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BRANCHED TAPPING SPOUT

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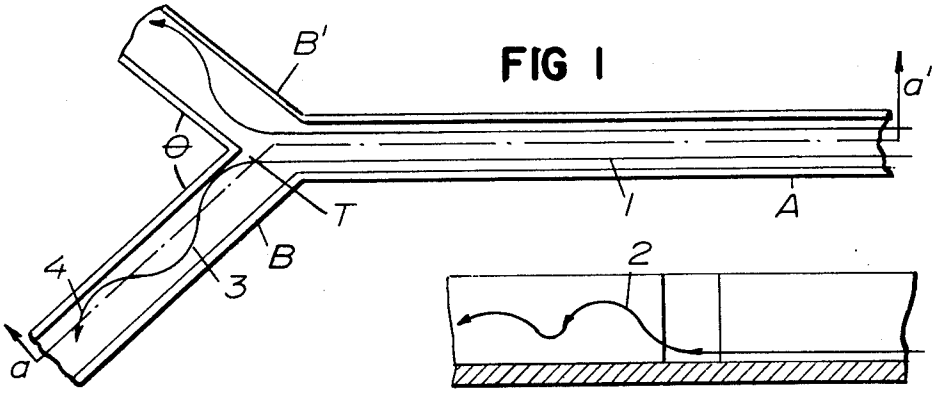


FIG 1

FIG 2

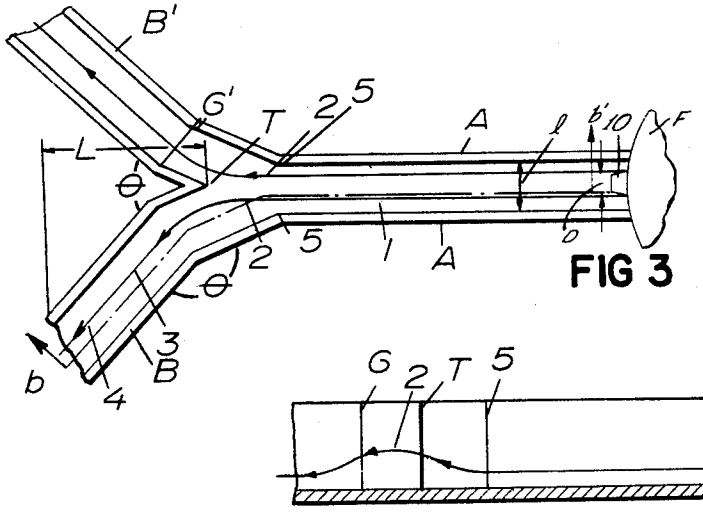


FIG 3

FIG 4

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BRANCHED TAPPING SPOUT

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This invention relates to a tapping spout. More particularly the present invention relates to a Y-branched tapping spout wherein the rise of a liquid steel on the wall is controlled and the flow of the liquid steel is smoothed.

The conventional tapping spout is a single spout. However, with the enlargement of furnaces, there has been a tendency to use a branched spout together with a plurality of ladles. The shape of such branched spout has casued difficult problems including the flow velocity of the liquid steel through the spout and the relative positions of the furnace and ladles. Specifically the control of the rise of the liquid steel on the wall of the spout branch and the smoothing of the liquid steel flow through the branched spout are problems important to safety measures.

The known branched spouts are merely branched in two directions forward. Therefore, in such a spout, the liquid steel flowing out of the tap will flow through the spout and will branch at the branching point. However, in such case, the liquid steel flow will rise high along the spout wall. Such rise will fluctuate depending chiefly on the flow velocity and the branching angle. According to experiments, if the diameter of the tap is D cm., the width of the spout is l cm., the flow velocity of the liquid steel is V cm./sec. and the branching angle is θ degrees, the height of the rise will be given as in the following formula:

$$h=7.3\times10^{-2}\sin^{3/2}\theta/2V\cdot D^{2/3}\cdot l^{-1/6}$$

Therefore, it is preferable that the branching angle should be as small as possible. However, in order to reduce the branching angle θ where the positions of the branched spout ends because of the arrangement of receivers or the ladles are fixed, the branching point will have to be moved toward the tap or the position of the ladle will have to be moved far away from the tap and then inefficiency will be unavoidable in the actual factory equipment.

Further, the streamline of the liquid steel flow after the branching will be in a direction depending on the size of the branching angle. Such streamline will be diverted by the branch wall and will come off the branch wall at an angle of about half the branching angle θ and will snake through the spout. Therefore, it is preferable that the shape of the branched spout will be curved outward in the direction of the reflected streamline so that the flow within the spout can be smoothed. In case the branching angle θ is reduced without using such a curve, there cannot be avoided the disadvantage that, in order to keep the spacing between the forward ends of the branched spout, the branches of the spout will have to be made very long and the liquid steel flow through the spout will flow off the branch wall at an angle of $\theta/2$ and will snake.

