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CONTINUOUS HEATING METHOD AND APPARATUS

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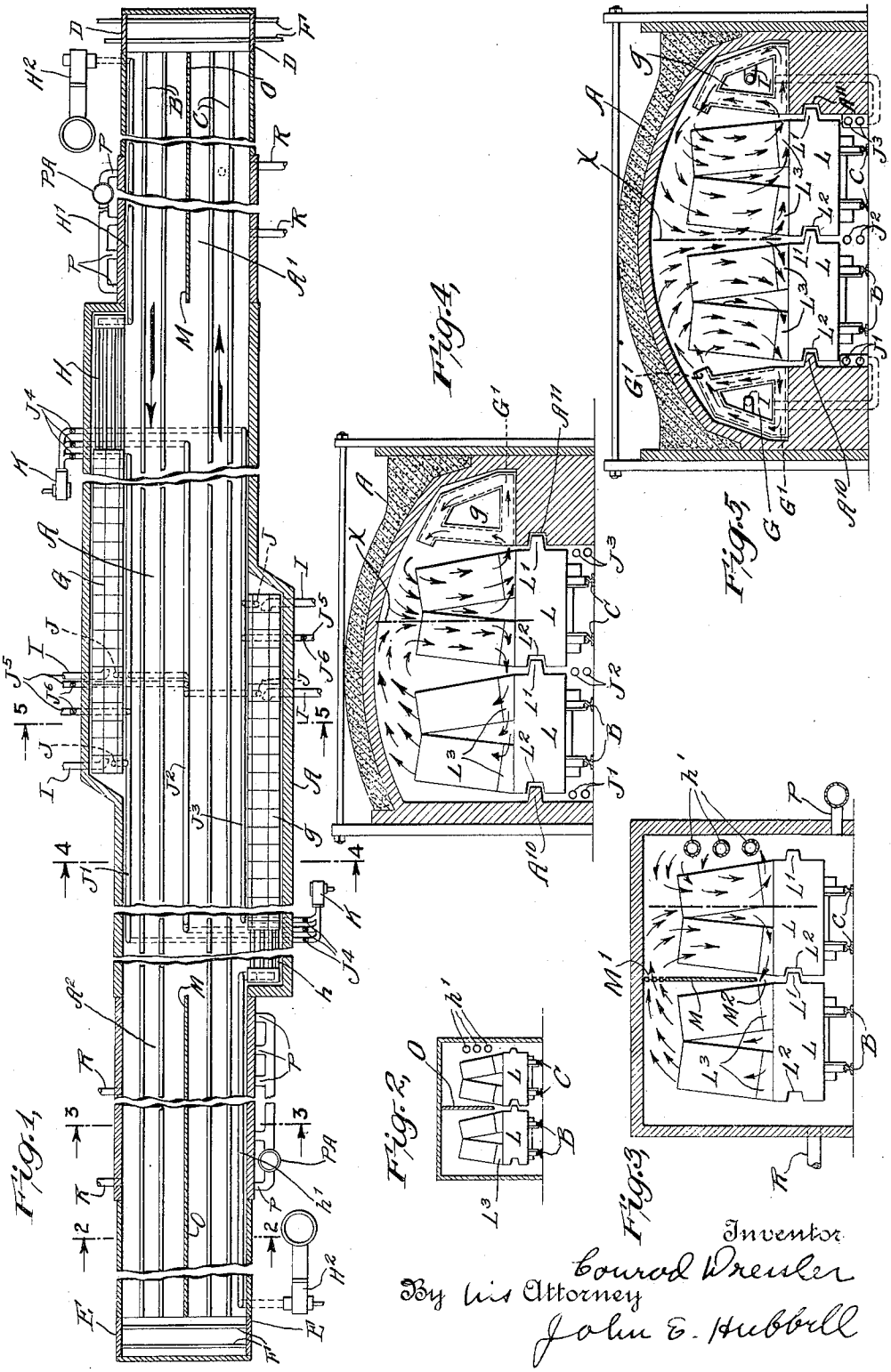


Fig. 4.

