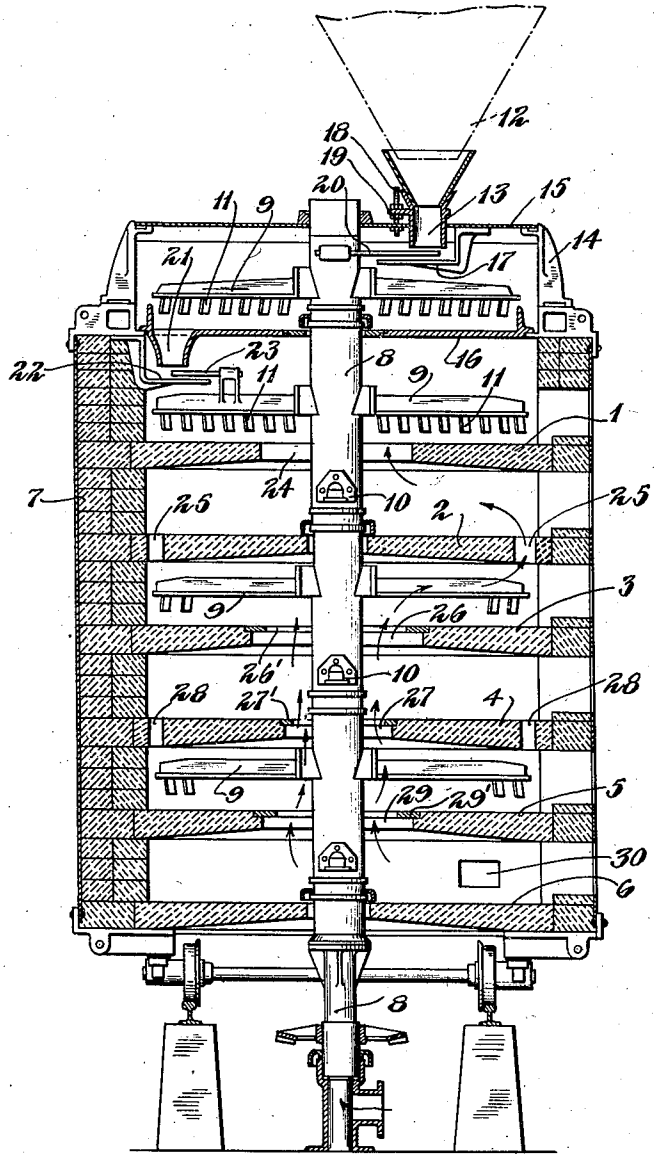
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FURNACE CONSTRUCTION AND OPERATION

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FURNACE CONSTRUCTION AND OPERATION.

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This invention relates to furnaces and particularly to multiple hearth roasting furnaces, an example of which is shown in U. S. Letters Patent No. 976,175 to John B. F. Herreshoff, dated November 22, 1910.

In furnaces of this type, there is often a large amount of dust exhausted with the gases therefrom, especially when dry, finely divided materials are under treatment. When the process and novel form of construction comprising this invention are utilized, the blowing and exhaust of dust is greatly reduced and at the same time, regardless of the type of material to be treated, means are provided whereby temperature conditions within the furnace may be readily controlled to give the furnace efficient and economical operative characteristics.

Various specific objects, features and advantages will more clearly appear from the detailed description given below taken in connection with the accompanying drawing which forms a part of this specification.

In the drawing, the figure illustrates in central vertical section a furnace embodying the invention.

In the furnace, as shown, a plurality of vertically spaced or superposed circular hearths are designated by the numerals 1 to 6 inclusive. These hearths are surrounded and supported in the usual manner by a cylindrical masonry furnace wall 7. The furnace wall in turn may be supported in any suitable well-known manner. The usual rotatable and internally cooled shaft extends vertically up through the furnace substantially along the central axis thereof and is here designated by the numeral 8. This shaft is provided with a series of rabble arms as at 9 and 10 extending radially from the shaft into the space between succeeding hearths. Suitable rabble teeth 11 are provided on the rabble arms for advancing the material being treated successively over each of the hearths. A hopper is indicated at 12 for discharging the material to be treated into the furnace through an ore-luted feeding device 13. As shown in the drawing, the top of the furnace may be surmounted by a support 14 and cross member 15. The material entering the furnace through the feeding device 13 falls upon a delivery bed 16 where it is given a preliminary heating and is effectively dried.

