United States Patent

[11] 3,633,654

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[73] Assignee **United States Steel Corporation**

[54] **POURING NOZZLE FOR CONTINUOUS-CASTING MACHINE**
5 Claims, 7 Drawing Figs.

[52] **U.S. Cl.** **164/278,** 164/281, 222/566
[51] **Int. Cl.** **B22d 11/06**
[50] **Field of Search** 222/566, 567, 569; 239/595, 596, 601; 164/281, 278

[56] **References Cited**

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1,944,611 1/1934 Reinartz et al. 222/Foundry
2,826,793 3/1958 Flickinger, Sr. et al. 222/Foundry

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Assistant Examiner—David A. Scherbel
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ABSTRACT: A method and nozzle construction for pouring liquid metal into a receiver, the width of which is several times greater than the thickness, for example, a continuous slab-casting mold. The metal discharges from a vessel supported above the receiver as a fan-shaped stream broadened in the direction of the width of the receiver. As applied to casting slabs, the invention avoids localized high-temperature areas in the skin of a partially solidified casting as it emerges from the mold. The method and nozzle may also be used to advantage for pouring metal between the belts of a belt-type continuous-casting machine.

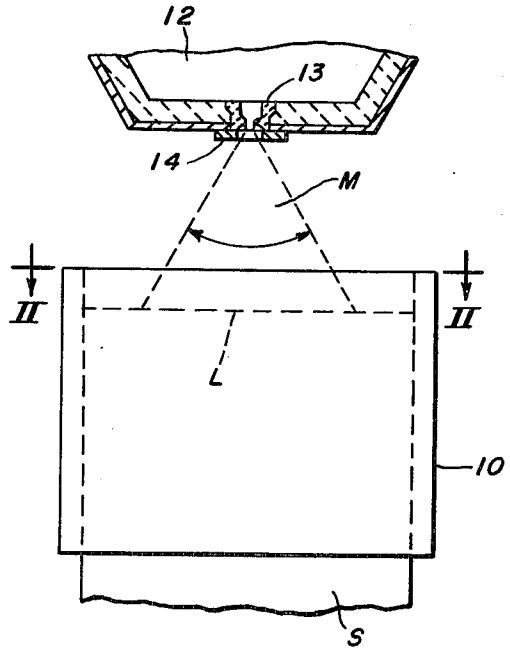

FIG. 1.

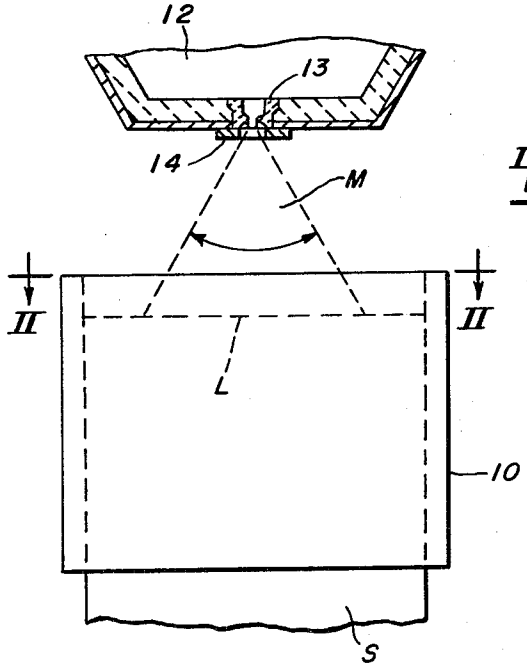

FIG. 3.

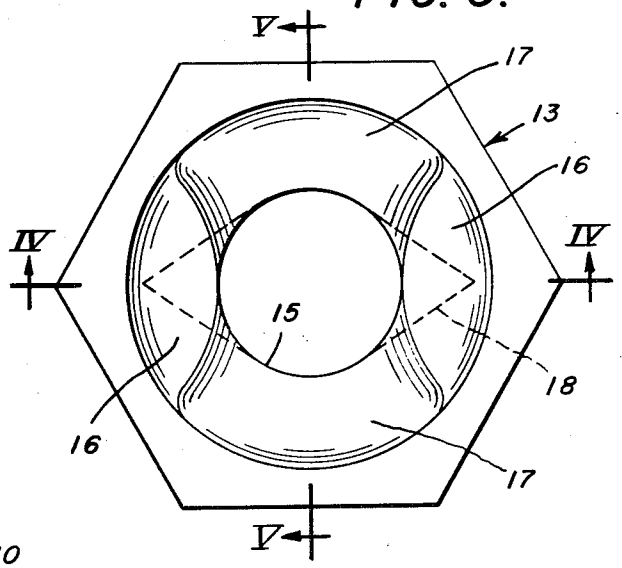

FIG. 2.

