Oct. 20, 1953 F. C. McGOUGH 2,656,172

METHOD OF OPERATING SOAKING PITS

Filed Nov. 29, 1949 3 Sheets-Sheet 1

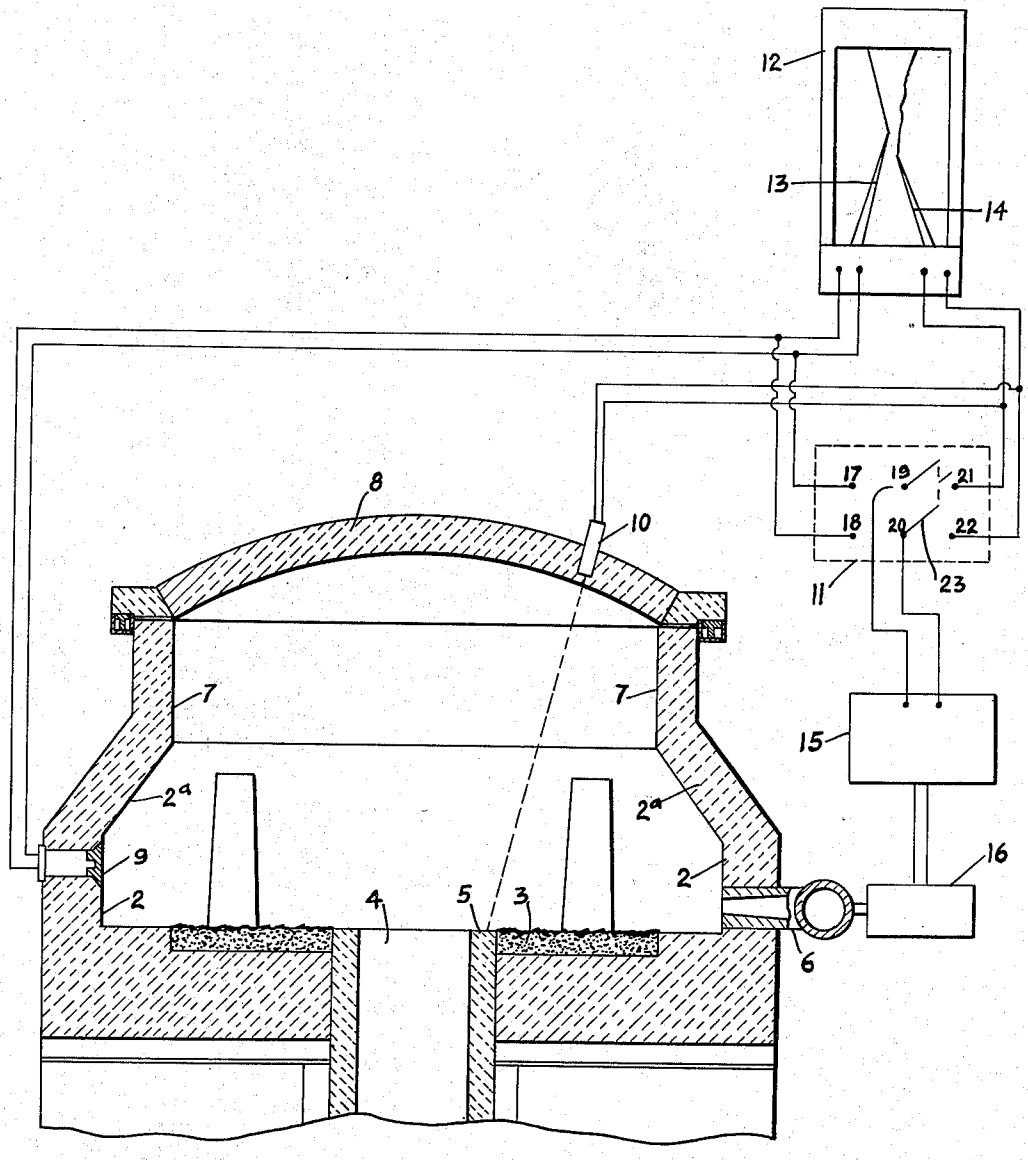


Fig. 1.

