June 11, 1935. A. G. McGREGOR 2,004,334

ROTARY FURNACE

Filed July 17, 1934 4 Sheets-Sheet 1

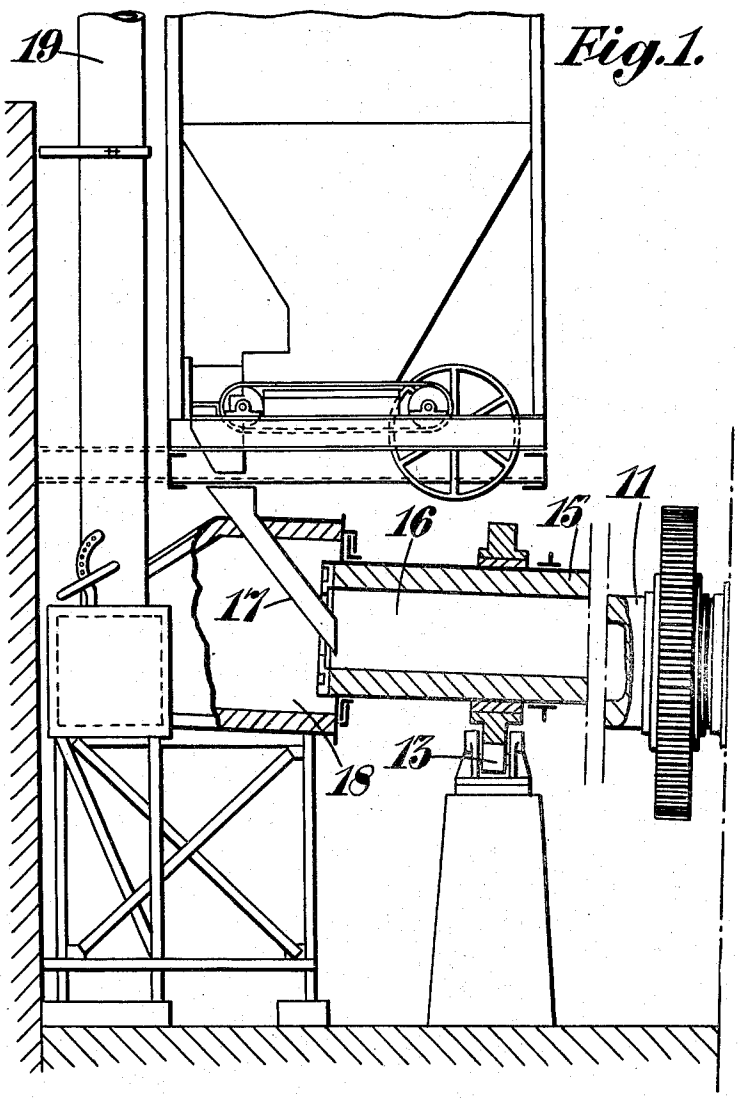


Fig. 1.