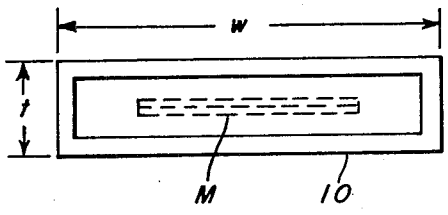

FIG. 4.

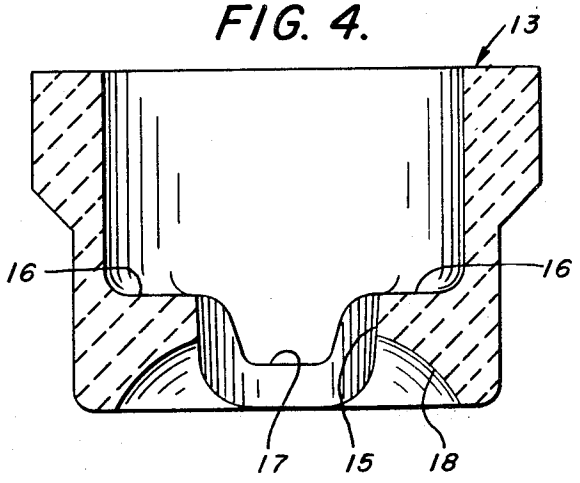

FIG. 5.

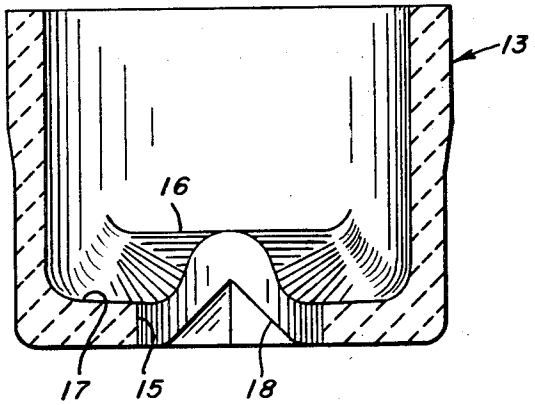

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FIG. 6.