The present invention has as its object the solution of such problems as are mentioned above.

An object of the present invention is to smooth the liquid steel flow in the branched spout while keeping the spacing between the ladles and the fixed distance between the tap and the ladle.

Another object of the present invention is to reduce the rise of the liquid steel on the spout wall after the branching while keeping the spacing between the ladles and the fixed distance between the tap and the ladle.

Other objects of the present invention will be made clear in the following explanation and the accompanying drawings.

FIGURE 1 is a plan view of a conventional branched tapping spout and a liquid steel flow therein.

FIGURE 2 is a sectional view on line $a-a'$ in FIGURE 1.

FIGURE 3 is a plan view of a spout according to the present invention and a liquid steel flow therein.

FIGURE 4 is a sectional view on line $b-b'$ in FIGURE 3.

The known conventional branched spout shall be explained with reference to FIGURE 1.

In such spout, a liquid steel flowing out of a tap will flow through a spout A as indicated by the arrow **1** and will branch into branch spouts B and B' at a branching point T. In such case, the liquid steel flow will rise high along the spout wall as indicated by the arrow **2** in FIGURE 2. This rise is according to the above mentioned empirical formula.

The device according to the present invention shall be explained in the following with reference to FIGURES 3 and 4.

In FIGURE 3, a tapping spout having a main spout part A is branched into diverging branch spouts B and B' having first branch parts starting at points **5** and a branching point T and diverging at an angle θ. The branch spout B and B' have further diverged parts extending in the direction in which the liquid steel comes off the branch wall and starting at the points **6** and **6'**, respectively and diverging from the first branch parts at an angle $\theta/2$.

In this case, the branching point T of the tapping spout A is spaced from the end of spout part A a distance such that the tap opening operation is not interrupted. The maximum of the branching angle θ is 90 degrees, because, if it is larger than 90 degrees, the branch spout will be in the form of W and the liquid steel flow will turn and will not be proper.

The further diverged parts **6** and **6'** as shown in FIGURE 3 start near the point where the liquid steel flows off the spout branch wall as shown in FIGURE 1.

Said further diverged parts are at a position to receive the part of the wave form of the rise of the liquid steel flow in the branching part which flows off the wall of the branch spout such that this part of the wave flows substantially axially of the spout branch. That is to say, the distance X cm. from the branching point T to the highest point of the rise of the liquid steel flow as it flows against the wall of the branch spout.

$$X=4.2\times10^{-2}\cdot\sin^{1/2}\theta\cdot V\cdot D^{1/2}\cdot i^{1/6}$$

wherein θ is a branching angle, V is a flow velocity in cm./sec. of a liquid steel in the main spout part A, D is a diameter in cm. of a tap **10** of a furnace F for the like and l is a width in cm. of the main spout part. This is according to experiments and therefore the distance X can be determined by this empirical formula.

As the present invention is constructed as described above, even if the branching angle θ is reduced considerably, the proper spacing of the ladles can be maintained by the further diverging of the branch spouts B and B' and the distance L from the branching point T to the line between the ends of the branch spouts can be made short for economy in the use of the factory equipment. Further, by the reduction of the branching angle θ, the rise of the liquid steel on the spout wall in the branching part can be reduced as indicated by the arrow 2 in FIGURE 4 and the flow through the spout can be smoothed with a great effect.

Example

Interval between ladles	cm.	300
Branching angle	degrees	60
Distance between branching point and further diverged part	cm.	70
Diameter of tap	cm.	15
Effective width l of the main spout part	cm.	40

What we claim is:

1. A taping spout, comprising a main spout part, and diverging branch spouts each having a first branch part, the first branch parts of the respective branch spout diverging from each other at an angle θ, and having further diverged parts, said further diverged parts diverging from the respective first branch parts at an angle of $\theta/2$ and from a point along the length of the first branch parts such that liquid steel which flows against the side wall of the first branch parts will flow substantially longitudinally axially in the further diverged parts.

2. A tapping spout, comprising a main spout part, and diverging branch spouts each having a first branch part, the first branch parts of the respective branch spouts diverging from each other at an angle θ, and having further diverged parts, said further diverged parts diverging from the respective first branch parts at an angle $\theta/2$ and each having the central longitudinal axis thereof in substantial alignment with the point along the length of the sidewall of the respective first branch part at which the flow of liquid steel against the sidewall of the first branch reaches its highest point, said point being at a distance X_{cm} in centimeters from the point at which the sidewalls of first branch parts against which the liquid steel flows diverge, said distance X_{cm} being according to the formula

$$X_{cm}=4.2\times10^{-2}\cdot(\sin\tfrac{1}{2}\theta)\cdot V\cdot D^{\frac{1}{3}}\cdot l^{\frac{1}{3}}$$

wherein V is the flow velocity in cm./sec. of the liquid steel in the main spout part, D the diameter in cm. of a tap, and l the width in cm. of the main spout part.

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