Fig. 5.

Fig. 4.

Fig. 2.

Fig. 3.

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UNITED STATES PATENT OFFICE.

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CONTINUOUS HEATING METHOD AND APPARATUS.

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To all whom it may concern:

Be it known that I, CONRAD DRESSLER, subject of the King of Great Britain, and resident of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Continuous Heating Methods and Apparatus, of which the following is a specification.

My present invention comprises an improved method of continuously heating material and an improved form of continuous tunnel kiln especially devised for carrying out my improved method. My improved kiln is of the duplex or twin tunnel kiln type, in which the material to be heated is passed in two parallel but oppositely moving streams through an elongated kiln, so that in each end portion of the kiln the outgoing material in the one stream is cooled and the incoming material in the other stream is heated by a heat transfer between the two streams, heat from the combustion or fuel or other independent source being supplied as required to bring the material in each stream to the desired maximum temperature in the central zone of the kiln.

The general object of the invention is to provide for a more effective utilization of the characteristic principles of a duplex tunnel kiln than has heretofore been made; and, in particular, to obtain a more uniform heating up of the material in each incoming stream than is possible of attainment in the known forms of duplex kilns.

A specific object of the invention is the provision of novel drier extensions to the ends of a duplex kiln whereby the available heat in the material and products of combustion leaving the heating kiln proper, may be advantageously utilized in drying the material heated in the kiln.

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, the advantages possessed by it, and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred form of apparatus.

Of the drawings:

Fig. 1 is a sectional and somewhat diagrammatic plan; and Figs. 2, 3, 4 and 5 are transverse sections taken, respectively, on the lines 2—2, 3—3, 4—4 and 5—5 of Fig. 1.

The particular apparatus shown in the drawings was primarily devised for use in drying and burning brick though not necessarily restricted to this use. The apparatus comprises a horizontally elongated kiln chamber A with extensions A′ and A² at its ends forming drying chambers. The walls of the kiln chamber are formed of refractory masonry, while the walls of the drying chambers may be formed of masonry, wood, or other suitable material. Extending longitudinally through the structure are track rails B, and track rails C. The goods treated in the kiln are carried on cars L running on the track rails B and C. The cars running on the track rails B enter the structure past one or the other of the doors D at the end of the chamber extension A′, being moved into the structure by the usual transfer table or car (not shown) running on the track rails F. The cars L running on the track rails C leave the structure past one or the other of the doors D and are moved out of the kiln by the transfer car or table running on the track rails F. At the opposite end of the structure are outlet doors E and rails F for a transfer car or table (not shown) which is employed to enter and remove from the kiln the cars running, respectively, on the track rails C and B.

Each car presented at either end of the kiln, is pushed into the kiln by a corresponding car pusher (not shown) of which various suitable forms are well known. Each pusher, on pushing a car into the kiln, thereby advances the corresponding train of cars on the same track one car length. A car is thus ejected at one end of the kiln structure each time a car is inserted at the opposite end. At the side of the kiln chamber A adjacent the track rails B is located a combustion chamber G. Conduit extension H and H′ thereof run toward the end of the kiln at which the cars on the track rails B enter the kiln, the extension H being located in the kiln chamber proper and the extension H′ being located in the drier chamber A′. A similar combustion chamber *g*, and exten-

sions h and h' of the latter, are located at the opposite side of the structure, but in this case the extensions h and h' run to the end of the kiln at which the cars on the track rails C enter the kiln and the extension h' is located in the drier chamber A^2. The combustion chambers G and g overlap one another along a central portion of the kiln chamber. The kiln chamber is laterally enlarged to receive the combustion chambers G and g and their extensions H and h. Each of the combustion chambers G, and g, as shown, is of the construction commonly employed in the well-known Dressler tunnel kiln having walls formed of hollow tile, providing open ended channels G' through which streams of the kiln atmosphere may flow upward past the combustion chamber proper. Combustible gas or other fuel is introduced into each combustion chamber through one or more inlets I of which two are shown for each combustion chamber. Adjacent each fuel inlet I, is an air inlet J. The products of combustion are drawn through each combustion chamber and its extensions, by a corresponding draft creating device which may be a stack or fan. As shown a separate fan H^2 is connected to each of the combustion chamber extensions H' and h' for this purpose.

