

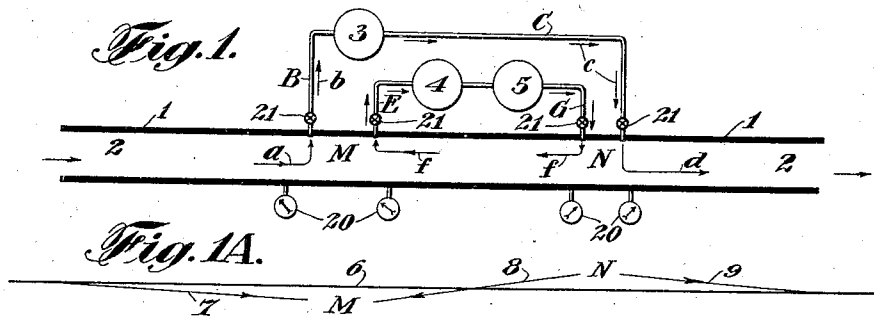
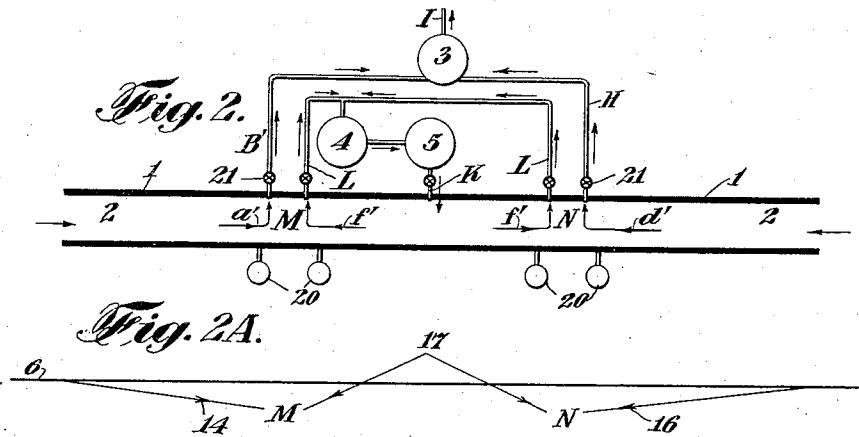
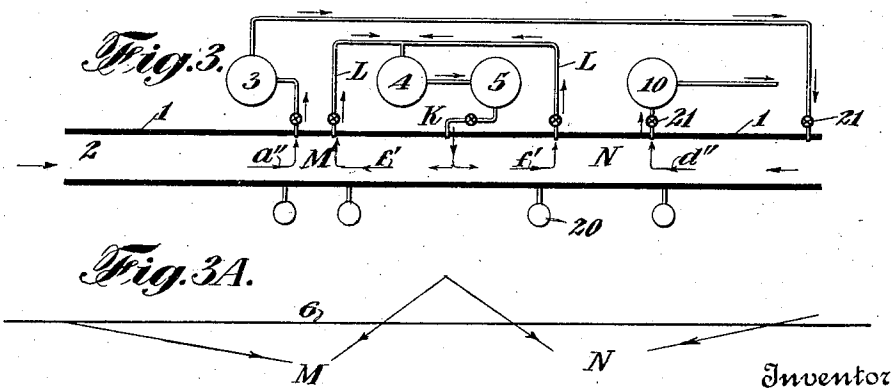
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TUNNEL KILN

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1,643,775



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TUNNEL KILN.

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This invention relates to furnaces, and the particular embodiment herein disclosed shows its application to tunnel kilns wherein material or articles to be heat-treated are passed through a tunnel, the parts of which are heated to the required temperatures. In tunnel kilns for firing ceramic ware, heat-treatment of steel, reduction of ores and other kindred uses, different gases in different parts of the tunnel are often required. For firing porcelain, for example, at lower temperatures, a strongly oxidizing atmosphere may be required, during the process of actual firing a reducing atmosphere, and during the cooling down a strongly oxidizing atmosphere. My invention provides for an improved method whereby one, two or more different gases may be kept within definite limits throughout the tunnel of the furnace without any substantial commingling.

Numerous objects and advantages of my invention will appear from the following description, taken in connection with the accompanying drawing, wherein—

Fig. 1 represents diagrammatically a kiln tunnel with means for supplying gases thereto.

Fig. 1^A is a diagram indicating the pressures of the gases at various points along the length of the tunnel shown in Fig. 1.

