Oct. 18, 1927. 1,646,254

P. A. MEEHAN

TUNNEL KILN

Original Filed June 14, 1923 2 Sheets-Sheet 1

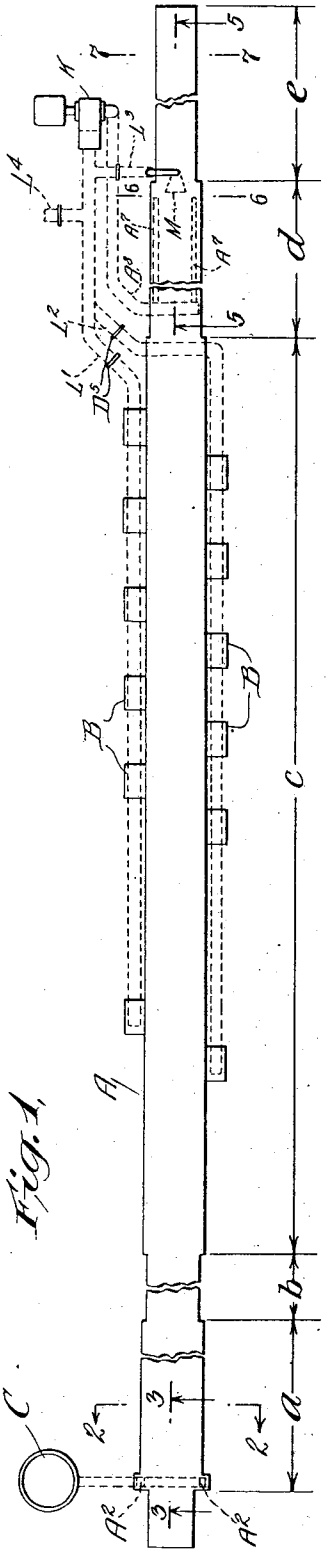


Fig. 1.

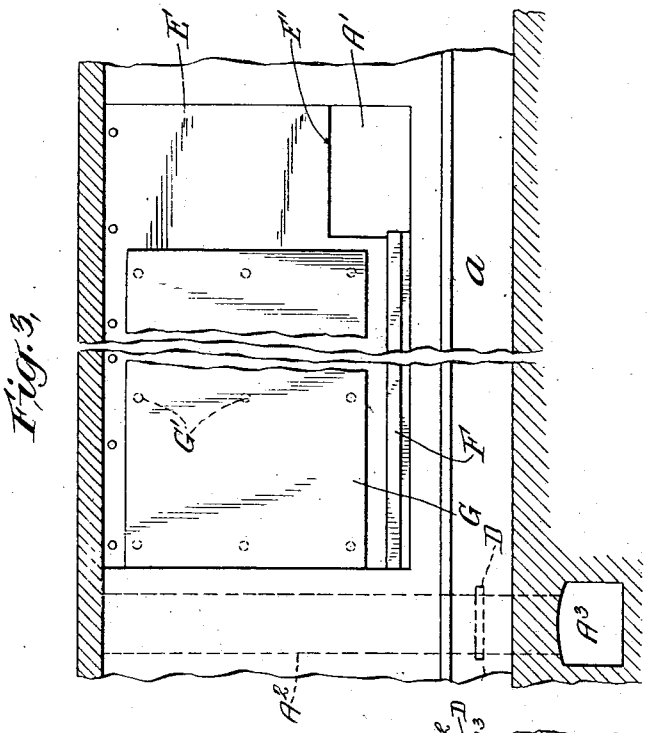


Fig. 3.

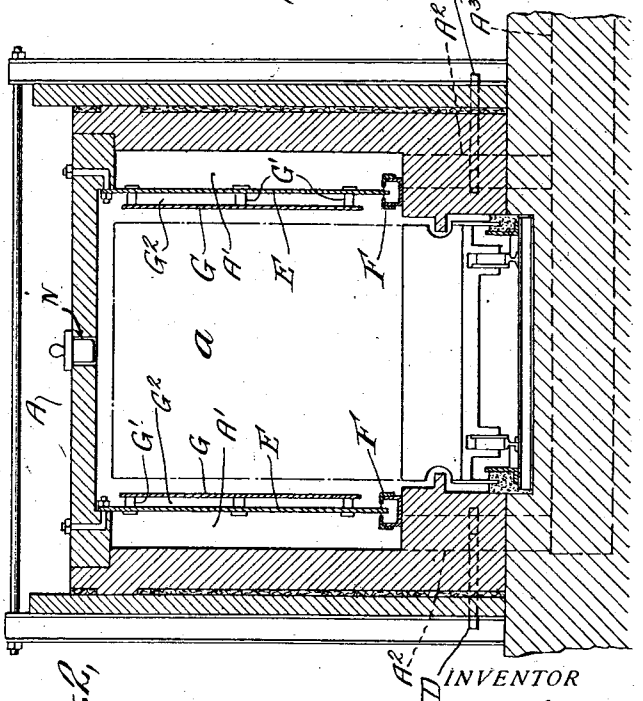


Fig. 2.