INVENTOR

A. G. McGregor,

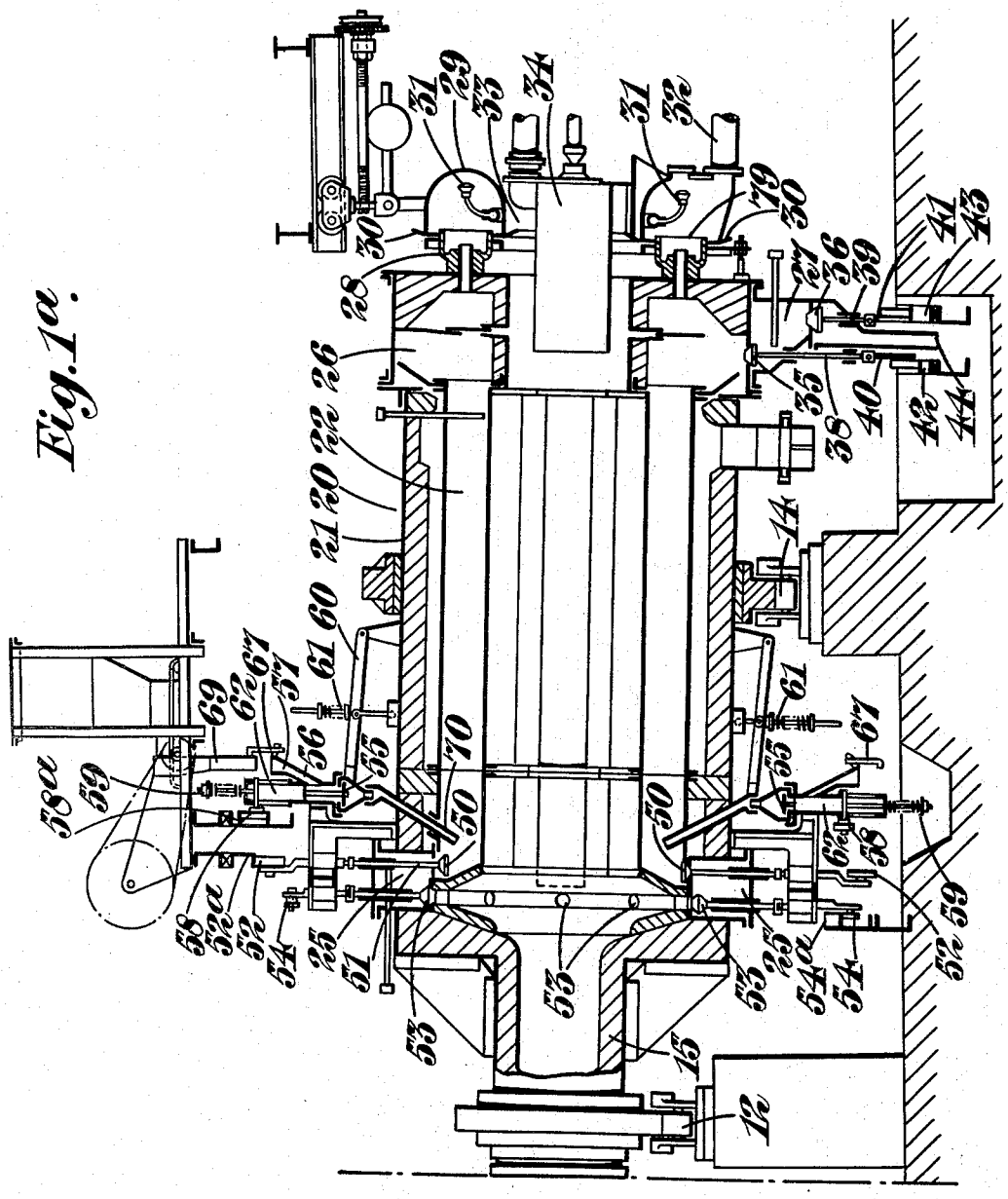
By Watson, Coit, Morse & Grindle ATTYS

June 11, 1935. A. G. McGREGOR 2,004,334

ROTARY FURNACE

Filed July 17, 1934 4 Sheets-Sheet 2

Fig. 1a.