The feeding device 13 may comprise a feed shelf 17 supported from the cross member 15 and upon which the material from the hopper falls and rests in a conical pile with a predetermined "angle of repose" depending upon the character of the material. The dimensions of this pile of material may be regulated by elevating or lowering an adjustable spout 18 which depends from the hopper 12 and the position of which is controlled by an adjustable supporting bolt and nut as indicated at 19. A rake or delivery arm 20 is secured to the rotating shaft 8 and is designed to engage the pile of ore or other material on the shelf 17, thereby delivering to the bed 16 once during each revolution of the shaft, as is well understood in the art, a predetermined quantity of material, depending upon the elevational adjustment of the spout 18 and upon the length of the arm 20 which may also be adjustable. The material which falls upon the delivery bed 16 is gradually advanced to a hopper 21 extending down from the delivery bed, such advancement of the material being effected by one of the rabble arms 9 provided with teeth 11, which are positioned at an angle to deflect the material outwardly from the center of the delivery bed toward the hopper 21. The hopper 21 forms a part of another ore-luted feeding device, comprising a shelf 22 and delivery arm or rake 23, which cooperate with the hopper in a manner similar to the operation of the feeding device 13, as above described.

The material being treated falls from the shelf 22 and passes down through the furnace over the successive superposed hearths in the usual manner, alternate hearths being provided respectively with central and peripheral discharge openings so that the ore or other material is gradually advanced inwardly of one hearth toward the central opening and outwardly over the next hearth toward the peripheral openings. For example, in the furnace shown in the drawing, hearth No. 1 is provided with an annular space 24 aronud the central shaft, which space comprises the central opening. The rabble teeth over this hearth are directed at an angle for advancing the material toward such opening and away from the point where it falls from the shelf 22 near the periphery of the hearth. Hearth No. 2 is provided with one or more peripheral openings as at 25 and the rabble teeth which cooperate with this

hearth are arranged at an angle for deflecting the material outwardly of the hearth where it is made to fall through the openings 25.

In the well-known form of furnace of this general type, while the material is passed downwardly through the furnace, oxidizing gas such as heated air is made to follow the same path, either in the same direction or in the opposite direction upwardly through the furnace. For certain purposes, this method of operating the furnace is subject to disadvantages. For example, if kieselguhr or other material which becomes dried and finely divided, is treated in the furnace, a great quantity of dust arising from the agitated material will be carried along with the rapidly flowing stream of gas and exhausted from the furnace with the gas, thus resulting in a considerable loss of the material under treatment. A substantial percentage of the dust is caused to be placed in suspension by the stream of gas by reason of the fact that the gases are driven through the same hearth openings through which the roasted material passes. This is particularly noticeable at the lowermost hearths where the material has become very dry and finely divided.

Furthermore, where the material being treated is passed downwardly through the funace over the various hearths and the heated gases are passed in the same or opposite direction over the same path, it is often found difficult to properly control temperature conditions within the furnace. For example, in the upper part of the furnace, where the material to be treated has just been introduced, comparatively low temperatures will often prevail not only because of the cold material being introduced, but because the upper hearths will be at a greater distance from the source of heat, when the heated gas is admitted from the bottom of the furnace. On the other hand, upon the lower hearths the material will have become thoroughly heated and such hearths will be nearest the source of heat and accordingly there is a tendency for excessive temperatures to prevail with such furnace constructions and methods of operating furnaces heretofore known. Again, where the gases ascend directly through the material as it drops through the various openings from hearth to hearth, combustion of the material may take place at such material drops, often to an undesirable extent, resulting in excessive temperatures and consequent formation of metallurgical combinations which are detrimental to the roasted product.

