Nov. 4, 1947. F. E. HATCH 2,430,171

ELECTRIC ROTARY FURNACE

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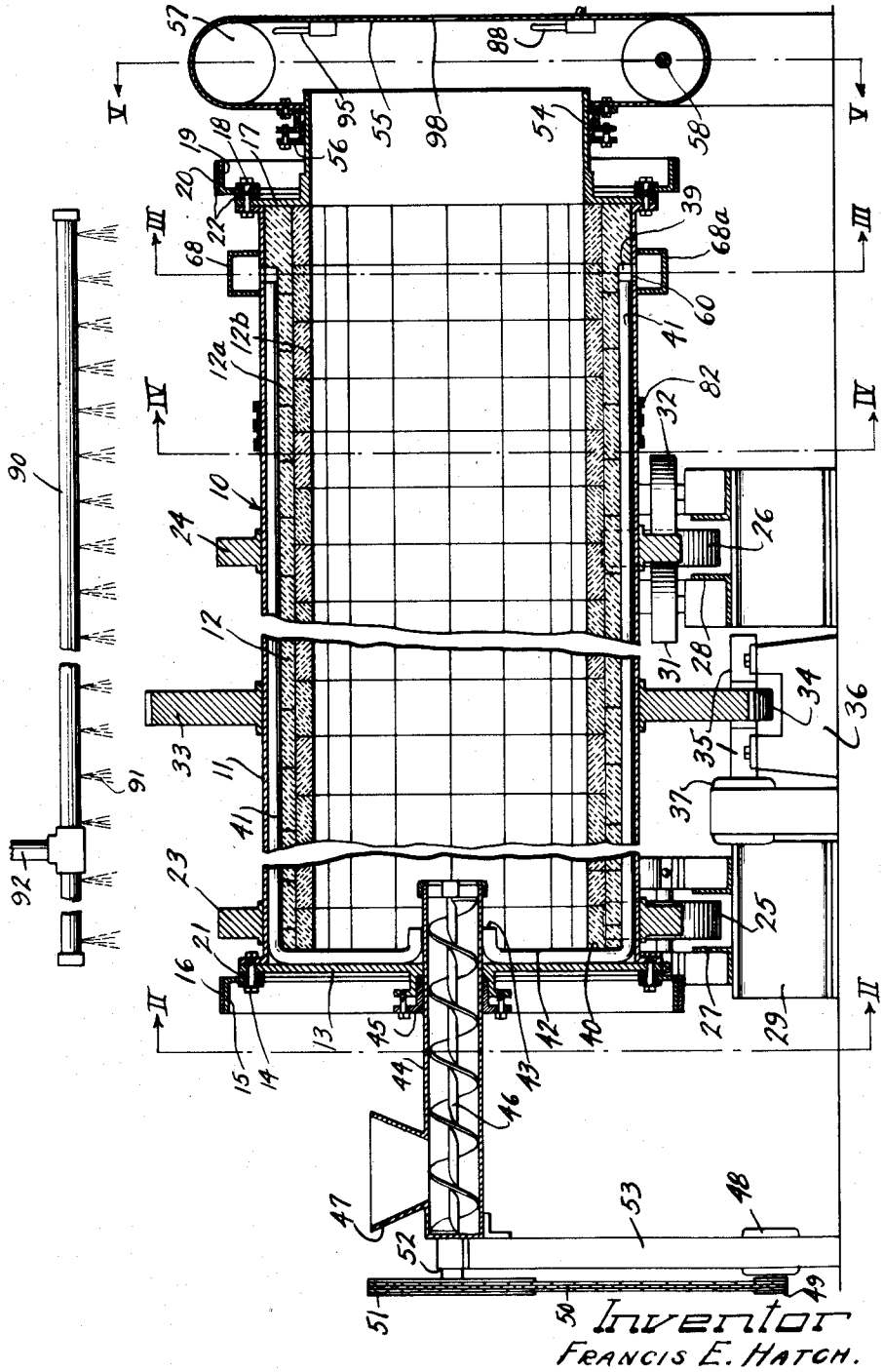


Fig. 1.

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Fig. 2.

