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3,373,910

**STOPPER ROD WITH TEMPERATURE RESPONSIVE COOLING MEANS**

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**ABSTRACT OF THE DISCLOSURE**

A stopper rod consisting of relatively high conductivity material with a collant being applied to the top of the rod only to extract heat conducted through the rod from its lower end.

This invention relates to a stopper rod and particularly to a stopper rod for use in controlling flow of molten metal from a ladle. These rods are subject to great heat and hence must be able to withstand high temperatures. Rods made of metal have been cooled by circulating compressed air through the length of the rod, but if the hot metal breaks through to the air there is danger due to violent expansion of the air. The air cooling systems rely on annular gas passages that often become bent or closed off during normal operation. The initial cost and maintenance of such rods are excessively high. The air will pass through any refractory components that it contacts, this being undesirable metallurgically.

Hence, it is an object of my invention to provide a stopper rod which is inexpensive to make and maintain.

This and other objects will be evident from the following specification and attached drawings, in which:

FIGURE 1 is an elevation of the stopper rod of my invention installed in a ladle and also showing a schematic wiring diagram; and

FIGURE 2 is an elevation of another species of my invention with parts broken away and shown in section.

Referring now to FIGURE 1, reference numeral 1 indicates a ladle containing molten metal M and having an opening 2 in its bottom. A gooseneck 3 is attached to the ladle 1 and has a portion positioned over the top of the ladle. The parts so far described are conventional and may vary in detail. More details are shown on page 451 of the Sixth Edition of "The Making, Shaping and Treating of Steel" which is published by United States Steel Corporation. I provide a stopper rod 4 which has its upper end extending above the top of the ladle and its lower end extending into the ladle so as to close the opening 2. The rod 4 is made of a relatively high conductivity material. Steel, copper and graphite are suitable materials with copper and graphite being preferred for better conductivity. The rod 4 extends through an opening 5 in the gooseneck 3. The upper portion of the rod has threads 6 thereon with nuts 7 and 8 threaded thereon and bearing against the upper and lower sides of the gooseneck 3 to support the rod 4. A hollow chamber 9 surrounds the top of rod 4 and is secured thereto as shown. Any suitable type of stuffing box 9S may be used to prevent escape of water from the chamber 9. Cooling water is supplied to the chamber 9 through a flexible conduit 10 having a motor operated flow control valve 11 therein. Water passes from the chamber 9 through a flexible conduit 12. I prefer to provide a temperature responsive device, such as a thermocouple 14, in the lower part of the rod 4. For this purpose an axial hole may be provided in rod 4. The output of the thermocouple 14 is connected to a control 15 which operates a motor 16 connected to valve 11 so as to open and close it.

In operation, heat passes from the bottom to the top of rod 4 due to the difference in temperature. The water

in chamber 9 carries away the heat from the top of the rod, thus maintaining the difference in temperature and drawing heat from the remainder of the rod to keep its temperature sufficiently low to prevent damage thereto. When the thermocouple circuit is used the control 15 is set so that the valve 11 will be moved to a more open position when a predetermined temperature is reached and to a more closed position when a lower predetermined temperature is reached. Thus, the rod is maintained at a safe operating temperature with a minimum amount of cooling water. Other means may be provided for cooling the top of the rod. Also, the chamber 9 may surround the rod 4 below the gooseneck 3 rather than above it.

FIGURE 2 shows a composite rod consisting of a steel tube 20 having an axial opening 21 therethrough with a copper rod 22 extending through opening 21 in close contact with tube 20. This may be done by a shrink fit. The tube 20 is threaded at 23 for attachment to the gooseneck 3 by means of nuts 24 and the rod 22 is threaded at 25 for support of the chamber 9.

While I have described several species of my invention, it is apparent that other modifications may be made within the scope of the following claims.

I claim:

1. In combination with a ladle containing molten metal and having an opening in the bottom thereof, a stopper rod of relatively high conductivity material supported on said ladle, the bottom of said stopper rod being adapted to close said opening, the top end of said stopper rod extending above said ladle, means providing a coolant to the top end of the rod only, to extract heat conducted through said rod from the lower end thereof, a temperature responsive device in the lower portion of said stopper rod, and means operable by said temperature responsive device for controlling the flow of cooling fluid to said chamber.
2. The combination of claim 1 in which the means providing a coolant to the top end of the rod includes a hollow chamber surrounding the top end of said stopper rod, and means for delivering cooling fluid to said chamber around said rod.
3. The combination of claim 1 in which said stopper rod is made of a material of the class consisting of steel, copper and graphite.
4. The combination of claim 1 in which said stopper rod includes a steel tube having an axial opening therethrough, and a copper rod extending through said axial opening in close contact with said steel tube and its upper end extending above said steel tube.
5. The combination of claim 2 in which said stopper rod is made of a material of the class consisting of steel, copper and graphite.
6. The combination of claim 2 in which said stopper rod includes a steel tube having an axial opening therethrough, and a copper rod extending through said axial opening in close contact with said steel tube and its upper end extending above said steel tube.

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