May 8, 1945. B. J. MOORE ET AL 2,375,317

INDUSTRIAL KILN AND OVEN

Filed April 18, 1944 2 Sheets-Sheet 1

FIG. 1.

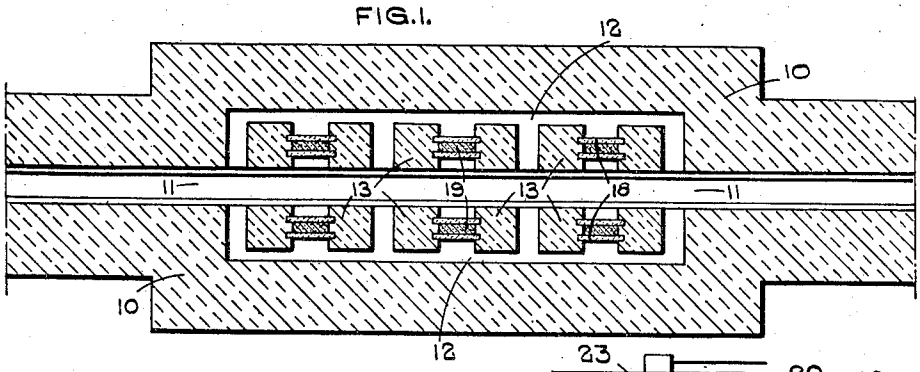


FIG. 2.

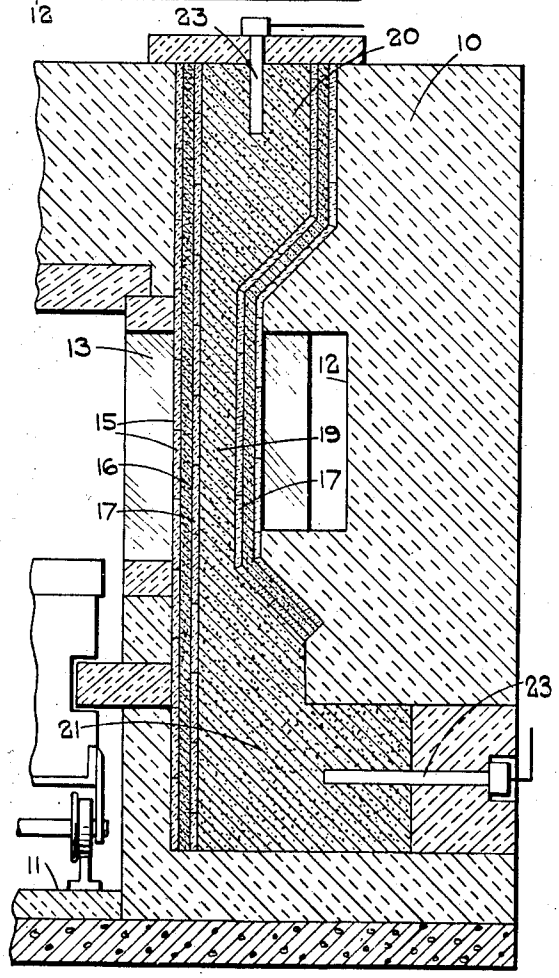
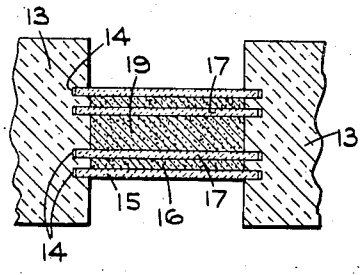


FIG. 3.



INVENTOR

Benjamin Joseph Moore

Benjamin Cline Moore.

BY Henry J. Lucas

ATTORNEY.

May 8, 1945. B. J. MOORE ET AL 2,375,317

INDUSTRIAL KILN AND OVEN

Filed April 18, 1944 2 Sheets-Sheet 2

FIG. 4.