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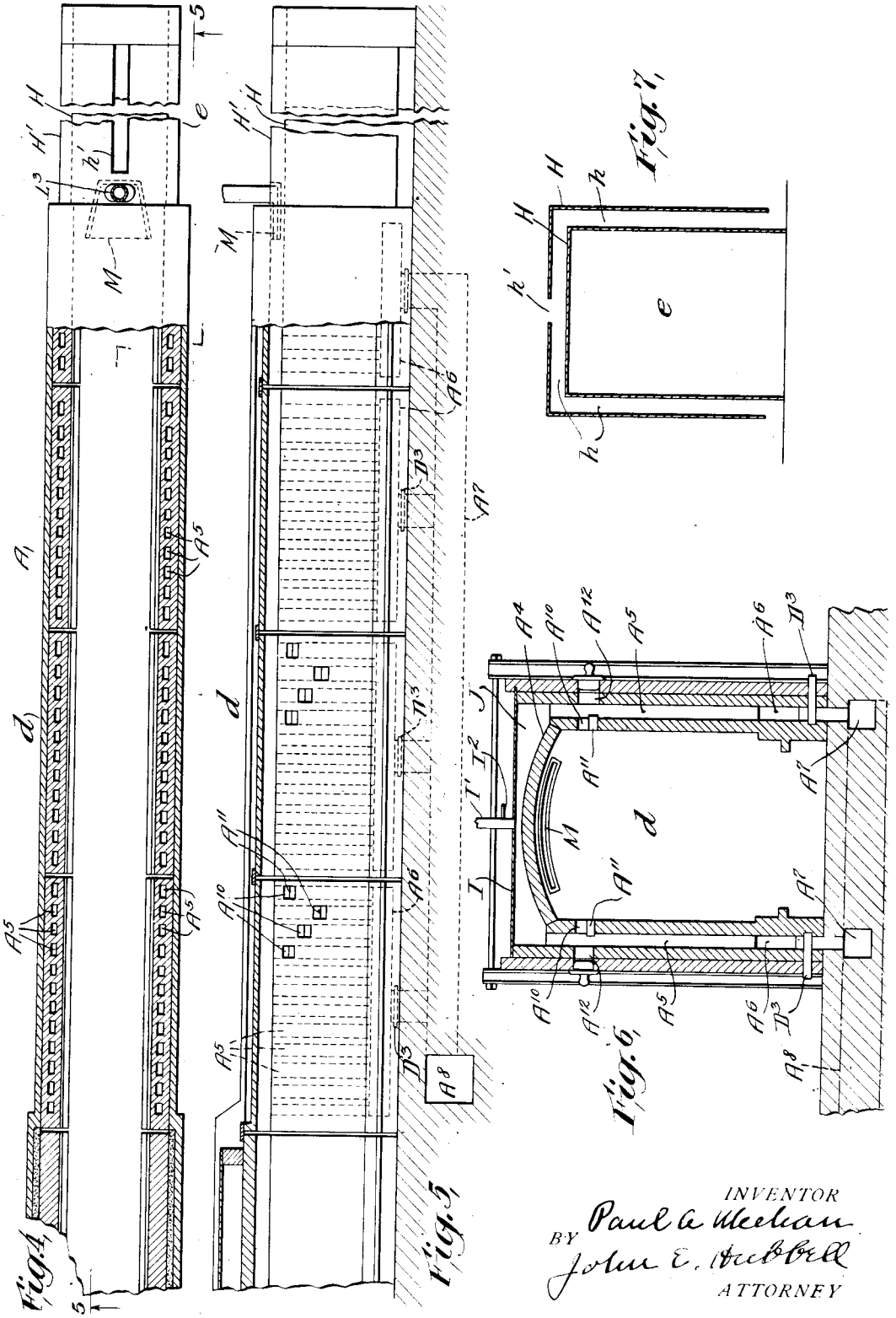


Fig. 4

Fig. 5

Fig. 7

Fig. 6

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Patented Oct. 18, 1927. 1,646,254

UNITED STATES PATENT OFFICE.