INVENTOR

A. G. McGregor

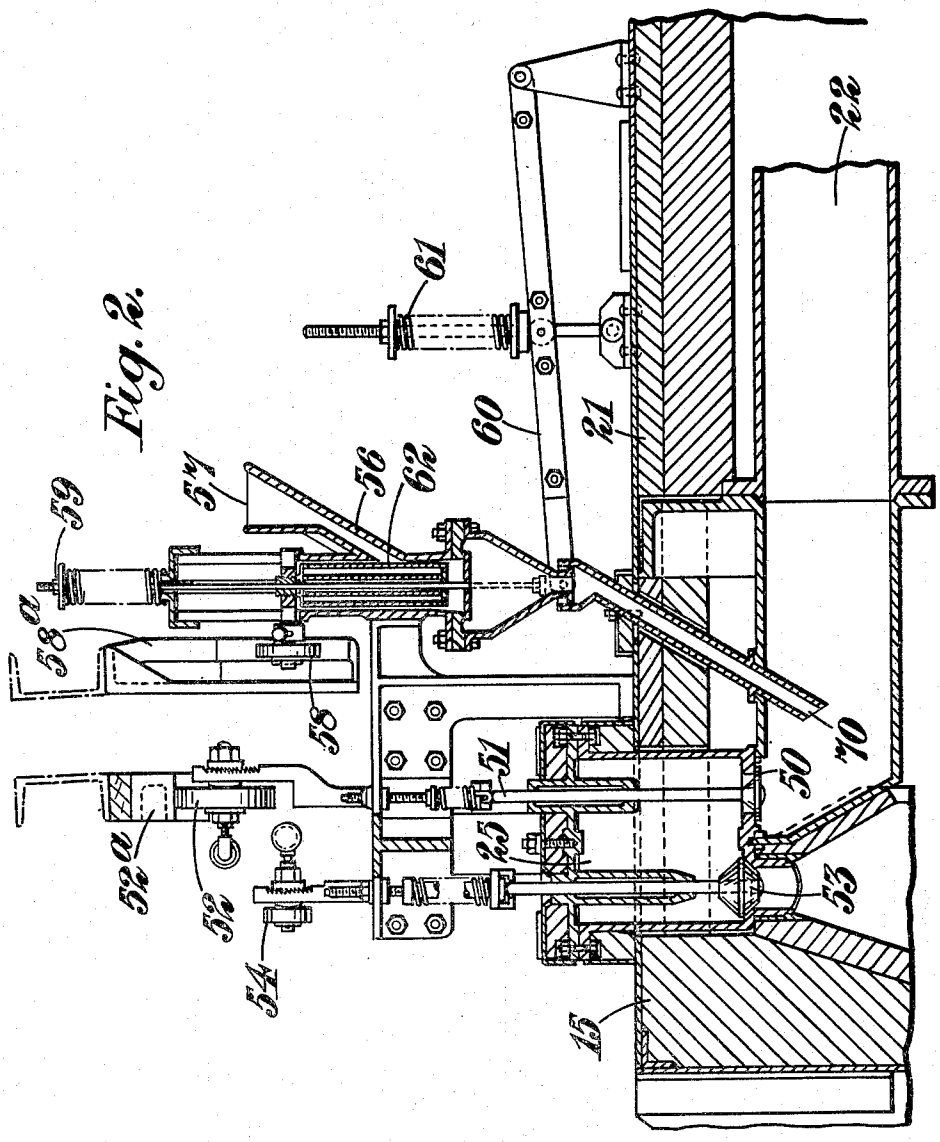
By Watson, Coit, Grover & Grindle ATTYS.

June 11, 1935. A. G. McGREGOR 2,004,334

ROTARY FURNACE

Filed July 17, 1934 4 Sheets-Sheet 3

Fig. 2.



INVENTOR
A. G. McGregor
By Watson, Coit, Moore & Grindle ATTYS.

June 11, 1935. A. G. McGREGOR 2,004,334

ROTARY FURNACE

Filed July 17, 1934 4 Sheets-Sheet 4

Fig. 3.

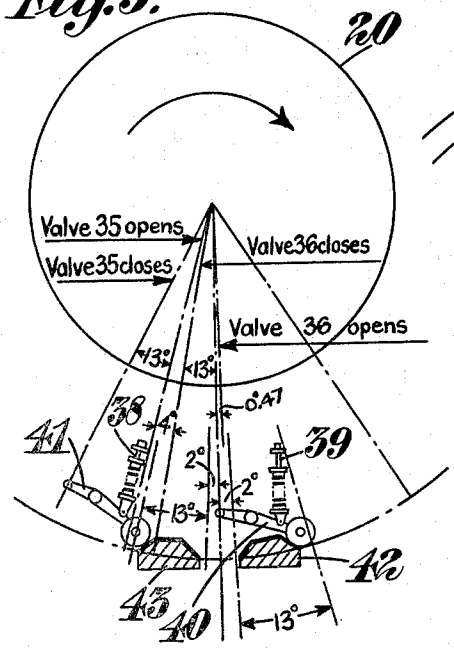


Fig. 4.

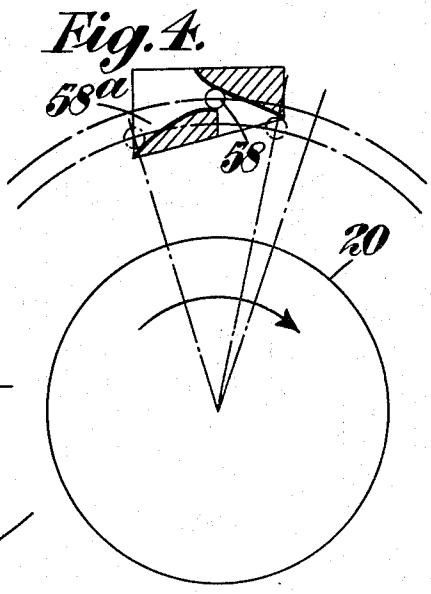


Fig. 5.

