36**.

The streams of molten metal flowing from the discharge openings **33** have a substantial upwardly flowing component, and the flow pattern established by the nozzle **30** is generally similar to the flow pattern described in connection with FIGS. **2**, **2A** and **2B**. The streams of flowing metal effect the desired removal of objectionable inclusions from the lateral surfaces of the casting, particularly from the wider faces of the casting. It has been found in practice that 90 percent of the aluminum killed steel continuously cast using nozzle **30** produces clean steel sheets having their wider surfaces smooth and free of objectionable inclusions (i.e. free of surface steel defects), whereas a typical bifurcated submerged injection nozzle yielded only 50 percent of the product free of objectionable inclusions, and the yield of product free of surface steel defects with a straight bore submerged injection nozzle was only 10 percent.

In the modified form of nozzle shown in FIG. **4** and FIG. **4A**, the cylindrical tubular injection nozzle **40** designed for use in a square casting mold is similar to nozzle **30** but is provided with four equally spaced circular discharge openings or passages **42** of equal size with the axes thereof lying in a single plane extending transversely of the nozzle **40**. In use the nozzle **40** is disposed within the square mold **43** with each of the discharge openings **42** directly facing the midpoint of a wall **44** of the mold **43** with the axis of each opening being perpendicular to the mold wall **44** adjacent thereto.

In the modified form of nozzle shown in FIGS. **5** and **5A**, the tubular nozzle **50** is similar to nozzle **30** but has a generally oblong or elliptical cross section and is provided with four oblong or generally elliptically shaped discharge openings **51** spaced symmetrically on opposite sides of the minor axis of the elliptical nozzle **50**. In use the nozzle **50** is positioned within the mold **55** with its minor axis pointing toward the midpoints of the wider sides **53** of the mold **55** so that none of the discharge openings **51** point directly toward the narrow sides **54** of the mold **55**.

In the modified form of nozzle shown in FIG. **6** and FIG. **6A**, the cylindrical tubular immersion nozzle **60** is similar to nozzle **30** but is provided with only two diametrically opposed symmetrical openings **62**, **62'** which have a shape which resembles a "bow tie" with the narrowest portion **63** being at the center thereof and the widest portions at the extreme ends thereof. In use, the nozzle **60** is disposed in the mold **65** with the openings **62**, **62'** directly facing the wider sides **66**, **66'** of the mold so that the streams flowing from the openings **62**, **62'** will cover substantially the entire wider sides **66**, **66'** of the mold or casting formed therein.

While the specific embodiments illustrating the present invention relate to the casting of steel, the invention can be used in the continuous casting of any metal or alloy, such as copper, brass, aluminum and magnesium.

We claim:

1. A tubular supply device for introducing molten metal below the surface of a pool of molten metal maintained in the upper end of a continuous casting mold having an elongated unitary refractory tubular lateral wall section defining a conduit for molten metal which has an upper end portion adapted to be connected to a source of molten metal and a lower end portion submergible in a said pool of molten metal and extend below the uppermost end of a solidifying continuous casting in said mold, said tubular section having the lower end thereof closed by an end wall and having as the only outlet for said molten metal supplied thereto a plurality of unobstructed discharge passages extending through said tubular section adjacent said lower end thereof with said passages being circumferentially spaced substantially less than 180° and having their midpoints at the outer ends thereof lying substantially in a single transverse plane through said tubular section, and said discharge passages having a cross-sectional area relative to

said tubular section and orientation in said tubular section which establish streams of molten metal flowing therefrom when said tubular section is connected with a molten metal supply container and maintained axially aligned within a pool of molten metal in the upper end of said continuous casting mold generally radially outwardly and upwardly at a rate of flow which causes said streams of molten metal to contact directly lateral portions of a solidifying continuous casting opposite said passages before intersecting the upper surface of said pool of molten metal and distribute said molten metal substantially uniformly over at least two oppositely disposed lateral portions of the casting comprising a major proportion of the circumference of said casting below the upper end thereof and having a major proportion of said molten metal of said streams flowing axially upwardly in wiping contact with said oppositely disposed lateral portions of the casting where said casting is initially solidifying and then flowing inwardly away from said casting at the surface of said pool to effect removal of objectionable inclusion material from the surface of said solidifying continuous casting before said inclusion material is frozen into the surface thereof.