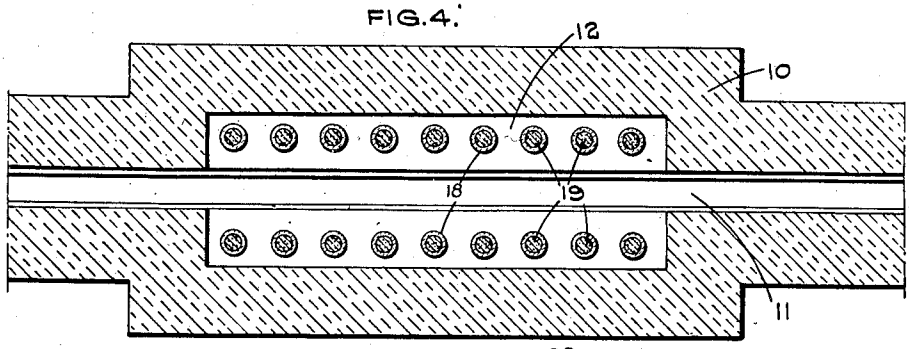


FIG. 6.

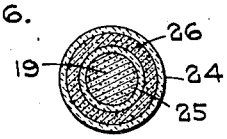


FIG. 7.

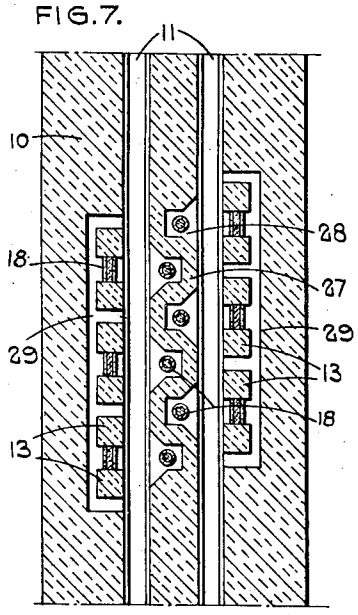
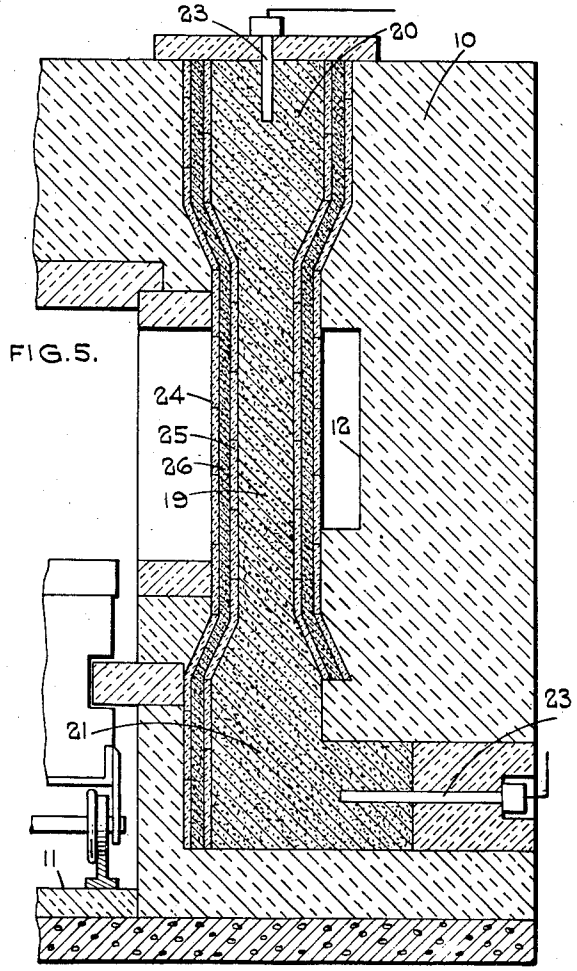


FIG. 5.



INVENTOR

Bernard Joseph Moore

Bernard Clive Moore

BY Henry J. Lucke

ATTORNEY.

Patented May 8, 1945 2,375,317

UNITED STATES PATENT OFFICE

2,375,317

INDUSTRIAL KILN AND OVEN

Bernard J. Moore and Bernard C. Moore,
Stoke-on-Trent, England

Application April 18, 1944, Serial No. 531,591
In Great Britain February 5, 1943

9 Claims. (Cl. 13—22)

This invention relates to industrial kilns and ovens hereinafter referred to and included in the term kiln and has for its object to provide an improved construction of kiln suitable for working at a high temperature.