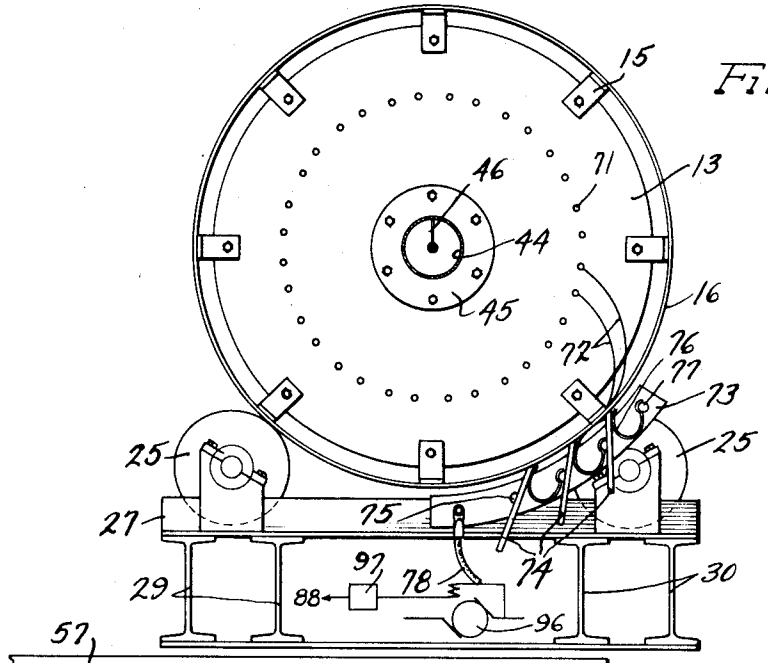
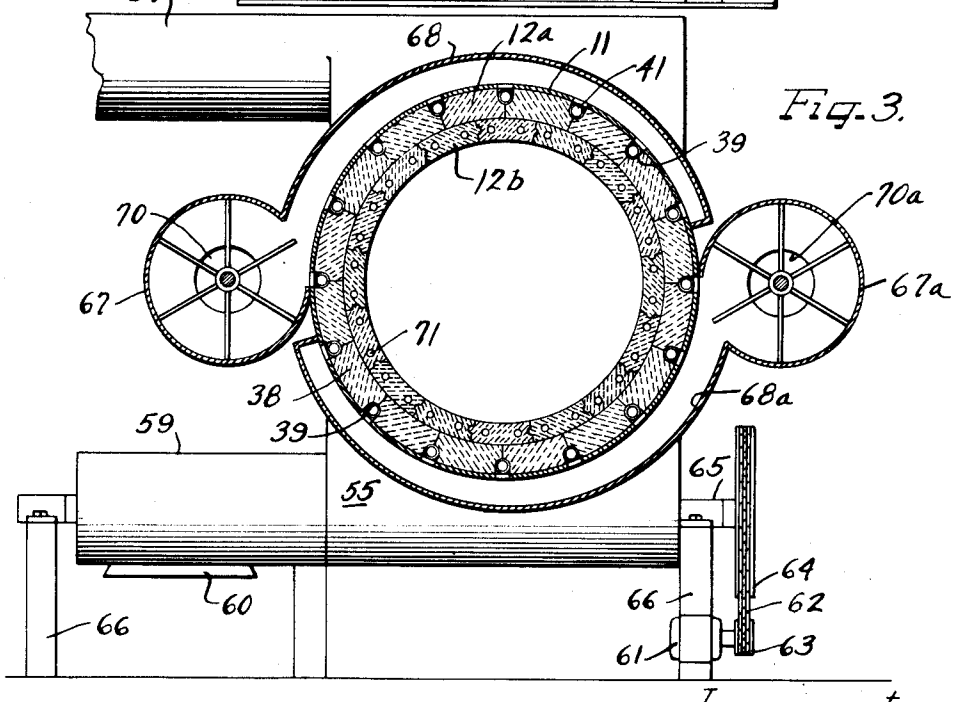


Fig. 3.



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Fig. 4.