PAUL A. MEEHAN, OF CLEVELAND, OHIO, ASSIGNOR TO AMERICAN DRESSLER TUNNEL KILNS, INC., OF CLEVELAND, OHIO, A CORPORATION OF NEW YORK.

TUNNEL KILN.

Application filed June 14, 1923, Serial No. 645,310. Renewed March 19, 1927.

My present invention relates to tunnel kilns and has for its object to provide improved means for controlling the temperature conditions in the end portions of the kiln, whereby the desired graduation in temperature in those portions of the kiln are obtained by means of features of kiln construction and arrangement characterized by their simplicity and effectiveness.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated a preferred embodiment of my invention.

Of the drawings:

Fig. 1 is a diagrammatic plan view of a kiln;

Fig. 2 is a transverse section on the line 2—2 of Fig. 1;

Fig. 3 is a partial longitudinal section on the line 3—3 of Fig. 1;

Fig. 4 is a plan view on a larger scale than Fig. 1, of a portion of the kiln with parts broken away and in section;

Fig. 5 is a partial section on the line 5—5 of Fig. 4;

Fig. 6 is a transverse section on the line 6—6 of Fig. 1; and

Fig. 7 is a section on the line 7—7 of Fig. 1.

In the drawings I have illustrated my invention in connection with an open fire tunnel kiln A, though some of the features of my invention are useful alike in open fire and muffle kilns. The kiln, as shown, comprises a muffled primary preheating zone *a*, a secondary preheating zone *b*, a firing or high temperature zone *c*, a primary cooling zone *d*, and a final cooling zone *e*. The firing or high temperature zone *c* of the kiln is heated by the combustion of fuel in fire boxes B suitably distributed along the two sides of this zone of the kiln. A stack C furnishes draft for moving the burning gases and products of combustion through the firing and secondary preheating zone portions of the kiln chamber, and through the flues A′ in the side walls of the muffled preheating zone *a* of the kiln.

The outer portions of the sides of the muffled section *a* of the kiln are formed of masonry, but the wall between the flue A′ in each such side wall and the kiln chamber proper is formed by a metal plate E which is securely anchored to the masonry structure of the kiln at its upper edges and has its lower edge dipping into a sealing device F comprising a trough shown as made of metal and filled with sand. This construction permits of the expansion and contraction of the plates E relative to the masonry portions of the kiln side walls without creating leakage producing strains. The metal plates E absorb heat rapidly from the heating gases flowing through the flues A. To increase the heat transfer from the plates E to the goods moving through the kiln, plates G are secured to the inner sides of the plates E, as by means of the connecting pieces G′. The plates G are spaced away from the corresponding wall plates E to provide a suitable air space G^2 at each side of the kiln which is open at its lower edge to the kiln chamber adjacent the bottom of the goods pathway, and is open at its upper edge to the kiln chamber adjacent the top of the latter. In operation the air in the air spaces G^2 heats up above the average temperature in the corresponding portion of the kiln chamber, and this sets up a directed and continuous circulation of the kiln atmosphere, which flows into the lower edges of the air spaces G^2, is heated in said spaces and passes out of the latter into the kiln chamber at the top of the latter.

At the junction of the zones *a* and *b* suitable provisions are made for permitting the products of combustion coming from the high temperature zone of the kiln chamber, to pass into the side wall flues A′. In the construction illustrated this is accomplished by cutting away portions of the plates E to provide inlet ports E′ to the flues A′, of suitable size and suitably located. Ordinarily these ports E′ are located adjacent the bottom level of the goods pathway. At the entrance end of the kiln the flues A′ communicate with vertical masonry channels A^2, each provided with a control damper D and each connected at its lower end to a tunnel A^3 running to the stack C.

The final cooling zone *e* of the kiln, in the preferred construction illustrated, is formed with metal inner and outer walls H and H′, respectively, separated by an air space *h* at

the sides and top of the kiln. The space H is open to the external atmosphere at each side of the kiln adjacent the bottom of the latter, and is provided with a hot air outlet h' at its top, which may have regulating dampers. The air space h with its outlet h' acts like a chimney to cause the atmospheric air to flow up through the space h and out into the atmosphere through the outlet h'. This air flow cools the inner wall H of the kiln and thereby enables the latter to absorb heat with the desired rapidity from the goods passing to the exit end of the kiln.