According to the present invention the kiln is provided with electric resistance heating elements formed of powdered graphite or other electrical conducting material contained in refractory housings, which comprise inner and outer refractory members spaced apart to provide a cavity therebetween and refractory powder filling said cavity.

The invention is particularly applicable to a tunnel kiln and as so applied the kiln may be provided with a plurality of the electric resistance heating elements which may be arranged substantially transversely to the length of the tunnel, i. e., substantially transversely to the direction of flow of the goods through the tunnel kiln.

Normally the heating elements would be arranged substantially vertically and together with the refractory housings disposed in recesses provided at opposite sides of the interior of the kiln, for instance, the kiln may be provided along its sides with a series of spaced brickwork pillars and the heating elements are located in the spaces between these pillars. Those faces of the pillars which are transverse to the length of the kiln may be provided with grooves or ribs extending from top to bottom and engaging these ribs or projecting into the grooves may be edges of refractory members in the form of plates which form the walls of the refractory housings for receiving the powdered graphite.

Alternatively, two refractory tubes of different diameters may be used one within the other and the intervening cavity filled with refractory powder, the powdered graphite or other conducting material being placed within the double-walled housing so formed.

Preferably the housings are elongated in the direction of current flow and may be tapered from top to bottom so that the higher temperature will be generated towards the bottom of the kiln.

In either form the cavity in the housing wall may be packed with powdered fused alumina, sand or any other refractory powder and the refractory members themselves may be made of fused alumina, sillimanite or fireclay although for working at lower temperatures the members may be made of fused quartz or silica.

Referring to the drawings—

Figure 1 is a cross sectional plan view of one form of tunnel kiln constructed in accordance with this invention.

Figures 2 and 3 are a sectional side elevation and a plan view, respectively, of one of the heating elements of the same construction drawn to an enlarged scale.

Figures 4, 5 and 6 are views corresponding with Figures 1, 2 and 3 illustrating a modified construction.

Figure 7 is a cross sectional plan view of multiple tunnel kiln provided with heating elements in accordance with this invention.

Referring to Figures 1 to 3 of the drawings the tunnel kiln there illustrated comprises a main refractory structure **10** of known form provided with the usually elongated heating chamber **11** along which the goods are fed slowly through the kiln and on opposite sides of the chamber the main structure is provided with recesses **12** within which the heating elements are disposed.

In the construction illustrated the heating chamber is arranged substantially horizontally and within the recesses **12** are arranged a plurality of spaced vertical pillars **13** of brickwork or other suitable refractory material. Between opposite faces of adjacent pillars extend vertical refractory walls **18** which are spaced apart to provide, in conjunction with the surfaces of the pillars, a housing for powdered conducting material **19**.

The refractory walls **18**, shown solid for convenience in Figure 1, are illustrated in detail in Figures 2 and 3, from which it will be seen that each comprises spaced outer and inner portions **15**, **17** built up of flat refractory plates placed vertically edge to edge, the cavity **16** between them being packed with a suitable refractory powder, such as fused alumina.

The material **19** forming the core of the heating element is preferably powdered graphite but other conducting materials may be used such, for instance, as other forms of carbon or carborundum.

The refractory housing of each heating element extends from the upper to the lower part of the kiln. The housing is flared outwardly at the upper and lower parts of the kiln and communicate with chamber **20**, **21** of enlarged section which are also filled with the powdered graphite or other conducting material, the effect of making the chambers of larger section being that the temperature of the graphite therewithin will be lower than that of the graphite forming the heating elements proper.

Preferably a pair of chambers **20** and **21** are

provided for each heating element although, if desired, a pair of such chambers may communicate with two or more than two of the elements and whatever arrangement is adapted each chamber is provided with an electrode **23** embedded in the powdered graphite therewithin.

In the alternative construction shown in Figure 4 of the drawings, the refractory members **18** forming the housings for the heating elements are of hollow cylindrical form and, as shown in detail in Figures 5 and 6, each such member comprises an outer tube **24** surrounding an inner tube **25** of smaller diameter so as to leave an intervening cavity **26** of hollow cylindrical form which contains refractory powder. Each tube is built up of a plurality of tubular elements placed one upon another, and the upper and lower ends of the refractory housing are flared outwardly to communicate with chambers **20** and **21** as in the preceding construction.