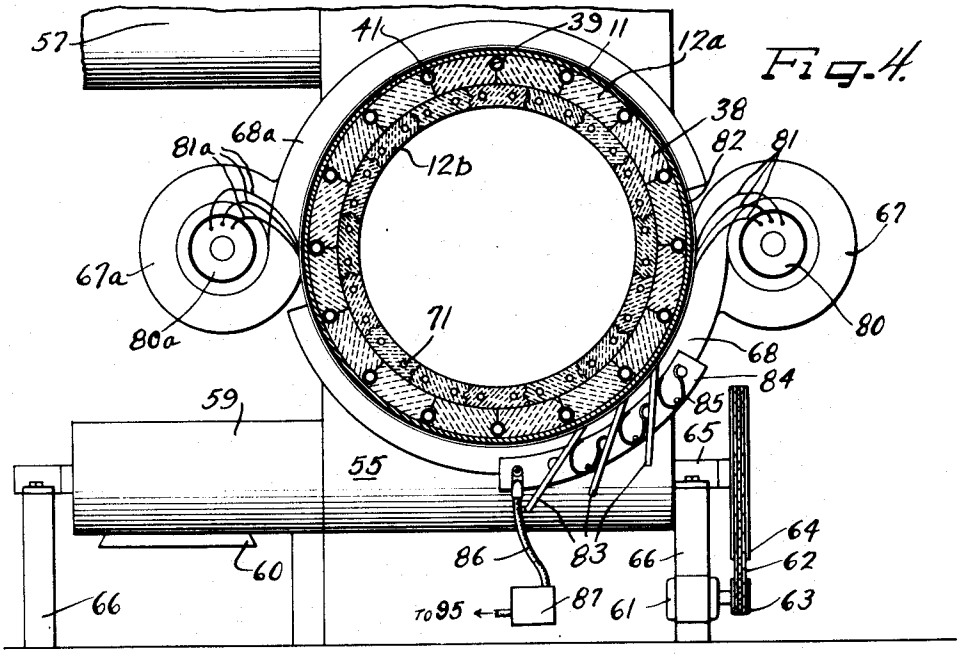
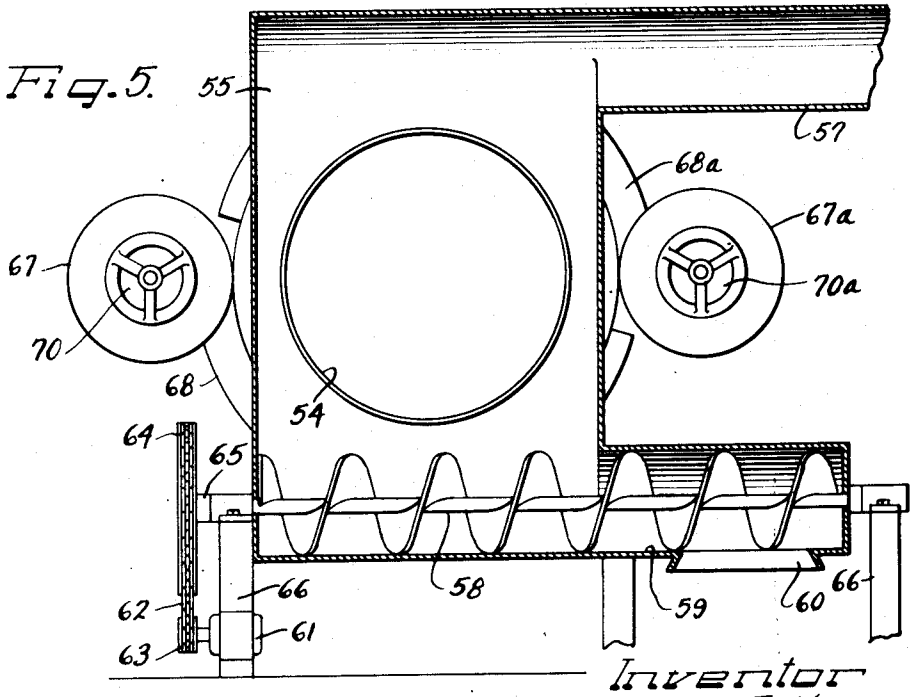


Fig. 5.