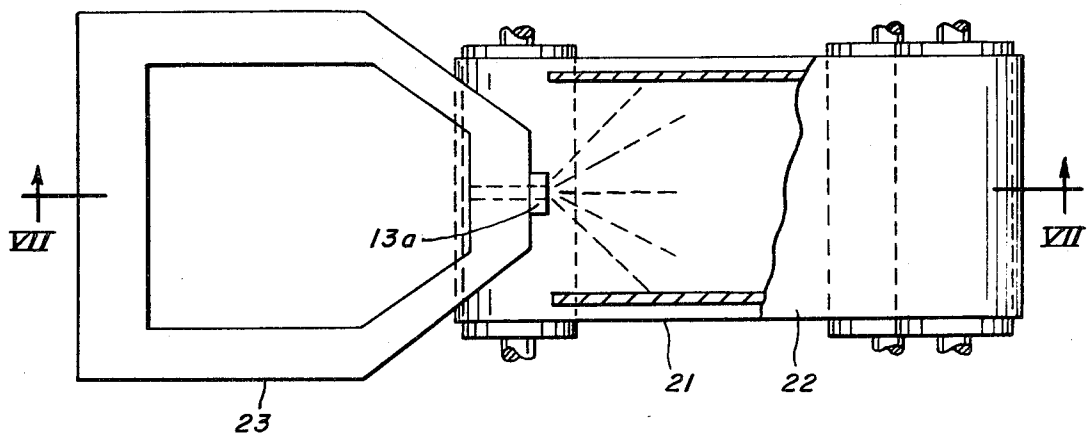
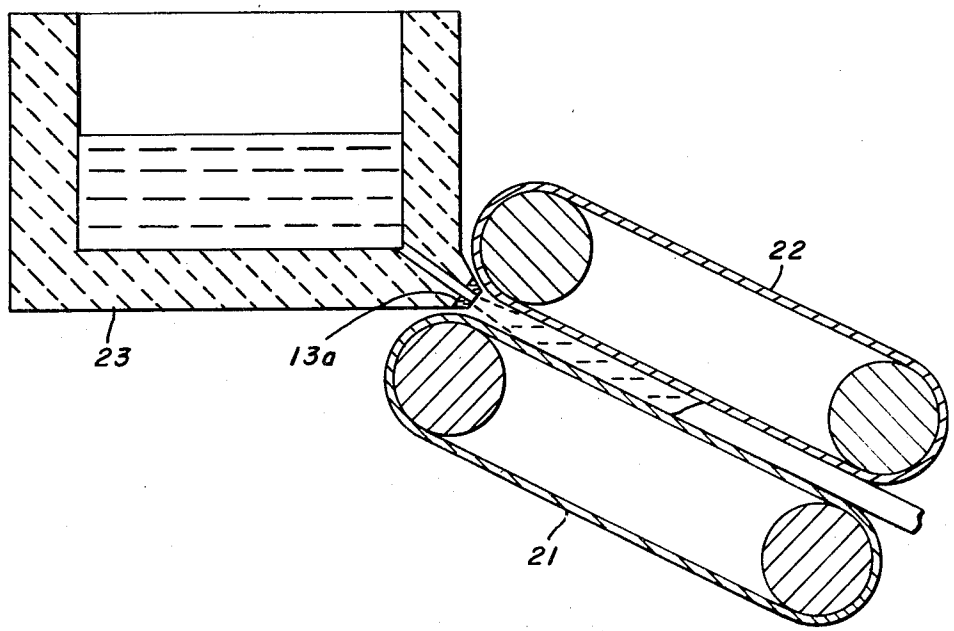


FIG. 7.



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POURING NOZZLE FOR CONTINUOUS-CASTING MACHINE

This invention relates to an improved method and nozzle construction for pouring liquid metal into a receiver.

Although our invention is not thus limited, our method and nozzle construction are particularly useful for pouring liquid steel from a tundish either into a continuous slab-casting mold or between the belts of a belt-type continuous-casting machine, such as that shown in Hazelett U.S. Pat. No. 2,904,860 and other patents to the same patentee. A typical continuously cast slab or strip has a width several times its thickness. Conventional practice in continuously casting slabs is to pour one or more relatively coherent streams or jets of steel generally of a circular cross section from a tundish into an open-ended mold of appropriate cross section. If there is only one stream, it is directed along the vertical centerline of the mold. If there are more than one, they are spaced across a vertical plane which bisects the two shorter sides of the mold. In either event the side faces of the casting have localized areas adjacent each stream where the temperature is greater than elsewhere. As the casting leaves the mold, only a thin skin at its outer surface has solidified; the core remains liquid for a considerable distance below the mold. This skin is easily ruptured, particularly along localized high-temperature areas adjacent the streams. When a breakout of liquid metal occurs, it is usually in one of these areas. When a strip is cast in a belt-type casting machine, there again is a problem in distributing the liquid metal across the width of the belts.

An object of our invention is to provide an improved pouring method and nozzle construction which distribute liquid metal more effectively across the width of a receiver, such as a mold or other casting machine, than previous methods or nozzle constructions.

A further object is to provide an improved pouring method and nozzle construction which produce a fan-shaped stream distributed across the major portion of the width of a mold or belt-type casting machine.

In the drawing

FIG. 1 is a partially diagrammatic side elevational view, partly in section, of a tundish and continuous slab-casting mold illustrating our pouring method;

FIG. 2 is a horizontal section on line II—II of FIG. 1;

FIG. 3 is a top plan view of our nozzle;

FIG. 4 is a vertical section on plane IV—IV of FIG. 3;

FIG. 5 is a vertical section on plane V—V of FIG. 3;

FIG. 6 is a diagrammatic horizontal sectional view of a tundish and belt-type continuous-casting machine illustrating our pouring method applied thereto; and

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

FIGS. 1 and 2 show diagrammatically a conventional open-ended mold **10** for continuously casting steel slabs S. The mold has a width *w* several times its thickness *t*. A conventional tundish **12** is supported over the mold and is equipped with a nozzle **13** constructed in accordance with our invention and preferably with a slidable gate **14** for controlling flow of metal through the nozzle. The mold usually is of copper and it may be equipped with the usual liquid-cooling system, oscillating mechanism, liquid level control, etc. The tundish may be equipped with any suitable mechanism for supporting and operating its gate **14**. We have not shown these parts, since they are not involved in the present invention.