The air entering the combustion chambers through the inlets J, is supplied, in the apparatus shown, by blowers K and sets of metal pipes J', J^2 and J^3 which are located alongside and between the track rails B and the track rails C. The pipes J', J^2 and J^3 run along the track rails through the high temperature portion of the kiln and serve to cool the under portions of the goods carrying cars as well as the track rails on which they run. At the same time the air flowing through the pipes J', J^2 and J^3 is so heated that it enters the combustion chamber at a desirably high temperature. Advantageously, as shown, each of the sets of pipes J', J^2 and J^3 is separately connected at each end to a corresponding blower K by separate connections including a throttle valve J^4, so that the proper distribution of flow among the various pipes J', J^2 and J^3 may be insured. If it becomes necessary, in order to obtain the desired car cooling effect, to blow more air through the pipes J', J^2 and J^3 than is required to support combustion in the combustion chambers G and g, some air may be allowed to escape from the pipes J', J^2 and J^3 through outlets J^5, each of which is provided with a regulating valve J^6. Flow of the kiln atmosphere between the portion of the kiln chamber above the tops of the cars and the portion of the kiln chamber below the cars is restricted by providing each car with a rib L' at one side and groove L^2 at the opposite side, and by providing a rib A^{10} projecting from one side wall of the kiln, and a groove A^{11} in the opposite side wall of the kiln. The rib A^{10} enters the aligned grooves L^2 in the adjacent train of cars while the aligned ribs L' of the cars in that train enter the grooves L^2 in the other train of cars, and the ribs L' of the last mentioned train of cars enter the grooves A^{11}.

The two pathways for the goods are separated in the entrance end portion or zone of each of the drying chamber extensions A' and A^2, by a partition or screen wall O which may be formed of metal plate or wood, and is suspended from the roof of the kiln chamber. In the remaining portion of each drying chamber, a screen member M is placed between the two goods pathways. These screens may be formed of metal plate or wood, and are suspended from the kiln roof as are the screens O, but the partitions M are spaced away from the roof and from the tops of the cars, or are otherwise arranged to provide ports M' and M^2 connecting the two goods pathways at the top of the chamber and adjacent the tops of the car bodies. The car bodies are provided with pier like extensions at their tops, or are otherwise formed to provide channels L^3 which are open at their upper sides and are open at the sides of the cars at the level of the ports M^2, and of the passages G' in the bottom walls of the combustion chamber. Suitable provisions are made for the removal of moisture from the driers and for the admission of air to facilitate the moisture removal. The provisions shown for this purpose comprise air inlets R and outlets P for moist air, both located adjacent the bottom of the driers, the inlets R being at the hot side and the outlets P at the cool side of each screen M. Each set of outlets P may be connected to a suitable stack PA or other exhausting device creating a slight draft which must not be great enough to interfere with the kiln and drying chamber circulation hereinafter described.

In the intended method of using the apparatus shown, the brick or other material to be treated are piled in a pyramidal and vertically pervious mass on each of the cars L.

During the initial portion of the travel of each car through the apparatus, the goods carried by it are subjected to a gentle warming action in the zone of the corresponding drier along which the corresponding partition O is located. This gradually heats up the goods while the surfaces of the latter remain moist in the absence of any exposure to appreciable air currents. It will ordinarily be unnecessary to remove vapors through roof openings or other outlets from this zone of the drier. As the goods pass through the succeeding drier zone, they are subjected to a more energetic warming action and are wholly or largely dried. The

steam and vapor driven out of the goods being dried, escapes from this zone through the outlets P, along with excess air, blown into the kiln chamber through the inlets R. After the goods being dried and heated up move into the kiln chamber proper, they are subjected to a still more vigorous heating action, and finally reach their maximum temperature in the central zone of the kiln in which the two combustion chambers G and *g* overlap. As the goods pass from this central zone they begin to fall in temperature because of their transfer of heat to the goods approaching the central zone of the kiln from the opposite direction. The cooling effect is enhanced, of course, as the goods pass through the drying zone traversed by the partition M, because in this zone of the kiln the heat of the goods being cooled is utilized in large part in evaporating moisture in the goods being heated up and dried in that kiln zone.