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UNITED STATES PATENT OFFICE

2,430,171

ELECTRIC ROTARY FURNACE

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Application February 5, 1945, Serial No. 576,310

5 Claims. (Cl. 13—21)

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This invention relates to an electrically heated rotary furnace.

The present invention more particularly relates to an improved construction of the type of rotary electric furnace disclosed in my prior Patents Nos. 640,283, issued January 2, 1900, 741,333, issued October 13, 1903, 946,727, issued January 18, 1910, and 1,665,546, issued April 10, 1928. The present invention incorporates all of the objects and advantages of the rotary electric furnace illustrated in these prior patents and, in addition, embodies certain new advantages effected by the improvements incorporated therein.

In accordance with the principles of my present invention, I provide a rotary electric furnace in which, as in the above mentioned prior patents, the electrical heating units are embedded in the refractory lining of the rotatable shell, but in which the means for cooling the shell, preheating the air or other gas, and utilizing said pre-heated air or other gas in the treatment of the material to be processed in the furnace are more effectively incorporated into the furnace construction and more efficiently controlled than in my prior forms of apparatus. In my present construction, such means comprise one or more blowers mounted on and carried by the rotatable shell of the furnace for rotation therewith, a plurality of pipes extending along the inside surface of the shell and embedded within the refractory lining thereof, with the discharge ends of said pipes opening adjacent the feed end of the furnace in the direction of feed of the material into the furnace, and one or more manifolds in flow communication from the blower, or blowers, to said pipes. By virtue of my improved construction, air or other gas may be introduced into the furnace in the direction of flow of the material being processed to effect either oxidation or reduction of such material, as circumstances may require.

Additionally, my present invention includes thermometric control means for controlling the amount of air or other gas introduced into the furnace by means of said blower, or blowers, in accordance with the temperature, obtaining within the furnace at some particular point, or points, as for instance at the discharge end thereof, whereby the flow of air or other gas may be regulated to maintain the optimum temperature conditions for the carrying out of the particular process intended.

My present rotary furnace construction also embodies new and improved features with respect to the feeding and discharge ends of the

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furnace. Both the feeding and discharge ends are entirely sealed except for the mechanism required for feeding in the material to be processed and that required for the removal and recovery, if desired, of the gaseous and solid products of the process carried out in the furnace. At the discharge end of the furnace, there is provided a casing having a portion that surrounds and seals the discharge end of the furnace, and said casing is provided with a flue for the removal of the gaseous products of the reaction and with a conveyor for the removal and discharge of the solid or semi-solid products of the reaction that takes place within the furnace. There is, thus, provided a construction that makes possible the complete, or substantially complete, recovery of both the gaseous and solid products of the process carried out in the furnace.

My present construction of rotary electric furnace furthermore makes possible a closer regulation of the conditions within the furnace, such as the oxidizing or reducing conditions obtaining in the furnace, temperature conditions and times of contact between the material being processed and the gases utilized in processing such material.

It is therefore an important object of this invention to provide a rotary electric furnace of improved construction for realizing the advantages above set forth.

It is a further important object of this invention to provide in a rotary electric furnace more efficient means for controlling the volume and temperature of air or other gas introduced into the reaction zone of the furnace, wherein such means include one or more blowers mounted on the rotatable shell of the furnace for rotation therewith and connected to one or more manifolds for supplying the air or other gas to a plurality of pipes extending lengthwise of the shell and adjacent to the inner surface thereof, whereby such air or other gas may be pre-heated to the desired temperature before being discharged into the reaction zone of the furnace, the discharge ends of said pipes being so arranged with respect to the feed of materials into the furnace as to flow in the direction of such feed and become intimately mixed with said materials.

Other and further important objects of this invention will be apparent from the disclosures in the specification and the accompanying drawings.

On the drawings:

Figure 1 is a broken, longitudinal sectional view of a rotary electric furnace embodying the principles of my invention, with parts in elevation.

Figure 2 is an end elevatonal view taken substantially along the line II—II of Figure 1, with parts in section.

Figure 3 is a sectional view taken substantially along the line III—III of Figure 1.