With a view to eliminating or substantially minimizing a part or all of these difficulties which have been heretofore encountered, the novel arrangement of gas and material openings as here shown at hearths Nos. 3, 4 and 5 have been provided. Through hearth No. 3 which normally would be provided with a central opening, such as the opening 24 through hearth No. 1, an extra large opening 26 is here provided. The material falls from hearth No. 3 over the edge of the hearth but only around the periphery of the opening 26, leaving the space adjacent the shaft free for the upward flow of the stream of gas. Hearth No. 4 which would normally be provided only with peripheral discharge openings, is here shown as also provided with a central opening 27 for gas only, whereas peripheral openings 28 are provided for the material. The major portion of the stream of gas is allowed to pass upwardly through the opening 27, and therefore the peripheral openings 28 through this hearth are made somewhat smaller or fewer than the peripheral openings 25 above referred to. Thus entirely independent openings are provided through this hearth respectively for the material being treated and for the rising oxidizing gases. As above stated, the central opening 26 through hearth No. 3 is made large. This is done not only to provide ample space both for the stream of gas and the falling material but also to insure the dropping of the material upon the hearth below without danger of the material falling through the central opening 27. Hearth No. 5 may be provided with a central opening 29, the inner or central portions of which provide ample space for a gas path and the peripheral part of which opening provides a material discharge space. This opening may be relatively smaller than the opening 26 inasmuch as hearth No. 6, the last hearth, has no central opening through which the material may fall.

In operating the furnace any suitable source of heat may be applied at any hearth consistent with metallurgical practice. For example, an oil torch or torches may be introduced through suitable port openings as at 30. The roasted material may be discharged from the hearth No. 6 in the ordinary manner through suitable openings therethrough (not shown).

The heated gases rising from hearth No. 6 are permitted to flow in a direct path following the central shaft through the various vertically aligned openings 29, 27 and 26 and although a portion of such gases and the heat thereof may be imparted to the hearths 5 and 4, the major portion of such heated gas will be delivered to the upper hearths, thus insuring a satisfactory high working temperature at the upper part of the furnace. On the other hand, in the lower part of the furnace, where the material has already reached high temperatures, excessive heating is avoided. Also, at the

lower hearths where the gases are at the highest temperature, the stream of gas follows a path more or less spaced from the falling ore at each opening, thus substantially reducing the undesirable combustion at such points.

Although the invention is here shown as applied to a furnace having six hearths, the same principles may be embodied in furnaces of different dimensions and those having a larger or smaller number of hearths. For example, in a furnace having 12 hearths, it may be desirable to provide central openings for by-passing the gas past 2 or more groups of 3 hearths, corresponding to hearths Nos. 3, 4 and 5 here shown. In other instances, it is desirable to provide all of the hearths with central gas passages. Although the gases are passed upwardly through the particular furnace here shown, the invention is of course also applicable to furnaces in which the gases follow a downward path through the furnace.

In order to readily control temperature conditions throughout the furnace to provide suitable roasting temperatures for various materials and under various working conditions, means may be provided for adjusting the cross-sectional area of each of the by-pass openings. To this end the openings 26, 27 and 29 may be respectively provided at their peripheries with replaceable semiannular members 26′, 27′ and 29′. To make the openings larger, these ring members may be removed and replaced by rings having larger central openings, or the rings may be dispensed with altogether. If smaller openings are desired, the rings may be replaced by other rings having smaller central openings.

It will thus be seen that means are provided entirely within the furnace for by-passing the oxidizing gases directly past a desired number of hearths, such means being adjustable if desired. Since the gases are by-passed through openings at the center of the furnace, no heat is wasted by radiation as would be the case if gas passages were provided from hearth to hearth at the periphery of the hearths or exteriorly of the furnace.

The usual practice as followed in the design of furnaces of this general type may be followed as to constructional details which are not specifically referred to herein.

While the invention has been described in detail with respect to certain particular preferred examples which give satisfactory results, it will be understood by those skilled in the art, after understanding the invention, that various changes and modifications may be made without departing from the spirit and scope of the invention and it is intended therefore in the appended claims to cover all such changes and modifications.

What is claimed as new and upon which it is desired to secure Letters Patent is:

1. In a furnace having a plurality of vertically spaced circular hearths surrounded by a cylindrical furnace wall, a rotatable shaft passing vertically through the center of the hearths, a series of rabble arms radiating from said shaft over the several hearths, alternate hearths being formed respectively with central and peripheral material discharge openings allowing the material under treatment to drop from each hearth to succeeding hearths, and said rabble arms being provided with teeth for advancing the material over each hearth toward the openings of that hearth, at least one of the hearths which has a peripheral opening being also formed with a central opening which together with the central openings in the hearths next below or above provides a direct gas passage to the other hearths partially independent of the path of the material being treated.