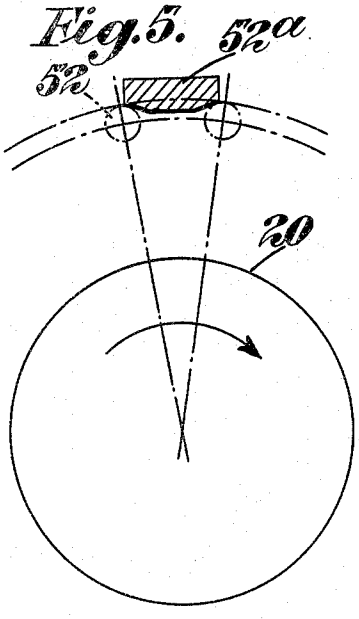
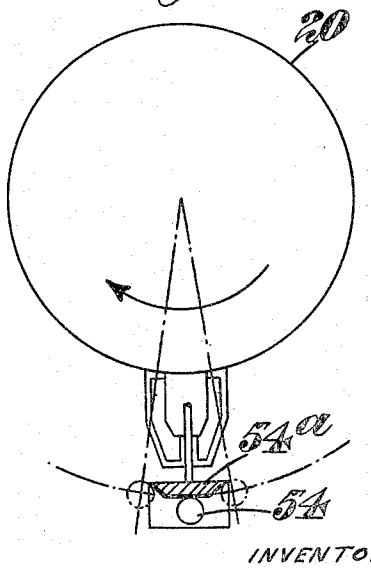


Fig. 6.



INVENTOR

A. G. McGregor

By Watson, Coit, Moore & Grindle

ATTYS.

Patented June 11, 1935

2,004,334

UNITED STATES PATENT OFFICE

2,004,334

ROTARY FURNACE

Alexander Grant McGregor, London, England

Application July 17, 1934, Serial No. 735,670
In Great Britain July 18, 1933

8 Claims. (Cl. 263—32)

This invention comprises improvements in or relating to rotary furnaces and has for its object to provide a muffle furnace in which ores and like materials may be heat-treated and in which progress of the ore through the furnace is automatic and continuous.

The invention comprises in a rotary furnace the combination of a muffle chamber or chambers rotating about an axis extending horizontally or at an inclination to the horizontal, a heating burner for the muffle, admission valves for the admission of material to the muffle chamber and discharge valves for the withdrawal of material therefrom respectively located at opposite ends of the muffle and automatically operated by the rotation thereof.

The muffle may consist of a chamber or chambers disposed in a ring formation around the axis and heated by gases passing through its centre. Preferably a plurality of tubular muffle-chambers are employed, disposed in a ring formation as aforesaid which open at their discharge ends into a ring-shaped header chamber common to them and provided with the said discharge valves. The muffle chambers may open at their inlet ends into a ring-shaped header chamber or chambers which abuts upon the outer sides of the muffle chambers so as to be shielded thereby from the direct heat of the internal heating flame and which is provided with internal diaphragms or the like to act as pockets whereby material fed to the bottom of the chamber may be carried to the top and there delivered through valves to the muffle tubes.

The muffle furnace may be constructed in axial alignment with a rotating tubular preheating furnace into which the heating flame from the muffle is led and through which the material to be treated is fed so as to be preheated before admission to the muffle. The apparatus constitutes a suitable means for the treatment of many kinds of materials, for example it may be used for carrying out the chloridisation of tin ores as hereinafter described.

The following is a description by way of example of one form of the apparatus in accordance with the invention:—

The accompanying drawings illustrate the apparatus:—

Figure 1 being a longitudinal side elevation partly in section,

Figure 2 a detail of the valve mechanism, and

Figure 3 to 6 diagrams showing the position of opening and closing the various valves.

The furnace comprises a long tubular casing 11 set at a slight inclination to the horizontal and mounted on rollers 12, 13, 14 so as to be rotatable. The major part of the length of the casing is of relatively small diameter compared with its length and is lined with heat-resistant material 15. This encloses a preheating chamber 16 and is provided with a chute 17 at its higher end into which material such as tin-bearing ore may be fed. It is also at this end provided with a take-off flue 18 to a chimney 19. Towards the lower end the casing of the furnace is enlarged at 20 to contain the muffle parts now to be described and the enlarged portion 20 is also lined with heat-resistant material 21.