Figure 4 is a sectional view taken substantially along the line IV—IV of Figure 1.

Figure 5 is a sectional view taken substantially along the line V—V of Figure 1.

The reference numeral 10 (Fig. 1) indicates generally the body portion proper of a rotary electric furnace embodying the principles of my invention. Said body portion comprises an outer cylindrical shell 11, which may be of any suitable metal, lined with fire brick, or other refractory material, indicated generally by the reference numeral 12. The shell 11 is provided at its feeding end with a head 13 secured to the flange end of said shell by means of bolts 14. Said bolts 14 also serve to attach to said head 13, as by means of brackets 15, a collecting ring 16 formed of copper or other good electrical conducting material. At the discharge end of said shell 11 there is a somewhat similar arrangement, comprising a head 17 secured to the flanged end of said shell by means of bolts 18, brackets 19 also secured to said head 17 by means of said bolts 18, and a second collecting ring 20 carried by said brackets 19. Insulating bushings 21 and 22 serve to insulate said brackets 15 and 19, from the heads 13 and 17 and the bolts 14 and 18, so that said collecting rings 16 and 20 are completely insulated from the body of the furnace. The purpose of the collecting rings 16 and 20 will be explained hereinafter.

The body portion 10 of the furnace carries a pair of annular tracks 23 and 24 near the feed end and toward the discharge end, respectively, of the shell 11. Said tracks 23 and 24 rest upon and bear against small rollers 25 and 26, respectively, which are supported from cross beams 27 and 28. The cross beams in turn are supported by longitudinally extending I-beams 29 and 30 (Figs. 1 and 2). In order to compensate for a thrust should the furnace body portion 10 be positioned at an angle inclined to the horizontal, there are also provided a pair of thrust rollers 31 and 32 supported from said cross beam 27 and 28 and adapted to bear against opposite vertical faces of the annular track 24.

The driving mechanism for the furnace comprises a large annular gear 33 suitably secured to the shell 11 and adapted to mesh with a driving gear 34. The stub shafts of the driving gear 34 are encased in dustproof bearings 35 mounted upon a support 36, and said gear 34 is driven by a motor 37.

The refractory lining 12 includes an outer layer 12*a* and an inner layer 12*b*, both of which layers are made up of individual bricks suitably held in place and united together. The individual bricks 38 and the outer layer 12*a* are notched at their outer mating faces to provide continuous grooves 39 (Figs. 1, 3 and 4) that extend longitudinally of the shell 11 and along the inner surface thereof for substantially the full length of said shell. Adjacent the feeding end head 13, both the outer and inner linings 12*a* and 12*b* are cut away as at 40 to provide radially extending grooves that join the longitudinally extending grooves 39. A pipe 41 is positioned in each of the longitudinally extending grooves 39. Each pipe 41 has a radially extending extension 42 that passes out through one of the radially extending grooves 40. The extremity of each of the radial

extensions 42 of the pipes 41 is offset to provide a discharge opening, as indicated at 43.

Said offset ends of the pipe extensions 42 are circumferentially spaced about a tubular member 44 which serves for the introduction into the furnace of the material to be treated. Said tubular member 44 extends through an opening in the head 13 provided for the purpose and is sealed therein by means of a stuffing box 45. A worm conveyor 46 is operatively positioned within said tubular member 44 for advancing material introduced into said tubular member through a hopper 47. The drive means for the conveyor 46 comprises a motor 48 having a sprocket 49 that is connected through a drive chain 50 with a sprocket 51 secured on the extended end 52 of said screw conveyor 46. A standard 53 serves to support both the motor 48 and the extended end 52 of said conveyor 46.

At the discharge end of the furnace, the head 17 is provided with a cylindrical extension 54 (Fig. 1) having an inside diameter the same as that of the inside diameter of the inner lining 12*b*. A casing, indicated generally by the reference numeral 55, serves to receive said extension 54 and is sealed thereto by means of a stuffing box 56. A flue 57 leads off from the top of the casing 55 for the removal of any gaseous products of the process carried out within the furnace. At the lower portion of the casing 55, there is positioned a screw conveyor 58 which extends out through a cylindrical extension 59 of said casing. Material removed from the bottom of the casing 55 is discharged through a discharge opening 60. A motor 61 drives the screw conveyor 58 through a chain 62 trained around a sprocket 63 on the motor drive shaft and a sprocket 64 on the extended end 65 of said screw conveyor. The motor and screw conveyor are supported by vertical supporting members 66.