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Filed Nov. 29, 1949 3 Sheets-Sheet 2

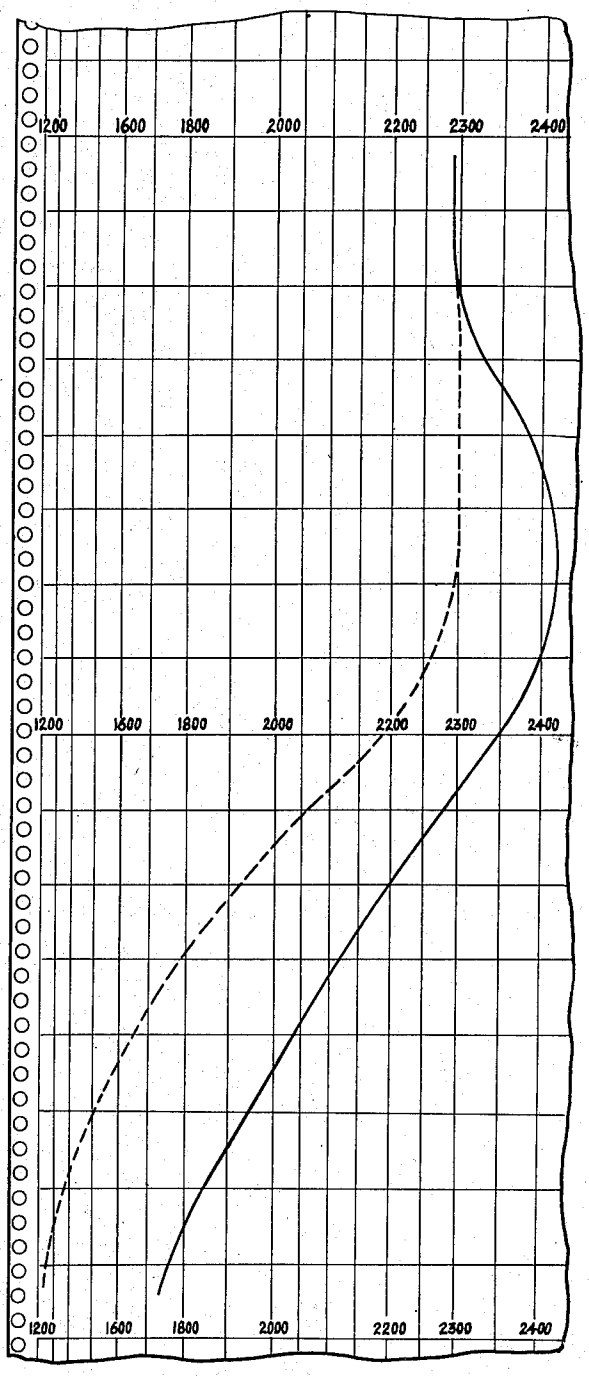


Fig. 2.