The muffle consists of eight tubes 22 circular in cross-section and formed of corrosion-resisting metal such, for example, as the nickel-iron alloy sold under the trade-mark "Cronite". These are disposed in a ring-formation parallel with the axis of the furnace, and spaced around the axis. At the end which lies nearest to the preheating section of the furnace they are united to an annular header chamber 25 which encircles them and contains a valve mechanism hereinafter described. Through this valve mechanism ore from the preheating furnace is first admitted to the header chamber and thence through the valves to the muffle tubes.

At the other end the muffle tubes 22 open into an annular discharge chamber 26 which carries at three points around its periphery outlet branches 27 for heat-treated material and is also connected by a ring-shaped casting 28 to a fixed gas-exit chamber 29. The ring-shaped casting 28 contains a port 79 of annular formation which opens into an annular port in the side of the gas-exit chamber 29 to which it is sealed by means of yieldingly-pressed pads 30 to make a gas-tight joint. Into the gas-exit chamber there are directed water sprays 31 and an outlet pipe 32 so as to carry away any gases or vapours not condensed and the solution produced by the water sprays. Through the gas-exit chamber on the centre line of the furnace there is a circular passage 33 to permit the mounting of a gas burner 34 directed into the furnace for heating the same.

Each of the outlet branches 27 on the discharge chamber 26 contains in series with one another two discharge valves 35, 36 opening outwards. Each of the valves 35, 36 is mounted on a sliding stem 38, 39 and controlled by a rocker 40, 41 supported by a bracket bolted on the discharge chamber close beside the outlet branch to which it belongs. A spring (not shown) pressing on the rocker serves to hold the valves closed and a

pair of fixed cam tracks 42, 43 are secured below the outlet chamber in the path of the valve rockers so that during rotation of the apparatus the rockers engage the cams near the bottom of their movement. The disposition of the cams is such that first the inner discharge valve 38 is opened and closed so as to allow material from the discharge chamber to pass into the space between the inner and outer valves and after the inner discharge valve is closed the outer valve 39 opens and permits the material to pass out of the outlet branch by gravity into a chute 44. By this means discharge is permitted without ever opening a free passage for escape of gases from the interior of the apparatus.

The valve mechanism at the inlet ends of the muffles is somewhat similar in principle to that at the outlet ends, just described. The annular header chamber 25 to which the muffle tubes are united is separated from the muffle tubes by a number of poppet type transfer valves 50 opening towards the muffles and stems 51 of which extend through the header chamber and through valve guides in its outer wall, outside which they carry cam rollers 52. Adjacent to these inlet transfer valves from the header chamber to the muffles there is a row of inlet valves 53 for admitting material from the end of the preheating chamber to the header chamber. These inlet valves open outwardly from the inner part of the furnace into the header chamber and are operated by cam-rollers 54. A set of auxiliary valves 55 in the outer wall of the muffle chamber and opening inwardly thereto are provided and each of these controls the inlet from a little chute 56 and reagent hopper 57 formed outside the header chamber. The stems of these valves carry cam-rollers 58 and crossheads 59 connected by links to levers 60 on which bear springs 61 adjusted to counterbalance the weight of the valves. Moreover, the stems of valves 55 are surrounded by plungers 62 which are pressed inwardly when the valves are opened and serve positively to force the reagent inwardly.

The hoppers 57 carry trip-members 67 to engage trap-doors 68 on a reagent feeder chute 69 located above the furnace and open it as the hopper 57 passes below. Thus the hoppers 57 are replenished just before the valve 55 opens.

Around the outside of the series of valve stems described there are disposed various fixed cams 52*a*, 54*a*, 58*a* for operating them at appropriate moments. The header chamber itself is subdivided by diaphragms extending across it in a plane parallel with the axis of the furnace so that each group of valves, comprising an inlet valve 53 to the header chamber and a transfer valve 50 to the muffles occupies a compartment of its own.