The primary cooling zone d is formed with masonry side walls and a masonry roof wall A^4, and with an air chamber J above the latter. The top wall I of the air chamber J may advantageously be formed of transversely corrugated sheet metal, and is provided with inlets I′ suitably distributed along the length of the kiln and each provided with regulating dampers I^2. In each vertical side wall of this portion of the kiln are formed a series of vertical flues A^5 which are in open communication at their upper ends with the air chamber J. Beneath the flues A^5 are a series of end to end horizontal flues A^6 each of which is connected to the lower end of each of the group of flues A^5 above it. Each of the different flues A^6 at each side of the kiln are connected to a corresponding flue A^7 beneath them, and dampers D^3 regulate the flow from each flue A^6 into the corresponding flue A^7. The two flues A^7 are connected by a cross flue A^8 to the inlet of a fan having outlets L′, L^2, L^3 and L^4, each provided with a regulating damper D^5.

Through the outlets L′ and L^2 the fan K supplies preheated air for the combustion of the fuel in the various fire boxes B. Through the outlets L^3 the fan supplies air to a nozzle M arranged to discharge a flat jet of air into the kiln chamber, along the roof of the latter, at or adjacent the junction of the primary and final cooling zones D and E. The jet discharged by the nozzle M is directed toward the entrance end of the kiln and assists in overcoming the tendency to an undesirable flow of the kiln atmosphere along the roof of the kiln chamber toward the exit end of the latter. To avoid disturbances in the combustion conditions in the high temperature zone d of the kiln which might occur if all or a large part of the air introduced through the nozzle M flowed into that zone, I advantageously withdraw some or all of this air through suitably located ports A^{10} connecting some of the side wall flues A^5 to the interior of the kiln chamber proper. Advantageously, means are provided for throttling the ports A^{10}, more or less, as by means of throttle bricks A^{11} which may be inserted, adjusted and removed through normally closed openings A^{12} in the outer walls of the flues A^6.

Through the outlet L^4, air not required by the nozzle M, or in the fire boxes B may be discharged into the atmosphere, or passed to drying or other apparatus in which it may be used.

In operation as the goods or ware treated progress through the kiln, the goods are initially heated in the muffle zone, a, by heat transmitted through the metal walls E from the heating gases flowing to the stack through the flue A′. The watersmoke or other gases driven out of the goods in this preliminary heating may, if proper kiln pressure and draft conditions are maintained, be discharged from the kiln chamber through an opening or openings N in the roof of the latter, and if not so discharged are drawn into the flues A′ through the ports E′, and hence do not have an opportunity to come into contact with the less highly heated goods on which they may condense or otherwise injure. The fact that the walls between the flues A′ in the kiln chamber may be formed by comparatively thin metal permits of a very rapid heat transfer. The heat transfer rate is augmented, and the distribution of the heat among the goods is improved by the chimney action of the air spaces between the plates E and the plates G. With the described construction the ports E′ can be shaped and located wherever experience or the conditions of operation for a particular kiln make desirable. It will be obvious that in the case of an existing kiln, it is a simple matter to enlarge the ports E′, or to put patches on the plates E at the margin of the ports E′ to thereby contract or change the shape of those ports.

In passing through the kiln zones b and c, the goods are heated up to the desired maximum temperature in the usual manner. As the goods progress through the cooling zone d they are subjected to a cooling action which can be precisely regulated to effect cooling in practically any manner which the character of the goods and conditions of operation make desirable. For example, most clay wares may safely be cooled rapidly down to a temperature several hundred degrees below their maximum temperature, but through a subsequent temperature reduction of some hundred of degrees, a much slower and more gradual rate of cooling is necessary to avoid checking or dunting. The temperature ranges in which the cooling may be rapid and in which it must be slow vary with different goods. It is always desirable, of course, to make the rate of cooling practically as rapid as the character of the ware will permit, since a shortening of the cooling time means in the case of a tunnel kiln, a reduction in the length of the cooling zone, and hence a reduction in the cost of construction of the kiln as a whole.

With the present invention practically any desired rate of cooling in any particular section of the cooling zone *d* can be obtained by a suitable adjustment of the draft regulating dampers connecting the different groups of vertical flues A^5 to the horizontal flues A^6. Moreover, this regulation of the cooling effect is obtained without the introduction of cold air into the high temperature end of the cooling zone with the consequent risk of unduly rapid cooling and resultant injury to portions of the ware on the cars with which the cold air passes into direct contact.

The introduction of air through the nozzles M into the low temperature end of the cooling zone *d* tends to prevent or restrict the drift of the kiln atmosphere along the roof of the kiln chamber from the high temperature zone of the kiln toward the exit end of the kiln, and the corresponding return flow in the lower portion of the kiln chamber. This drift is objectionable, as it interferes with the desired graduation of temperature along the length of the kiln, and the desired uniformity in temperature at different levels in any transverse section of the kiln chamber. By withdrawing this air through the ports A^{10}, the undesirable addition of air to the products of combustion in the high temperature zone of the kiln is avoided. It will also be apparent that by varying the relative draft effects exerted on the kiln chamber adjacent the junction of the zones *c* and *d*, the point along the kiln where appreciable cooling begins, as well as the initial rate of cooling may be varied. The fact that in the zone *d*, the cooling air is drawn from the air chamber J above the masonry roof of the kiln chamber insures an adequate cooling of said roof which is thus swept by the cooling air when in its coldest state.