Figs. 2 and 2^A are similar to Figs. 1 and 1^A respectively but showing a modified form of my invention, and Figs. 3 and 3^A are similar to Figs. 1 and 1^A respectively but showing a further modification.

Referring to Figs. 1, 2 and 3, reference character 1 represents the walls of the tunnel and reference character 2, the space inside the tunnel. For the purpose of explaining the application of my invention to the form shown in Fig. 1, let it be assumed that between the points M and N in the tunnel space a reducing atmosphere is required, between the point M and the end of the kiln to the left and between the point N and the end of the kiln to the right, an oxidizing atmosphere is required. Reference characters 3 and 4 represent fans or exhaust blowers, and 5 a storage reservoir for carbon monoxide or a carbon monoxide gas producer. When the fan 3 is connected to the tunnel by the pipe B and exhausted into the pipe C, both of which pipes connect with the interior of the tunnel as shown, a stream

of air sucked in from the left-hand end of the tunnel will flow as indicated by the arrows *a*, *b*, *c* and *d*. Fig. 2^A indicates diagrammatically the pressures at various points in the tunnel, the line 6 representing normal atmospheric pressure. Line 7 represents the pressure in the tunnel from the inlet at the left to the point at which the pipe B connects with the tunnel, and shows a gradual decrease in pressure below atmospheric. Line 9 represents the pressure in the tunnel at the right of the point at which the pipe C connects therewith, and shows a pressure above atmospheric and gradually decreasing to atmospheric pressure at the right end of the tunnel. If no means were employed for preventing the flow of air toward the left from N to M, there would be a circulation of air in the tunnel from the outlet of pipe C to the inlet of pipe B. By proper regulation of the flow of carbon monoxide from the reservoir 5 through pipe G, thence through the tunnel as indicated at *f* to the inlet to pipe E and thence to and through the blower 4 so that the pressures of the air and gas at the portion N in the tunnel are substantially equal and the pressures of the air and gas at the portion M are substantially equal. I am able to separate the streams of air and carbon monoxide and prevent any substantial commingling of these gases. The pressures of the carbon monoxide along the tunnel from M to N are indicated by the line 8 in Fig. 1^A, and it will be noted that the pressure of the carbon monoxide at the point M is substantially equal to the pressure of the air at the point M, and that the pressure of the carbon monoxide at the point N is substantially equal to the pressure of the air at the point N.

Referring to Fig. 2, the blower 3 draws in air from both ends of the furnace tunnel along paths *a'* and *d'* to the points M and N respectively. The air then passes along parallel paths through pipes B' and H to the blower 3 and is discharged to the atmosphere through pipes I. The blower or fan 4 discharges through the producer 5 and through the pipe *k* to a point in the tunnel approximately midway between the points M and N, whence the gas flow divides and passes through the tunnel in opposite directions, as indicated at *f'*, to the points M and N, and thence returns to the fan through

pipes L. The pressures in the tunnel are indicated in Fig. 2^A and it will be seen that the pressure drops from atmospheric pressure at the left hand end of the tunnel to the point M, as indicated by the arrow 14. Similarly, the pressure from the right hand end of the tunnel drops from atmospheric pressure to the point N, as indicated by the arrow 16. Between the points M and N the pressure rises to the point 17 which represents the pressure in the tunnel at the outlet of the pipe K. It will be noted in Fig. 2 as well as in Fig. 1 that the pressures of the air and carbon monoxide at the point M are substantially equal, and this is likewise true at the point N. It will also be noted that at the point M the air and carbon monoxide are moving in opposite directions through the tunnel, and this is likewise true at the point N. These two conditions, namely, the equality of the pressure of the two streams at adjacent points and the motion of the gases in opposite directions at these points, serve to effectually prevent any substantial commingling of the gases.

Fig. 3 represents a system similar to that shown in Fig. 2, the principal difference being that by heating the cold air during the passage along the tunnel at a'' to the point M this air may be employed to heat up any ware entering the tunnel at the right and moving toward the point N. This is accomplished by exhausting the gases from the fan 3 into the tunnel at the right hand end and causing them to pass toward the left through the tunnel, as indicated at d'', to the point N, whence they are exhausted through the fan 10 into the atmosphere. The pressures at various points in the tunnel are shown in Fig. 3^A. The heating of the cold ware as it passes into the tunnel by means of heated gases may be utilized in the construction shown in Fig. 1, where it will be seen that if the ware enters the tunnel from the right hand end it will be exposed to the heat of the air which has passed through the tunnel at the left hand end, this air being heated by contact with the heated ware as it passes through the left hand end of the tunnel.