A characteristic advantage of the apparatus and mode of operation described of much practical importance is the relatively uniform manner in which all portions of the load of goods on each car is dried, heated and cooled in its progress through the kiln and drying chambers. This is because the heating up of the goods and their cooling are both mainly due to convection currents of the chamber atmosphere which act in a very uniform manner on the goods. With the arrangement and mode of use described shown there are set up in all zones of the apparatus except those containing the partitions O, two sets of convection currents of the chamber atmosphere. In the central portion of the kiln one set of these currents is created by the heat of each combustion chamber. Elsewhere one set of currents is created by the heat of the combustion chamber or its extension at the one side of the goods being heated up, and the other set is created by the difference in temperatures between the goods being heated up and the goods moving in the opposite direction. These two sets of convection currents have oppositely directed orbital movements indicated by the arrows in Figs. 3, 4 and 5. Midway between the ends of the central zone of the kiln, the two sets of convection currents will normally be symmetrical. The up flow in this portion of the kiln chamber will be wholly through the passages G′ of the two combustion chambers G and *g*, and the down flow will be quite equally divided between the two goods pathways. Nearer the end of the apparatus the up flow at the one side will be through the goods being cooled, and the down flow for both sets of currents will be mainly or wholly confined to the pathway for the goods being heated. The relative importance of the convection currents rising through the good being cooled ordinarily increases with the distance from the central zone of the kiln, as the goods being cooled will ordinarily not cool as they travel away from the central zone as rapidly as do the products of combustion in the combustion chamber and its extension at the other side of the kiln, or as rapidly as the goods being heated, heat up. In consequence the plane X of division between the two sets of current shifts ordinarily from the longitudinal center of the kiln in the central zone of the kiln, to a position somewhat beyond the center of the pathway for the goods being heated at the points at which the partitions O and M meet. The progressive shifting of this plane X is itself an advantage because of the tendency to the development of a relatively cool portion of the goods at the bottom of this plane. The cooling of the goods moving away from the central zone of the kiln, by the convection current transfer of heat, increases as does the volume of these currents with the difference in temperature between the goods in two streams. The partitions M, the length of which relative to the length of the kiln as a whole may vary considerably with conditions, advantageously separate the two goods pathways in the portions of the apparatus in which there is substantial difference in temperature between the goods being heated up and the goods being cooled. The partitions M then tend to prevent local and consequently unequal goods heating and cooling, both by preventing appreciable transfer of heat by direct radiation from the goods in one pathway to the goods in the other, and by giving proper direction to the convection currents.

The utilization of the track and car cooling pipes J′, J² and J³ as the air supply pipes for the combustion chambers provides a desirable preheating of the air supporting combustion without requiring an air flow through the goods pathways which would interfere with the desired convection current heating and cooling of the goods.

The relative proportions of different portions of the apparatus may obviously vary widely but it may not be amiss to state, by way of example, that in a large brick drying and heating kiln, the preliminary drying zones may well be each forty (40) feet or so in length, the second drying and heating zones (alongside the partitions M) may be eighty (80) feet or so in length, the central zone in which the combustion chambers overlap may be forty-five (45) feet or so in length, and the portions between the central zone and the partitions M may be one hundred (100) feet or so in length.

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 changes may be made

in the form of apparatus disclosed without departing from the spirit of the invention set forth in the appended claims, and that certain features of the invention may sometimes be used 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. The method of heating material which consists in passing the material in two oppositely moving streams along side by side pathways through an elongated chamber and in subjecting the material in each stream during an initial portion of its travel through the chamber to the action of a set of convection currents of the chamber atmosphere wholly induced by the heat of the adjacent material in the other stream, and to the action of a second set of convection currents of the chamber atmosphere induced by a separate source of heat.