A pair of blowers 67 and 67*a* (Figs. 3, 4 and 5) are mounted upon opposite sides of the shell 11 near the discharge end thereof. Said blowers 67 and 67*a* discharge into a pair of manifolds 68 and 68*a* that extend about the periphery of the shell 11 to substantially enclose the same. Said manifolds 68 and 68*a* are tapered in the direction of flow of the gas discharge from said blowers to provide cross-sectional areas of progressively decreasing size.

As is best shown in Figure 1, the manifolds 68 and 68*a* enclose the open groove ends 39 so as to be in communication with the ends of each of the pipes 41, the shell 11 being apertured, as at 69 to provide entrance into each of said end groove portions 39. Accordingly, air or other gas taken through the openings 70 and 70*a* into said blowers 67 and 67*a* is caused to flow through the respective manifolds 68 and 68*a*, into the pipes 41 and to be discharged through the open ends 43 of said pipes in the direction of travel of the material fed into the furnace through the tubular member 44.

The means for heating the furnace comprise a plurality of electric resistance elements 71 (Figs. 3 and 4), which extend the full length of the furnace and which are embedded in the refractory bricks of the layer 12*b*. As best shown in Figure 2, the ends of said electrical resistance elements 71 at the feeding end of the furnace are connected by means of wires 72 to the collecting ring 16. At the discharge end of the furnace, the corresponding ends of the electrical resistance elements 71 are similarly connected to the collecting ring 20. Since the connections at both ends are identical,

only those at the front end, as illustrated in Figure 2, will be described.

A bus bar 73 is mounted adjacent to the collecting ring 16, but in spaced and conforming relationship thereto. Said bus bar 73 carries a plurality of copper gauze brushes 74, which are pivotally supported from said bus bar upon copper rods 75. Individual springs 76 secured at one end to a copper rod 77 extending from the bus bar 73, bear at their free ends against said brushes 74 to urge the same into good electrical contact with the collecting ring 16. A cable 78 connects the bus bars 73 at the respective ends of the furnace to a suitable source of electrical current such as a shunt wound direct current generator 96 (Fig. 2). A thermometric control 97 responsive to a thermocouple 88 in the lower part of the discharge end casing 55 (Fig. 1) is connected to the shunt winding of the generator. Electrical current is furnished to each of the motors 80 and 80*a* (Fig. 4) for the blowers 67 and 67*a* by wires 81 and 81*a* connected to collecting rings 82, of which there would be three for a three-phase circuit such as illustrated. A separate brush 83 is provided for each of the collecting rings 82, and the brushes are mounted, as previously described, upon a bus bar 84, with individual springs 85 urging said bus bars into contact with the respective collecting rings. A cable 86 connects the bus bar 84 with a suitable source of current for driving the motors 80 and 80*a*.

The function of the blowers 67 and 67*a* is to furnish pre-heated air, or other gas, for the reaction that is to be carried out within the furnace. In passing through the longitudinally extending pipes 41 the gas serves to cool the shell 11, while at the same time being pre-heated by the heat that is transferred from the electrical resistance elements 71 through the lining layers 12 and 12*a*. This pre-heated gas is then discharged from the open ends 43 into the interior of the furnace in the direction of flow of the material being treated.

In order to control the amount of gas delivered by the blowers 67 and 67*a* in accordance with the requirements, as determined by the temperature of the gases at some particular point, or points, I provide a thermometric control mechanism, indicated at 87 (Fig. 4), which is responsive to such temperature, for instance that at the position indicated by the thermocouple 95 (Fig. 1). In this way the amount of air can be controlled by the thermometric control mechanism 87 in conjunction with the control of the heating elements 71 by the control mechanism 97 to give the desired temperature conditions within the furnace. Thus, by a joint control of the operation of the blowers 67 and 67*a* and of the electrical energy fed into the electrical resistance wires 71, a very close control indeed of the operating conditions of the furnace can be maintained.