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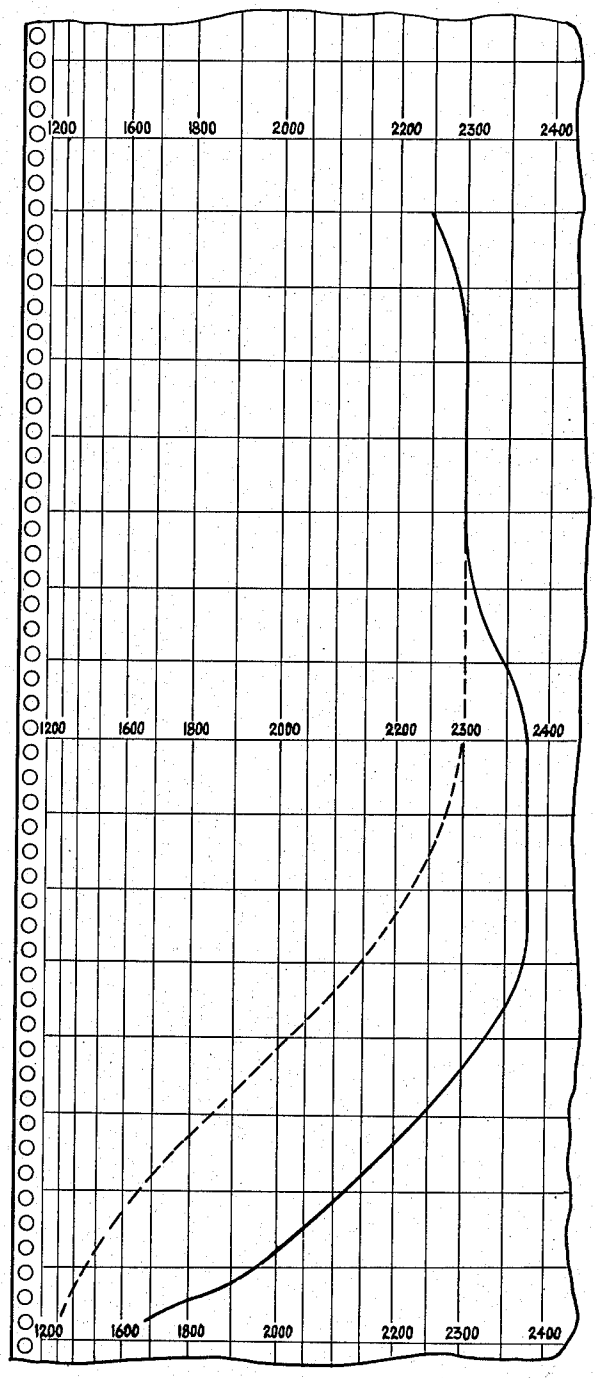


Fig. 3.

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Patented Oct. 20, 1953

2,656,172

UNITED STATES PATENT OFFICE

2,656,172

METHOD OF OPERATING SOAKING PITS

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Application November 29, 1949, Serial No. 129,910

3 Claims. (Cl. 263—52)

1

This invention pertains to soaking pits utilized in heating metal ingots to bring them up to a rolling temperature, and to a method of operating the same, and more particularly to an improved method over that disclosed in my joint application with Branko M. Putich filed December 10, 1947, Serial No. 790,884.

In the rolling of steel, the ingots, prior to being rolled, are placed in a heating furnace known in the industry as a "soaking pit." The soaking pit is an enclosed refractory-lined structure having a movable cover. It is usually circular and the ingots are stood on end in a circular pattern on the floor of the soaking pit. Generally there is a central opening in the floor through which the hot gases of combustion are carried away from the soaking pit chamber, while burners, usually gas burners, are provided at one or more points around the side wall. The soaking pit has a movable cover so as to permit ingots to be charged into the furnace and removed from it.

In the operation of the furnace after the ingots are charged into the furnace, the cover is moved into place and the burners are operated to supply full heat to the furnace. In conventional practice the heat is supplied to the full capacity of the burners and the outside surfaces of the ingots are more or less quickly brought up to a satisfactory rolling temperature, but thereafter heat must be applied at a lower rate which will bring the center sections of the ingots up to rolling temperature without excessively overheating the surface of the ingots. This sustained heating, during which the interior of the ingots are brought up to rolling temperature, is referred to in the art as "soaking."

It is the common practice in the art at the present time to control the heat supplied to the soaking pit by means of a heat responsive unit, such as a pyrometer, located in the side wall of the soaking pit. The outer surface of the ingot and the interior wall of the soaking pit approach the rolling temperature at about the same rate. However, after the outer surface of the ingots has reached rolling temperature, it is difficult to know how long to retain the ingots in the soaking pit before they are ready to be rolled. At the present time this is determined largely on the basis of experience and on the basis of the skill of the operator in charge.