In treating cassiterite in the apparatus described the ore is fed to the head of the preheating chamber 16 and a heating flame is directed through the furnace from the muffle end by the burner 34. The ore proceeds through the preheating chamber in a similar way to the passage of lime through a rotating kiln and becomes heated to a temperature which is preferably regulated to be somewhat in excess of that which is required in the muffle. At the end of the preheating chamber the ore drops into the larger space which surrounds the muffles and right at the entry to this space it overlies the inlet valves 53 to the header chambers 25. These are opened by the cams 53*a* at the bottom of the rotation and the material finds its way into the successive compartments of the header chamber 25. The rotation of the apparatus carries each compartment in turn to the top. Immediately afterwards the transfer valve 50 is opened, the other valves being shut, and the material is delivered to the uppermost muffle tube 22 for treatment therein. Here the reagent valve 55 is opened and the chute 69 delivers reagents comprising a proportion of carbonaceous material and common salt to the hopper 57 and through the valve 50 to the chute 70 and muffle 22. Each muffle tube having its own set of valves is regularly fed with material as it reaches the uppermost point of its rotation.

The material finds its way through muffle tubes 22 owing to the slight inclination of the apparatus and after the treatment enters the annular discharge chamber 26 from which it is discharged as already described.

Stannous chloride gases are evolved from the material during the operation in the muffle chamber and pass along with any other evolved gases through the gas-exit into the water sprayed exit chamber 29. Here the stannous chloride gases are dissolved as they are very soluble and only waste gas passes as such out of the final exit 32.

Although the invention has been described in connection with the treatment of cassiterite by a chloridizing process, it is to be understood that the apparatus can be employed in many other heat-treatment processes where ore requires to be heated in a muffle chamber along with suitable reagents. For example the furnace could be used for making sponge iron from iron oxide sands. Also it could be used for treating zinc ores, taking off metallic zinc as a fume. The reagent required for either of these two purposes would simply be a sufficient amount of a solid carbonaceous material introduced into the hoppers and auxiliary valves.

I claim:—

1. In a rotary furnace the combination of a muffle chamber mounted to rotate about a non-vertical axis, a heating burner for the muffle chamber, admission valves for the admission of material to the muffle chamber, discharge valves for the withdrawal of the material therefrom, said valves being respectively located at opposite ends of the muffle and automatic means operated by the rotation of the muffle for actuating said valves.

2. In a rotary furnace the combination of a muffle chamber mounted to rotate about a non-vertical axis and disposed in a ring formation around the axis, a heating burner for the muffle so disposed as to heat it by gases passing through the centre, admission valves for the admission of material to the muffle chamber and discharge valves for the withdrawal of material therefrom respectively located at opposite ends of the muffle and automatically operated by the rotation thereof.

3. In a rotary furnace the combination of a plurality of muffle chambers disposed in a ring formation around an axis, a ring-shaped header chamber common to the muffle chambers at one end thereof, a second ring-shaped header chamber at the other end thereof, admission and discharge valves for delivering material to the header chamber and from thence to the muffle chambers at one end, further admission and discharge valves for delivering material from the muffle chambers to the second header chamber at the other end and from the second header chamber to the exterior discharge thereof and means automatically operated by rotation of the furnace for actuating said valves.

4. Apparatus as claimed in claim 2, wherein the muffle chamber takes the form of a plurality of tubes which open at their inlet ends into a ring-shaped header chamber which abuts upon the outer sides of the muffle tubes and is provided with internal pockets whereby material fed to the bottom of the header chamber may be carried to the top and there delivered through the admission valves to the muffle tubes.

5. Apparatus as claimed in claim 1 constructed in axial alignment with a rotatable tubular preheating furnace in free communication with the heating flame from the muffle, means for feeding the material to be treated into the preheating furnace and means for transferring it from the said furnace into the muffle.

6. Apparatus as claimed in claim 3 constructed in axial alignment with a rotating tubular preheating furnace in free communication with the heating flame from the muffle, means for feeding the material to be treated into the preheating furnace, and for delivering it from the said furnace to the first said ring-shaped header chamber.

7. Apparatus as claimed in claim 1, wherein the admission and discharge valves are constituted by lift valves having outwardly projecting stems from the rotating furnace operatively connected to valve-actuating members and the valve-actuating members are located so as to be operated by fixed cams disposed around the furnace at appropriate points.

8. Apparatus as claimed in claim 3, wherein the admission and discharge valves are constituted by lift valves having outwardly projecting stems from the rotating furnace operatively connected to valve-actuating members and fixed cams are disposed around the furnace at appropriate points so as to engage and operate the valve-actuating members.

ALEXANDER GRANT McGREGOR.