As a further means for keeping the shell 11 of the furnace relatively cool, I may provide an overhead sprinkler system comprising an elongated pipe 90 running the full length of the shell 11 and provided with a plurality of spaced apertures through which water or other cooling medium is discharged in the form of sprays 91. The pipe 90 is connected to a source of a cooling medium by means of a supply pipe 92.

The conditions within the furnace may be observed by the operator through a peep-hole 98 in the casing 55 (Fig. 1) so as to keep a close check on its performance.

The uses to which my electric rotary furnace may be put are suggested in part in my prior patents previously identified. In general my furnace may be used in connection with the extraction of gold and silver, in the metallurgical treatment of copper, zinc and other ores; in the recovery of sulfur from ores containing sulfides; in the manufacture of sponge iron; carbon for filters; coal and coke products; for the incineration of garbage; for the burning of limestone to produce calcined lime; and for many other purposes. The close control of temperature and of oxidizing or reducing conditions within the furnace makes it possible to carry out these and various other processes to produce a uniform product with a high degree of efficiency.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. In a rotary electric furnace including a rotatable shell having a refractory lining and heating elements embedded in said lining adjacent the inside surface thereof, means for cooling said shell and for supplying a preheated gas to the interior of said furnace comprising a gas blower mounted on said shell for rotation therewith, an annular manifold connected to the discharge end of said blower and partially surrounding said shell and a plurality of pipes open at one end to said manifold and extending along said lining adjacent the inside of said shell to discharge preheated gas into the interior of said furnace while at the same time protecting said shell from the heat of said heating elements.

2. In a rotary electric furnace including a rotatable shell having a refractory lining and heating elements embedded in said lining adjacent the inside surface thereof, means for cooling said shell and for supplying a preheated gas to the interior of said furnace comprising a gas blower mounted on said shell for rotation therewith, an annular manifold connected to the discharge end of said blower and partially surrounding said shell, said manifold gradually decreasing in cross-sectional area in the direction of flow of the gas from said blower and a plurality of pipes open at one end to said manifold and extending along said lining adjacent the inside of said shell to discharge preheated gas into the interior of said furnace while at the same time protecting said shell from the heat of said heating elements.

3. In a rotary furnace including a rotatable shell having a feeding end and a discharge end, means for feeding material to be treated through said feeding end and means for withdrawing gaseous and solid products at said discharge end, means for cooling said shell, preheating a gas and introducing said preheated gas into contact with said material to be treated, comprising a plurality of pipes extending substantially the full length of said shell on the inside thereof and having discharge ends surrounding said feeding means for discharging a preheated gas in the direction of feed of said material and a blower for forcing a gas through said pipes.

4. In a rotary furnace including a rotatable shell having a feeding end and a discharge end, means for feeding material to be treated through said feeding end and means for withdrawing gaseous and solid products at said discharge end, means for cooling said shell, preheating a gas

and introducing said preheated gas into contact with said material to be treated, comprising a plurality of pipes extending substantially the full length of said shell on the inside thereof and having discharge ends surrounding said feeding means for discharging a preheated gas in the direction of feed of said material, a manifold adjacent the discharge end of said shell connected to said pipes, and a blower mounted on said shell for rotation therewith and connected to said manifold.

5. In a rotary furnace, a rotatable shell, having a feeding and a discharge end, an apertured plate closing said feed end, a tubular member extending through said apertured plate, a screw conveyer in said tubular member for feeding therethrough material to be treated in said furnace, a casing sealing said discharge end having a flue connected to an upper portion thereof, means in the lower portion of said casing for removing solid treated material therefrom, a plurality of pipes extending the length of said shell on the inside thereof with their discharge ends spaced about said tubular member and opening in the direction of feed of said material and a

blower mounted on said shell adjacent the discharge end thereof for rotation therewith and connected to said pipes to force a gas therethrough for cooling said shell and to be preheated prior to discharge through the open discharge ends of said pipes.

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