2. A supply device as in claim 1, wherein at least two pairs of diametrically opposed said discharge passages are formed in said lateral section.

3. A supply device as in claim 1, wherein at least three pairs of diametrically oppositely disposed discharge passages are formed in said lateral wall section at about equally spaced intervals about the circumference of said tubular member.

4. A supply device as in claim 3, wherein at least one of said pairs of discharge passages has a cross-sectional area smaller than the cross-sectional area of the remaining said passages.

5. A supply device as in claim 1, wherein the cross-sectional area of the said outlet ends of said discharge passages varies inversely with the distance said outlet ends are spaced from the lateral surface of the said solidifying continuous casting.

6. A supply device as in claim 1, wherein said tubular member has at least two said discharge passages having a cross section whose width is greater than the height thereof.

7. A supply device as in claim 1, wherein the longitudinal axis of each of said discharge passages is inclined upwardly forming an acute angle with a transverse plane through said tubular member.

8. A supply device as in claim 6, wherein said angle is about 10°.

9. A continuous casting apparatus having in combination; an open ended continuous casting mold in which a continuous casting is formed and a molten metal supply device for said mold comprising a molten metal supply container having operatively associated therewith a depending elongated unitary refractory tubular member with a lateral wall section defining a conduit for molten metal which has the longitudinal axis thereof maintained axially aligned with said mold and having the upper end of said tubular member connected with said supply container and a lower end maintained within the upper end of said mold between oppositely disposed wall portions of said mold and adapted to be submerged in a pool of said molten metal in the upper end of said mold and extending below the upper end of a solidifying continuous casting in said mold, said tubular member having said lower end closed by an end wall and having as the only outlet for said molten metal supplied thereto a plurality of unobstructed discharge passages extending through said lateral wall section adjacent said lower end thereof with said passages circumferentially spaced substantially less than 180° and having their midpoints at the outer ends thereof lying substantially in a single transverse plane through said tubular member, and said tubular member and said discharge passages therein having a cross-sectional area and orientation relative to said wall portions of said mold which impart to streams of molten metal flowing therefrom a generally radially outwardly and upwardly flow at a rate of flow which causes said streams of molten metal to contact directly lateral portions of said continuous casting opposite said passages before intersecting the upper surface of said pool of molten metal and distribute said molten metal substantially uniformly over at least two oppositely disposed lateral portions of the solidifying casting comprising a major proportion of the circumference of said casting with a major proportion of said molten metal of said streams flowing axially upwardly in wiping contact with said oppositely disposed lateral portions of the casting where said casting is initially solidifying and then flowing inwardly away from said solidifying casting at the surface of said pool to effect removal of objectionable inclusion material from the surface of said casting before said inclusion material is frozen into the surface thereof.

10. A continuous casting apparatus as in claim 9, wherein said continuous casting mold is an elongated rectangular mold and said tubular member has six equally circumferentially spaced discharge passages with the longitudinal axis of each of said passages inclined upwardly relative to a transverse plane through said tubular member, and said tubular member with said discharge passages being symmetrically directionally oriented within said rectangular mold and discharging said molten metal in outwardly flowing streams through said discharge passages to effect substantially uniformly distributing said molten metal over the oppositely disposed wide faced of a solidifying continuous casting formed in said rectangular mold with a major proportion of said molten metal flowing upwardly in wiping contact with said wide faces and then flowing inwardly away from said wide faces effecting removal of objectionable inclusion material therefrom.