2. In a furnace having a plurality of vertically spaced circular hearths surrounded by a cylindrical furnace wall, a rotatable shaft passing vertically through the center of the hearths, a series of rabble arms radiating from said shaft over the several hearths, alternate hearths being formed respectively with central and peripheral material discharge openings allowing the material under treatment to drop from each hearth to succeeding hearths, and said rabble arms being provided with teeth for advancing the material over each hearth toward the openings of that hearth, at least three succeeding lowermost hearths being formed with annular openings around said shaft for by-passing the stream of oxidizing gas past the said lower hearths directly to the upper hearths or hearth.

3. In a furnace having a plurality of vertically spaced circular hearths surrounded by a cylindrical furnace wall, a rotatable shaft passing vertically through the center of the hearths, the next to the lowermost hearth having an opening around said shaft for admitting gas and discharging material, the second from the lowermost hearth having a material discharge opening at its periphery and a gas admitting opening at said shaft, and the third from the lowermost hearth having an opening around said shaft which is of substantially greater diameter than the opening next below, whereby material is discharged to the next hearth below and gas is admitted directly from the lowermost hearth.

4. In a furnace having a plurality of superposed hearths surrounded by an insulating cylindrical furnace wall, a series of openings formed through successive hearths to provide a path from hearth to hearth for the material being treated, a

path for gases passing through the furnace also being provided wholly within the inner limits of said furnace wall, at least a part of said path for gases comprising a by-pass leading directly past certain hearths and comprising hearth openings independent of said material openings.

5. In a furnace having a plurality of superposed hearths, a series of openings through the hearths to provide a path from hearth to hearth for the material being treated, the openings through successive hearths being offset from vertical alignment, and a series of openings in vertical alignment through at least three of the hearths to provide a direct path for gas passing through said three hearths.

6. A closed furnace sealed against fugitive escapement of gases and having a plurality of superposed hearths, openings through the hearths for passing ore downwardly and gases upwardly through the furnace, certain of said openings through successive hearths being vertically aligned and at the center of the furnace and providing a gas path at least partially independent of the path of the ore.

7. The process of treating ore in a furnace having a plurality of superposed hearths, which comprises passing the ore down through the furnace over each successive hearth, passing a stream of heated oxidizing gas upwardly through the furnace, the temperature conditions in the furnace being controlled by allowing the gas to follow a direct path past the lower hearths directly to the upper hearths, and passing the gas along an upper hearth or the successive upper hearths, over the ore thereon.

8. The process of treating dusty material on a plurality of superposed hearths in a furnace which comprises passing the material over each successive hearth, allowing the material to drop through openings in each hearth to the succeeding hearth, and passing a stream of hot gas past certain successive hearths along a straight vertical path within the hot middle portion of the furnace but substantially spaced from the path of the material being treated.

9. A roasting process to be carried on in a roasting furnace having a plurality of vertically spaced hearths, which comprises passing the material to be treated down through the furnace over each successive hearth, passing a stream of oxidizing gas upwardly through the furnace, and allowing the gas to follow a direct substantially vertical path past the lower hearths and a tortuous path over the upper hearth or hearths, whereby efficient roasting temperatures are attained on all hearths.

10. A closed furnace sealed against fugitive escapement of gases and having a pluraliy of superposed hearths, openings being formed through the hearths for passing material to be treated downwardly through the furnace, and rabbling means for advancing the material over each hearth toward the said openings through such hearth, one of the intermediate hearths being formed with a gas admitting opening substantially out of the path of the material, the hearths next above and below said intermediate hearth also being formed with openings substantially in alignment with said gas opening.

11. A furnace construction having a plurality of superposed hearths, openings being formed through the hearths for passing material to be treated downwardly through the furnace, and rabbling means for advancing the material over each hearth toward the said openings through such hearth, one of the intermediate hearths being formed with a gas admitting opening substantially out of the path of the material, the hearths next above and below said intermediate hearth also being formed with openings substantially in alignment with said gas opening.

In testimony whereof I have signed my name to this specification.

DUDLEY BAIRD.