The nozzle **13** discharges a relatively thin fan-shaped stream M of liquid metal into the mold **10**, where it reaches a level L. This stream is symmetrical with respect to planes which bisect the mold in the direction of its width *w* and its thickness *t*. The stream fans out in the direction of the former plane and at its lower end occupies the major portion of this plane. The partially solidified casting S emerges from the bottom of the mold.

FIGS. 3, 4 and 5 show nozzle **13** in detail. When the tundish **12** is positioned for pouring, nozzle **13** is oriented with plane IV—IV of FIG. 3 parallel with the width *w* of mold **10** and plane V—V parallel with the thickness *t*. The nozzle is a cup-shaped refractory body which has a relatively small circular pouring opening **15** in its bottom wall. The upper surface of the bottom wall has a pair of relatively high areas **16** at diametrically opposite sides of opening **15**, which areas are bisected by plane IV—IV. The upper surface of the bottom wall also has a pair of relatively low areas **17** at diametrically opposite sides of opening **15** between the high areas, which low areas are bisected by plane V—V. The under surface of the bottom wall has a recess **18** elongated beneath the high areas **15** and also bisected by plane IV—IV.

According to our pouring method, we support the tundish **12** over the mold **10** with the nozzle **13** oriented as already described. We open the gate **14** to pour liquid steel from the tundish into the mold. The configuration of the nozzle causes the stream issuing through its opening **15** to assume a fan shape broadened in the direction of the mold width *w*. The liquid metal is distributed across almost the full width of the mold, and there are are no localized high-temperature areas in the skin of the partially solidified casting S as it emerges from the mold. Thus the likelihood of breakouts or surface cracks is much diminished.

FIGS. 6 and 7 show our method and nozzle construction applied to pouring liquid metal between the belts **21** and **22** of a belt-type continuous-casting machine. The nozzle **13***a* is mounted in the lower transverse edge of a tiltable tundish **23** located to pour into the space between belts, the opposed faces of which travel continuously in a downward direction. The nozzle is of similar construction to that already described, and its action in producing a fan-shaped stream is similar. Such stream is distributed uniformly across the width of the belts. Tilting of the tundish controls the volume and direction of flow through the nozzle.

Although we have described our invention as applied to pouring metal from a tundish into a continuous slab-casting mold, or a belt-type continuous-casting machine, it may have other application for pouring liquid from any bottom pour vessel into any receiver which has a width substantially greater than its thickness.

We claim:

1. A nozzle comprising a cup-shaped refractory body having a circular pouring opening in its bottom wall, the upper surface of the bottom wall having a pair of relatively high areas at diametrically opposite sides of said opening and a pair of relatively low areas at diametrically opposite sides of said opening between said high areas, the under surface of the bottom wall having a recess elongated beneath said high areas, whereby liquid discharging through said opening forms a fan-shaped stream broadened in the direction of elongation of said recess.

2. A bottom pour vessel equipped with a nozzle constructed as defined in claim 1.

3. A vessel equipped with a nozzle constructed as defined in claim 1 located in a lower transverse edge thereof.

4. In combination, a continuous slab-casting mold having a width substantially greater than its thickness, a tundish supported over said mold, said tundish having in its bottom wall a nozzle constructed as defined in claim 1 oriented so that the fan-shaped stream discharging therefrom is symmetrical with respect to planes which bisect the mold in the direction of its width and its thickness and broadened in the direction of the first-named plane to distribute steel across the mold width, whereby localized high-temperature areas are avoided in the skin of a partially solidified casting emerging from said mold.

5. In combination, a belt-type continuous-casting machine which includes a pair of spaced-apart belts, opposed faces of which travel in a downward direction, and a tiltable tundish for pouring liquid metal into the space between said belts, said tundish having a nozzle constructed as defined in claim 1 in its lower edge adjacent the space between belts for discharging a fan-shaped stream of metal into said space, said stream being broadened in the direction of the width of the belts.

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