2. The method of heating material which consists in passing the material in two oppositely flowing streams along side by side pathways through an elongated chamber and in subjecting the material in each stream during an initial portion of its travel through the chamber to the action of a set of convection currents of the chamber atmosphere wholly induced by the heat of the adjacent material in the other stream, and to the action of a second set of convection currents of the chamber atmosphere induced by a separate source of heat which is separated from the last mentioned stream of goods by the other stream of goods.

3. In a tunnel kiln, the combination with an elongated kiln chamber and means for moving goods in opposite directions through the chamber along side by side pathways in open communication with each other, of two kiln heaters, one at each side of the kiln and each comprising one portion overlapping the other along a central portion of the kiln and a portion extending away from said overlapping portion toward the end of the kiln chamber at which the goods on the adjacent pathway enter the kiln, so that each stream of goods as it approaches said central portion of the kiln chamber may heat the adjacent kiln heater and the oppositely moving goods.

4. In a tunnel kiln, the combination with an elongated kiln chamber and means for moving goods through said chamber in opposite directions along side by side pathways in open communication with each other, of two kiln heaters, one at each side of the kiln and each comprising one portion overlapping the other and a portion extending away from said overlapping portion toward the end of the kiln chamber at which the goods on the adjacent pathway enter the kiln.

5. In a tunnel kiln, the combination with an elongated kiln chamber, of two sets of tracks arranged side by side at the bottom of the kiln chamber, goods carrying cars running in one direction along one of said tracks, other goods carrying cars running in the opposite direction along the other track, combustion chambers at the sides of the kiln, means for supplying fuel to said combustion chambers, and means for supplying air to said combustion chambers comprising air supply pipes extending along the tracks whereby the under portions of the cars running on the tracks are cooled and the air passing through the pipes is preheated before its delivery to the combustion chambers.

6. In a tunnel kiln and drier, the combination with an elongated chamber and means for moving goods through said chambers in opposite direction along side by side pathways, of two heating devices one at each side of the chamber and each comprising a portion overlapping the other along a central portion of the chamber and another portion extending toward the end of the chamber at which the goods moving along the adjacent pathway enter the chamber, means separating the two goods pathways adjacent the ends of the chamber to prevent the drying of the entering goods by convection currents of the chamber atmosphere induced by the heat of the goods leaving the chamber.

7. In a tunnel kiln, the combination with an elongated chamber having two side by side trackways for goods-carrying cars, of cars running on each of said trackways, and a partition separating the pathways for the goods on the cars running on one track from the pathway for the goods on the other cars running on the other track, said partition being suspended from the roof of the chamber and extending into proximity with the tops of the cars.

8. In a tunnel kiln, the combination with an elongated chamber having two side by side trackways for goods carrying cars, of cars running on each of said trackways, and a partition separating the pathways for the goods on the cars running on one track from the pathway for the goods on the other cars running on the other track, said partition being suspended from the roof of the chamber and extending into proximity with the tops of the cars, with ports at top and bottom of said partition to permit circulation of the kiln atmosphere from one pathway to the other.

9. In a tunnel kiln the combination with an elongated chamber and means for moving goods through said chamber in opposite direction along side by side pathways, of two kiln heating devices one at each side of the kiln and each comprising a portion overlapping the other along a central portion of the kiln and another portion extending to-

ward the end of the kiln at which the goods moving along the adjacent pathway enter the kiln; and a screen interposed between the two goods pathways, adjacent the ends of the chamber, to restrict heat radiation from the goods in one pathway to the goods in the other, with ports at top and bottom of said screen permitting free circulation of the kiln atmosphere from one pathway to the other.

Signed at New York in the county of New York and State of New York this 24th day of February, A. D. 1920.

CONRAD DRESSLER.