In my aforesaid joint application with Branko M. Putich, we have disclosed our discovery that the ingots are in a proper rolling condition when the temperature registered at the point where the gases are leaving the soaking pit coincides with the side wall temperature of the soaking pit. We have further disclosed a method wherein the rate of combustion is controlled according to the increase in the side wall temperature. That is, the rate of combustion is high until the side

2

walls of the soaking pit, and hence the skin surfaces of the ingots, reach the rolling temperature, and then the rate of combustion is reduced to avoid any temperature rise above the rolling temperature.

This method is especially useful for so-called alloy steels where any overheating is to be avoided, but with ordinary carbon steels, the side wall temperature may rise above the rolling temperature a few hundred degrees without detriment to the steel, and the method described in our said application restricts the capacity of the soaking pit for operations with carbon steel because it does not allow advantage to be taken of the fact that heating above rolling temperature is not detrimental, since with the method disclosed in said application the high rate of combustion is reduced in time to prevent overheating of the surface of the metal.

The object of the present invention is to provide for the more effective operation of the soaking pit with carbon steels and other metals which may be heated without damage above the rolling temperature, and at the same time provide a definite program of operation wherein advantage is taken of the fact that the metal is ready for rolling as soon as the temperature at the part for the outgoing gases reaches the predetermined side wall temperature.

The invention has for a further object to provide greater flexibility in the operation of the soaking pit. These and other objects are obtained by my invention.

In accordance with the present invention, the operation of the burners is controlled according to or by the operation of the heat responsive means for measuring the temperature at the spent gas outlet part of the soaking pit. The high rate of combustion is maintained until the outlet port temperature is the same as the rolling temperature, which means that the side wall temperature of the pit, and the skin surfaces of the ingots, will be a few hundred degrees above the rolling temperature, but because of the higher rate of combustion, the heating up and soaking time is reduced. When the temperature at the gas outlet port of the pit reaches rolling temperature, the rate of combustion is reduced until the side walls cool down to the rolling temperature, but at a rate such that the outlet port remains at the rolling temperature. When the side walls have cooled down to coincide with the temperature at the outlet port, the ingots are ready for rolling.

Using the spent gas outlet port temperature responsive means to control combustion entirely may result in the side wall temperature and the skin temperature of the ingots being heated too high above the rolling temperature and to a detrimental extent. To avoid this, the method may

be modified to initially use the side wall temperature to control the rate of combustion and thereby limit the side wall temperature to a predetermined level a few hundred degrees above rolling temperature until the temperature at the gas outlet port equals the desired rolling temperature. Then the control is switched from the side wall temperature recorder to the outlet port temperature recorder to keep the temperature at the outlet port from rising above or dropping below the rolling temperature. This will require a lower rate of combustion, and the side wall temperature will gradually drop. When the side wall temperature equals the outlet port or rolling temperature, the ingots will be ready for rolling.

This invention may be more fully understood by reference to the accompanying drawings, in which:

Fig. 1 is a more or less schematic view through a soaking pit equipped for the practice of the invention and showing the transfer switch and recorder and controller;

Fig. 2 is a typical graph traced by the recorder on a common chart with the outlet flue gas controlling throughout the operation, the solid line being the line traced by the pyrometer in the side wall of the soaking pit, and the dotted line being the one traced by the pyrometer responding to the temperature of the effluent gases; and

Fig. 3 is a typical graph traced by the recorder on a common chart, the solid line being the sidewall temperature and the dotted line being the effluent gas temperature. In this graph the sidewall temperature initially controlled the operation until the effluent gas temperature reached the rolling temperature of the metal, then the remainder of the operation was controlled by the temperature of the outlet flue gas.

In the drawings, 2 designates the side wall of a conventional soaking pit having a floor 3 with a central opening 4 providing an outlet for the gases of combustion. Around the opening is a refractory wall or curb 5. A burner opening is indicated at 6, and there are usually a plurality of these burners. Above the side walls 2 the pit slopes inwardly as indicated at 2*a*, and there is an upper portion 7 providing a seat for a removable cover 8. The cover usually slides in a horizontal plane into and out of position over the pit. The ingots are placed end up on the floor 3 as indicated.