With this construction the vertical pillars **13** are dispensed with and the cylindrical heating elements are arranged spaced apart in the two recesses **12** of the kiln.

With both constructions it will be observed that the sides of the upper chamber **20** are wholly, and those of the lower chamber **21** are partially, lined by the refractory housing of the associated heating element.

Also in both constructions, the joints between the plates or tubular elements forming the outer wall of the refractory housing are staggered in relation to those forming the inner wall.

The provision of a powdered refractory filling in the cavity **16** or **26** of the housing wall ensures that, should any cracks develop in the inner portion **17** or tube **25** they will immediately become sealed by the fused alumina or other similar material.

In addition to applying the invention to a single tunnel kiln it may be applied to a multiple tunnel kiln for example as shown in Figure 7 wherein the kiln is provided with a pair of spaced tunnels through which the goods travel in opposite directions and the two tunnels are separated by a brickwork wall **27** of substantially zigzag configuration in plan so as to provide adjacent oppositely directed recesses **28** within which are housed heating elements of a form similar to that shown in Figures 4 to 6 of the drawings while the remaining two sides of the tunnels are provided with recesses **29** similar to the recesses **12** of the construction shown in Figures 1 and 3 and provided with heating elements in the manner described in connection with that construction.

In using the construction shown in Figure 7 the temperature in adjacent tunnels can be controlled as desired and one tunnel may be worked at a temperature different from that of an adjacent tunnel.

In addition to applying the invention to tunnel kilns it may be applied to kilns of the oven chamber type in which case, the heating elements constructed as described, may be placed around the sides of the oven chamber with the narrow dimension of each element at right angles to the wall of the oven.

What we claim then is:

1. An industrial kiln provided with electric resistance heating elements formed of powdered conducting material contained in refractory housings said refractory housings comprising inner and outer refractory members spaced apart to provide a cavity there-between and refractory powder filling said cavity.

2. An industrial kiln according to claim 1 wherein said refractory powder comprises fused alumina.

3. An industrial kiln having a heating chamber, said heating chamber having a plurality of spaced recesses, electric resistance heating elements formed of powdered conducting material disposed in each of said recesses, refractory members in the form of spaced plates extending between opposite sides of said recesses, said elements being disposed between said plates and said recess sides.

4. An industrial kiln having a heating chamber, a plurality of spaced pillars arranged at the side of the heating chamber, electric resistance heating elements formed of powdered conducting material disposed between adjacent pillars, refractory members in the form of spaced plates extending between opposite faces of said pillars, said elements being disposed between said plates and said pillar sides.

5. An industrial kiln having a heating chamber, a plurality of spaced pillars arrange at the side of the heating chamber, electric resistance heating elements formed of powdered conducting material disposed between adjacent pillars, two pairs of refractory plates extending between opposite faces of said pillars, said elements being disposed between said pairs of plates and said pillar sides, the plates of each pair being spaced apart to provide a cavity there-between and refractory powder filling said cavity.

6. An industrial kiln provided with electric resistance heating elements formed of powdered conducting material contained in refractory housings comprising a pair of concentric tubes, the inner and outer tubes being spaced apart to provide a cavity there-between and refractory powder filling said cavity.

7. An industrial kiln provided with electric resistance heating elements of elongated form, formed of powdered conducting material contained in refractory housings, opposite ends of said elements communicating with chambers of cross section greater than that of said elements and containing powdered conducting material, electrodes in said chambers in contact with the conducting material therein and refractory members partially surrounding the conducting material within said chambers.

8. A multiple tunnel kiln comprising a pair of adjacent tunnels, a wall separating said adjacent tunnels, said wall being of zigzag configuration to provide recesses directed alternately towards one or the other tunnel and electric resistance heating elements formed of powdered conducting material disposed in each of said recesses and contained in refractory housings.

9. A multiple tunnel kiln comprising a pair of adjacent tunnels, a wall separating said adjacent tunnels, said wall being of zigzag configuration to provide recesses directed alternately towards one or the other tunnel, electric resistance heating elements formed of powdered conducting material disposed in each of said recesses and contained in refractory housings comprising a pair of concentric tubes, the inner and outer tubes being spaced apart to provide a cavity there-between and refractory powder filling said cavity.

BERNARD J. MOORE.
B. C. MOORE.