The hollow metal kiln wall construction employed in the rapid cooling zone *d* of the kiln provides the final cooling result ordinarily desired in this portion of the kiln, with a very simple and effective wall construction, and without requiring any fans or the like.

While in accordance with the provisions of the statutes, I have illustrated and described the best forms of my invention now known to me, it will be apparent to those skilled in the art that many changes in form may be made without departing from the spirit of my invention, and that certain features of my invention may sometimes be employed to advantage without a corresponding use of other features.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In an open fire tunnel kiln having side wall flues along a section of the kiln adjacent its entrance end and draft creating means for drawing heating gases from the kiln chamber into and through said flues, the improvement which consists in walls between said flues and the kiln chamber comprising metal plates suspended from the roof of the kiln, and sealing troughs into which the lower edges of said plates extend.

2. In an open fire tunnel kiln having side wall flues along a section of the kiln adjacent its entrance end and draft creating means for drawing heating gases from the kiln chamber into and through said flues, the improvement which consists in metal walls separating said flues from the kiln chamber and formed with flues opening to the kiln chamber at upper and lower levels.

3. In a tunnel kiln, a cooling zone section having vertical flues in and distributed along the length of its side walls and means associated with adjacent groups of said flues for exerting a separately regulable draft suction effect on each group of flues.

4. In a tunnel kiln, a cooling zone section having vertical flues in its side walls, a series of longitudinal flues distributed along the length of said cooling zone section and each connected to an adjacent group of vertical flues, and means associated with each longitudinal flue for regulating the flow of cooling air through the vertical flues to which it is connected.

5. In a tunnel kiln having vertical side wall flues distributed along the length of a cooling zone portion of the kiln, the improvement which consists in a series of longitudinal flues arranged end to end along the length of said cooling zone portion and each connected to an adjacent group of vertical flues, and means associated with each longitudinal flue for regulating the flow of cooling air through the corresponding group of vertical flues.

6. In a tunnel kiln, a cooling zone section having vertical flues in its side walls distributed along the length of the zone, a series of horizontal flues to which the lower ends of the vertical flues are connected, each of said horizontal flues being connected to a group of vertical flues, and means for exerting different draft suction effects on the different horizontal flues.

7. In a tunnel kiln, a cooling zone section formed with masonry side and roof walls, and with an air chamber above the roof walls and having ports opening to the atmosphere and with vertical flues in its side walls communicating at their upper ends with said air chamber, and means for exerting different draft suction effects on different ones of said flues.

8. In an open fire kiln comprising a high temperature zone and a cooling zone, provisions for supplying heated air to the cooling zone portion of the kiln chamber at a

point remote from, and in a stream directed toward said high temperature zone and flowing along the roof of the kiln chamber, and means for withdrawing air from the kiln chamber at a point intermediate the first mentioned point and said high temperature zone.

9. In a tunnel kiln the improved final cooling zone portion of the kiln comprising a hollow metal kiln wall formed with an air space open to the atmosphere adjacent the bottom of the kiln and above the top of the kiln chamber.

10. In a tunnel kiln the improved final cooling zone portion of the kiln comprising an inner metal kiln wall and an outer wall of metal spaced away from the inner wall to provide an air space enveloping the sides and top of the kiln chamber and communicating with the atmosphere adjacent the bottom of the kiln, and above the top of the kiln chamber.

11. In an open fire kiln comprising a high temperature zone and a cooling zone, provisions for withdrawing air from a relatively high temperature portion of the cooling zone thereof and for passing air thus withdrawn back into the kiln chamber in a relatively low temperature portion of the cooling zone thereof, in a stream directed toward said high temperature zone of the kiln and flowing along the roof of the kiln chamber.

12. In a tunnel kiln having vertical side wall flues distributed along the length of a cooling zone portion of the kiln, the improvement which consists in a series of longitudinal flues arranged end to end along the length of said cooling zone portion and each connected to the lower ends of the vertical flues in an adjacent group, and a damper controlled port associated with each longitudinal flue for regulating the flow of cooling air through the corresponding group of vertical flues.

Signed at Cleveland, in the county of Cuyahoga and State of Ohio this 8th day of June, A. D. 1923.

PAUL A. MEEHAN.