This method of controlling various gases and gas mixtures in various parts of the tunnel or chamber may, of course, be varied at will. Two or three zones such as that shown between M and N may be located in the same tunnel, using different gases. Various oxidizing or other gases may be employed in various parts of the tunnel. The conditions of flow and pressure in the various parts of the tunnel may be indicated by pressure gauges, as shown diagrammatically at 20 in Fig. 1, and the control of the pressures in the various parts of the tunnel

may be effected by control of the blowers or by valves such as are indicated diagrammatically at 21 in Fig. 1. When the heating of cold ware by heated gases is desired, I prefer the forms of my invention disclosed in Figs. 1 and 3. Where, however, this heating is not of great import, the form shown in Fig. 2 is preferable. While I have shown fans or blowers as a means for inducing the draught, chimneys or other draught-inducing appliances may be used. It will be understood that the rate of change in the pressure from point to point of the tunnel, which is indicated in Figs. 1^A, 2^A and 3^A by the angles which the pressure lines make with the datum line 6, may be varied without departing from the spirit of the invention.

I claim:

1. The method of operating a tunnel kiln which comprises causing a stream of gas to enter the tunnel under pressure so as to substantially fill a portion of the tunnel, withdrawing said gas at another point of said tunnel at a pressure below atmospheric, admitting another gas to the tunnel so as to substantially fill another portion of the tunnel, and withdrawing said second gas adjacent the point of withdrawal of said first gas and at substantially the same pressure below atmosphere said gases being in contact with each other adjacent their point of withdrawal.

2. The method of operating a tunnel kiln which comprises substantially filling adjacent portions of the tunnel with an oxidizing gas and a non-oxidizing gas respectively in contact with each other at a predetermined point maintaining a supply of each of said gases to their respective portions of the tunnel, and withdrawing each of said gases at a point adjacent to said point of contact between said gases.

3. The method of operating a tunnel kiln which comprises substantially filling adjacent portions of the tunnel with an oxidizing and a reducing gas respectively, maintaining said gases in direct contact with each other at a predetermined point, and withdrawing gas from said tunnel adjacent said point of withdrawal so as to cause a flow of fresh gas toward said point.

4. The method of operating a tunnel kiln which comprises substantially filling different portions of the continuous tunnel with an oxidizing and a reducing gas respectively, said tunnel portions being in open communication with each other as portions of the same continuous tunnel passage, and withdrawing gas from each of said portions so as to cause a flow of fresh gas in each portion, the material passing through the kiln being subjected to said oxidizing and reducing gases at different times.

5. The method of operating a tunnel kiln

which comprises causing oxidizing gas to flow through separated portions of the length of the tunnel adjacent the two ends thereof, causing a reducing gas to flow through an intermediate portion of the tunnel, the flow of reducing gas at the ends of said intermediate portion being in the opposite direction from the flow of oxidizing gas adjacent the ends of said portion, and the pressure of the reducing gas at each end of said intermediate portion being substantially the same as the pressure of the oxidizing gas adjacent said end.

6. The method of firing ware in a tunnel kiln which comprises causing air to pass through a portion of the tunnel adjacent one end and be exhausted through a portion of the tunnel adjacent the other end, causing a reducing gas to flow through a portion of said tunnel intermediate said first named portions, maintaining a substantially uniform pressure in the tunnel at the portions thereof where the air and gas are adjacent to one another, and passing the ware through the tunnel from the second mentioned end

of said tunnel to the first mentioned end, whereby air which has been heated by outgoing ware serves to heat the ingoing ware.

7. The method of operating a tunnel kiln which comprises drawing air into opposite ends of the tunnel and causing the air to flow through portions of the tunnel adjacent said ends, introducing a reducing gas into said tunnel approximately midway between said portions and exhausting said reducing gas from said tunnel at points adjacent said portions.

8. The method of operating a tunnel kiln which comprises drawing air into opposite ends of the tunnel and causing the air to flow through portions of the tunnel adjacent said ends, introducing a reducing gas into said tunnel approximately midway between said portions, exhausting said reducing gas from said tunnel at points adjacent said portions, and maintaining the pressure in said tunnel substantially uniform along the portions of said tunnel where the gas and air are adjacent to one another.

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