At a suitable location in the side wall 2 of the furnace is a temperature responsive means such as a pyrometer 9, similar to the one now commonly used in soaking pits. It responds to the temperature of the space between the ingot and the side wall of the soaking pit. It is connected to terminals 17 and 18 on the transfer switch 11, which may be of the double pole double throw type; and when terminals 17 and 18 are joined with 19 and 20 respectively, then it is connected to actuate the temperature controller 15 and burner regulator 16. The pyrometer is also connected in parallel with the transfer switch to the proper terminals on the recorder 12 so as to operate the sidewall temperature recording arm 13.

The recording instrument 12 is provided with a second arm 13 which records on the same record sheet. The arm 14 is actuated by means responsive to the temperature of the space in the vicinity of gas outlet opening 4 at the center of the soaking pit. Hence it responds more or less directly to the temperature of the effluent gases. This means conveniently comprises a radiation pyrometer 10 on the roof 8 of the soaking pit so set as to focus against or respond to the temperatures at the top of the refractory curb or outlet 5. It is connected by the proper terminals on the recorder and also to terminals 21 and 22 on the transfer switch 11 which is in parallel with the recorder. When terminals 21 and 22 are closed with terminals 19 and 20 by the switch, then it is connected to actuate the temperature controller 15 and burner regulator 16.

There are two closely related methods of operating the soaking pit. The first involves controlling the rate of combustion by the temperature of the outgoing gases solely. The second method involves controlling initially by the side wall temperature, and then completing the operation by outlet gas control temperature.

The first method requires that the transfer switch be set so that the temperature of the outlet gas controls and the temperature of the sidewall only records. Terminals 21 and 22 are connected with 19 and 20 respectively by the switch completing the circuit, whereby the outlet temperature actuates the controller 15 and regulator 16. In this position the outlet gas temperature is recorded and controls the operation, while the side wall circuit to the controller is broken and the sidewall temperature is recorded only.

The soaking pit is charged and fired as usual, the initial firing rate being at the full rate, until such time as the pyrometer 10 indicates that the outgoing gases have reached the rolling temperature. In the meantime the sidewall temperature is much higher than the rolling temperature. When rolling temperature is reached on the outgoing gases, the rate of combustion is reduced and this temperature at the outlet port is maintained constant at the rolling temperature by the control. Due to the reduced rate of combustion, the temperature recording for the side wall will gradually drop. When the side wall temperature equals the outlet port temperature, which is the rolling temperature, then the steel is ready for rolling.

In Fig. 2 we have shown a typical chart such as is produced by the recording instrument. The solid line traced by the arm 13 which indicates sidewall temperature shows a rapid increase in temperature to above the rolling temperature of the metal. The dotted line traced by arm 14, which represents the outgoing gas temperature, rises at a slower rate to the predetermined control level and is maintained. From the time the dotted line reaches the rolling temperature, the solid line temperature gradually falls; and when it coincides with the dotted line, the metal is properly soaked and ready for rolling.

In the second method, terminals 17 and 18 are connected to 19 and 20 respectively, so that the sidewall temperature is recorded and operates the control point and the outgoing gas temperature only records. Control is set so that the sidewall temperature is limited to the maximum furnace temperature allowed, which is above the rolling temperature and is determined by the maximum temperature to which either steel or furnace, or both, may be safely subjected.

The soaking pit is charged and fired as usual, the initial firing rate being at the full rate, until such time as pyrometer 9 indicates that maximum allowable temperature has been reached. This temperature is higher than the desired rolling temperature. This temperature is held constant by the control and the firing rate is automatically reduced. When the outgoing gas temperature, which has been rising at a slower rate during this

time, reaches the rolling temperature, then control is either manually or automatically transferred by means of the selector 23 on the transfer switch so that the outgoing gas temperature, which is set to control at rolling temperature, controls. In this position, terminals 21 and 22 are connected to 19 and 20, so that the outgoing gas temperature is in control and the sidewall only records. The outgoing gas is maintained at rolling temperature, while the reduced heating causes the sidewall temperature to drop. When the two coincide, then the metal is soaked and ready.

