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TAP HOLE MIX

Leroy C. Werking, Cleveland, Ohio, assignor to Union Carbide and Carbon Corporation, a corporation of New York

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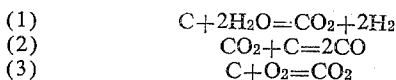
This invention relates to tap hole mixes to be used for closing ("plugging") the tap holes of blast furnaces and the like.

For the removal of molten metal from blast furnaces and the like a tap hole must be provided. This tap hole extends through the lining of the furnace into the hearth and communicates with a trough on the outside of the furnace for directing tapped, molten metal to a ladle or other receptacle. Between casts from the furnace the tap hole must of course be closed, and for closing it, it is conventional practice to extrude a mass of water wet clay from a "mud gun" into the hole. With such clay may be admixed crushed fire brick, coke or coal and the like to make the mix more porous. Such ceramic or carbonaceous materials may, of course, be present in the mix of the invention, and are referred to in the appended claims as fillers. The heat of the furnace causes the clay to set up, forming a refractory plug in the tap hole. When the time comes to tap the furnace this plug is partially drilled out, and conventionally is then subjected to the action of an oxygen lance to burn through into the furnace hearth or until the molten metal starts to flow from the furnace.

For many years carbon has been recommended as a lining material for blast furnaces, particularly in the hearth, and because of its excellent characteristics, its use for this purpose has become rather widespread. More recently, carbon has been used as a lining in the immediate vicinity of the tap hole as well as in other portions of the furnace, but here some difficulty has been encountered in that there is a loss of carbon in the vicinity of the tap hole during use of the furnace. This loss of carbon manifests itself by a gradual thinning of the lining and the formation of a funnel-shaped depression in the zone surrounding the tap hole. If unchecked, such carbon loss would lead to a "run-out," that is, accidental discharge of molten metal from the furnace.

It is the principal object of this invention to prevent this destruction of the carbon lining. More specifically, it is an object of the invention to provide a novel tap hole mix for plugging the tap holes of blast furnaces and the like.

The invention by means of which this object is attained is based on the discovery that the destruction of carbon in the vicinity of the tap hole is attributable in part to reaction between steam evolved from the wet clay used to plug the tap hole and the carbon and in part to reaction of oxygen from the oxygen lance with the carbon. Such reactions are exemplified by the following equations:



In accordance with the present invention Reactions 1 and 2 are substantially prevented from taking place by utilizing a tap hole mix which is substantially free of

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water, and the detrimental effect of Reaction 3 is substantially avoided by the deposition of carbon from the novel tap hole mix used.

The invention comprises a tap hole mix consisting of at least one comminuted solid such as milled clay, crushed fire brick, coke or coal, clay being preferred, and a carbonaceous thermosetting, carbonizable binder. The binder is composed of resin-forming organic material such as a phenol-aldehyde composition or a mixture of tar and aldehyde such as furfural so compounded as to be thermosetting. Preferably the binder is a material which will remain plastic at room temperature for an indefinite time but which hardens quickly at temperatures of about 400° F. Such a mixture is extrudable from a conventional mud gun, hardens almost instantaneously in the zone of a tap hole close to the furnace hearth and less quickly in the zone farther removed from the furnace hearth. An essential characteristic of the mix of the invention is substantial freedom from water, and another essential property is that it be thermosetting.

In the tap hole mix of the invention the proportion of a solid to binder should be about 3 to 1 to 5 to 1, varying between these extremes to suit the desires of the operator. Typically, a tap hole mix according to the invention may contain by weight about 80% solids, preferably milled clay, and 20% binder, although as in conventional practice, the clay may be admixed with crushed fire brick, coke or coal as filler materials. As above indicated such binder may be an anhydrous heat-hardenable "A" stage phenol-aldehyde reaction product. Such binder may include a conventional acid or alkaline catalyst. A preferred tap hole mix is composed of milled clay and a binder consisting of tar, furfural and an accelerator such as sulfur. Typically such a composition contains 80% to 82% of comminuted solid material, 11% to 12% tar, 5% to 6% furfural and 1% to 2% sulfur. A specific example of this type of mix contains by weight, 81% milled clay, 11.7% tar, 5.8% furfural and 1.5% sulfur. This mix will remain completely plastic at room temperature for several weeks but will become hard and infusible in two hours at 400° F. At the temperature existing in the hot zones of a tap hole it will set almost instantaneously.

Tests of the tap hole mix of the invention have been made on full-size iron blast furnaces using a mix of the specific composition just given. The mix was prepared during the course of these tests by mixing milled clay with the binder, the binder having been previously prepared. The mix was readily extruded from the mud gun and was successfully used to plug the tap hole, hardening quickly in place. In one series of tests the tap hole was plugged twelve times with this mix over a period of about 52 hours. In each case the tap hole was successfully plugged, and the mix hardened satisfactorily. When the hole was drilled out to tap the furnace it was apparent that the plug formed with the tap hole mix of the invention was more refractory than a conventional plug formed from a clay-water mix, for the drilled hole was not enlarged by erosion caused by the flow of molten iron.

Since the tap hole mix of the invention is substantially free of water, its use has no detrimental effect on the carbon lining of the furnace in the vicinity of the tap hole. Further, it has the property of depositing carbon when the volatile materials of the binder are decomposed by the heat of the furnace, and thus tends to build up a deposit of carbon adjacent the tap hole.

What is claimed is:

1. A substantially water-free, extrudable, thermosetting tap hole mix for blast furnaces and the like consisting of at least one comminuted solid selected from

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the group consisting of clay, fire brick, coal and coke and a binder comprising tar and furfural, in a proportion by weight of about 2 parts tar to 1 part furfural said solid being present in a proportion about 3 to 5 times by weight the proportion of binder.

2. A substantially water-free, extrudable, thermosetting tap hole mix for blast furnaces and the like consisting of comminuted clay and a binder comprising tar and furfural, in a proportion by weight of about 2 parts tar to 1 part furfural said clay being present in a proportion about 3 to 5 times by weight the proportion of binder.

3. An extrudable, thermosetting tap hole mix for blast furnaces and the like consisting by weight of 80% to 82% of at least one comminuted solid selected from the group consisting of clay, fire brick, coal and coke; 11% to 12% tar; 5% to 6% furfural and 1% to 2% sulfur.

4. A substantially water-free extrudable thermosetting tap hole mix for blast furnaces and the like consisting of a comminuted solid refractory filler and

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a binder of an anhydrous heat hardenable phenol aldehyde reaction product, said binder being present in a proportion about $\frac{1}{3}$ to $\frac{1}{5}$ by weight of said comminuted filler.

5. A substantially water-free extrudable thermosetting tap hole mix for blast furnaces and the like, consisting of a comminuted ceramic filler, a comminuted carbonaceous filler and a binder, comprising tar and furfural, in a proportion by weight of about 2 parts to 1 part of furfural, said fillers being present in a proportion of about 3 to 5 times by weight the proportion of binder.

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