In Fig. 3 I have shown a typical chart such as is produced by the recording instrument. The solid line traced by arm 13 which indicates sidewall temperature, shows a rapid increase in temperature to the predetermined maximum allowable. At this point it is leveled off by the control and maintained at the predetermined maximum temperature. When the dotted line indicating outgoing gas reaches the rolling temperature and control has been shifted to maintain this temperature, then it is leveled out and forms a straight path. The sidewall temperature, due to reduced firing, then commences to drop; and when the two coincide, the metal is soaked and ready for rolling.

This invention, which arises from the discovery that only when the ingots are properly soaked will the temperature of the outgoing gases substantially coincide with the temperature of the ingot, provides an absolute indication to the operator, showing positively when the ingots may be withdrawn. This principle utilized in the method of heating the outside of the ingots above the rolling temperature and allowing the thermal head above the rolling temperature of the steel to dissipate heat to the center until they are both at the proper temperature, is an improvement in operation, in that it shortens the time required for soaking carbon steels while providing a definite cycle which the operator may rely upon.

This invention may be installed on soaking pits of various designs and construction, the one illustrated being merely one typical form of soaking pit. The advantages are increased tonnage, reduced fuel cost, reduced scale loss, reduced conditioning cost after rolling, less maintenance of furnace bottom, control over metal and furnace temperatures at all times, and the impartation of superior working qualities to the metal by the rapid heating and immediate rolling when soaked. It also removes the elements of skill and experience of the operator and enables a novice to secure proper performance.

While I have shown and described one specific form of my invention, and that it is applicable to soaking pits of various shapes, including those wherein the combustion gases leave the chamber through a point located elsewhere than in the bottom, it will be understood that I have described one typical embodiment and that various changes and modifications may be made in the invention within the contemplation of my invention and under the scope of the following claims.

I claim:

1. The method of operating a soaking pit having side wall peripheral burners and a sidewall temperature recording means and also having an outlet port for spent gases with an outlet recording means, and a fuel supply for combustion control arranged to be operated in accordance with the side wall temperature or the exhaust gas outlet temperature which comprises controlling the fuel input by the temperature of the side wall and reducing the rate of fuel input only when the temperature of the effluent gases reaches a predetermined rolling temperature while the side wall temperature of the pit is brought to a temperature above the rolling temperature, thereafter, when the temperature of the effluent gases reaches rolling temperature, decreasing the rate of fuel input to hold the temperature of the effluent gases at the rolling temperature whereby the side wall temperature diminishes, and continuing the operation with the effluent gases equaling the rolling temperature until the side wall temperature also equals such rolling temperature.

2. The method of operating a soaking pit having side wall peripheral burners and a sidewall temperature recording means and also having an outlet port for spent gases with an outlet temperature recording means, and a fuel supply for combustion control arranged to be operated in accordance with the side wall temperature or the exhaust gas outlet temperature, which comprises controlling the rate of combustion as the temperature of the side wall increases and until the temperature of the side wall rises above the rolling temperature of the steel, but limiting the same to a maximum furnace temperature several hundred degrees above the rolling temperature; and when the temperature of the outlet gases reaches the rolling temperature of the steel, then controlling the rate of combustion by the outlet gas temperature to maintain said outlet temperature constant at the rolling temperature, continuing the operation until the temperature of the side wall drops and coincides with the outlet gas temperature.

3. A method of operating a soaking pit having side wall peripheral burners in the lower portion of the side wall, a side wall temperature recording means and an outlet port for exhaust combustion products with an outlet temperature recording means which comprises operating the burners at a high rate of combustion under control of the side wall temperature until the exhausting combustion products' temperature reaches a desired ingot rolling temperature while holding the wall temperature to a maximum of several hundred degrees above the ingot rolling temperature, then with a continuing gradual reduction in fuel combustion rate while under the control of the temperature of the exhaust combustion products and while maintaining the exhaust gas outlet temperature at the ingot rolling temperature until the wall temperature coincides with the exhaust gas outlet temperature.

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