Sept. 15, 1942. F. O. HESS 2,295,732

CONTINUOUS KILN

Filed April 30, 1938 4 Sheets-Sheet 1

Fig. 1.

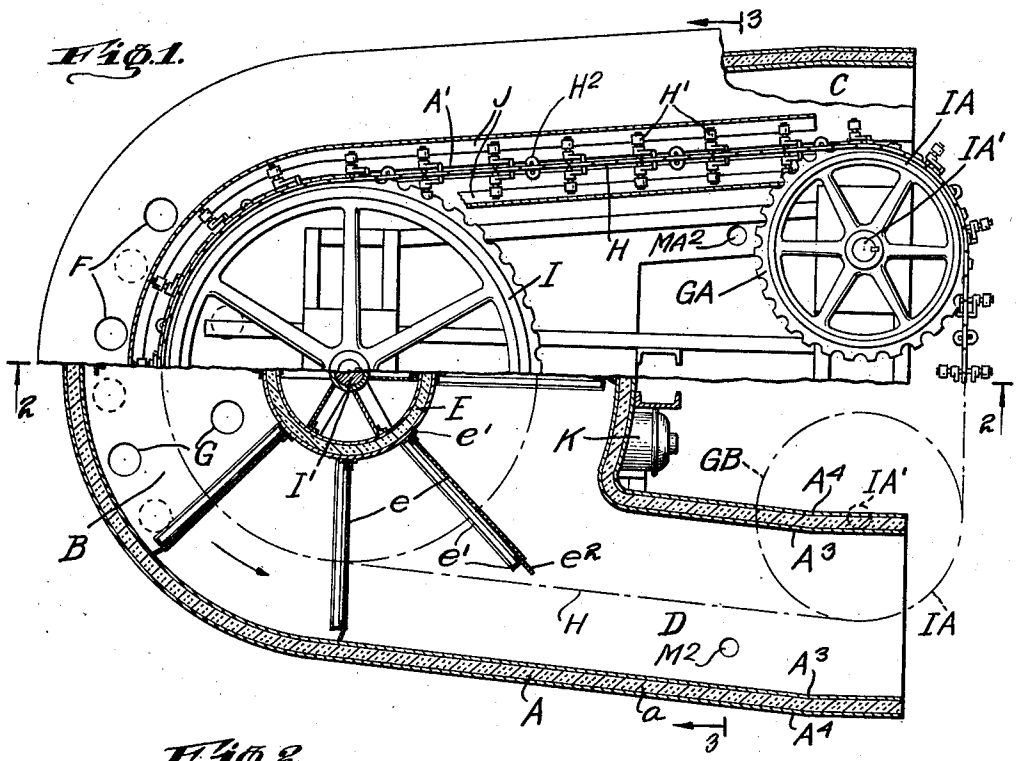
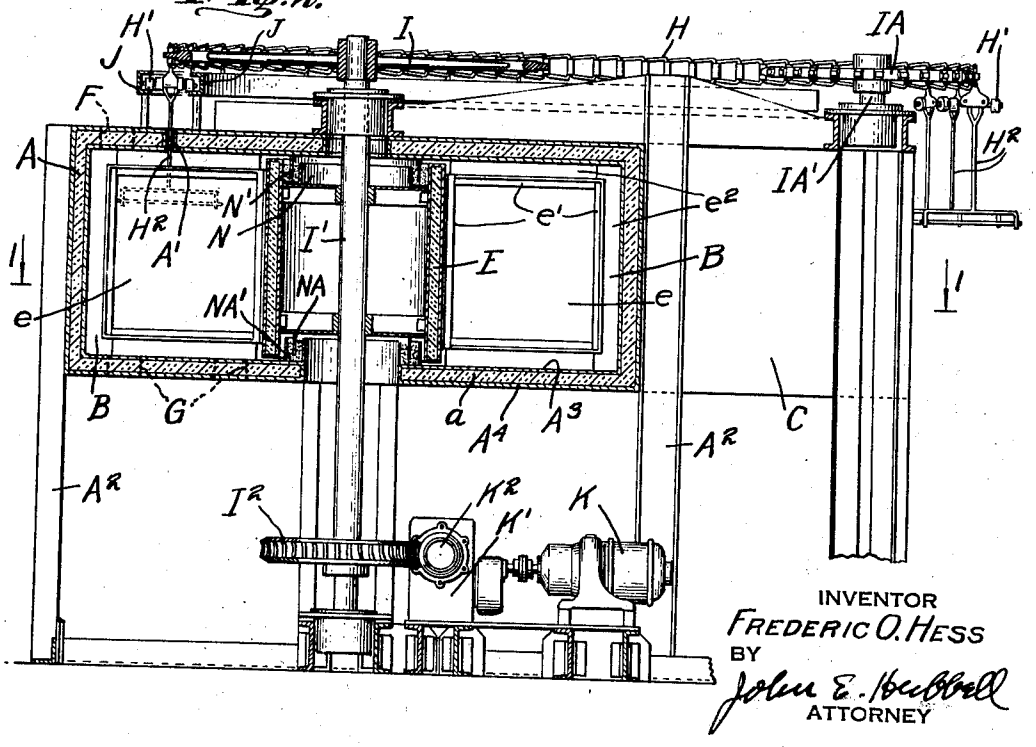


Fig. 2.



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Sept. 15, 1942. F. O. HESS 2,295,732

CONTINUOUS KILN

Filed April 30, 1938 4 Sheets-Sheet 2

Fig. 3.

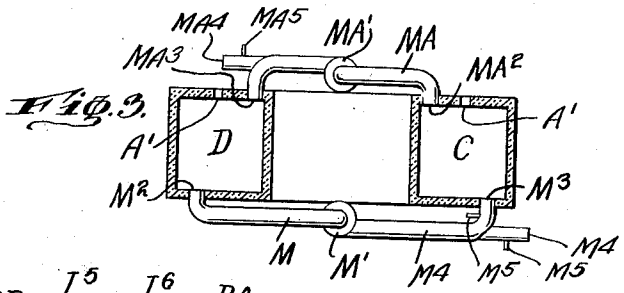


Fig. 4.

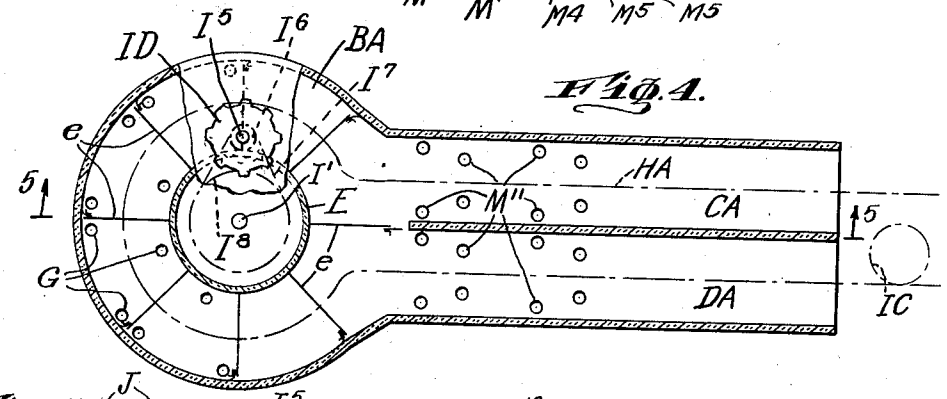


Fig. 5.

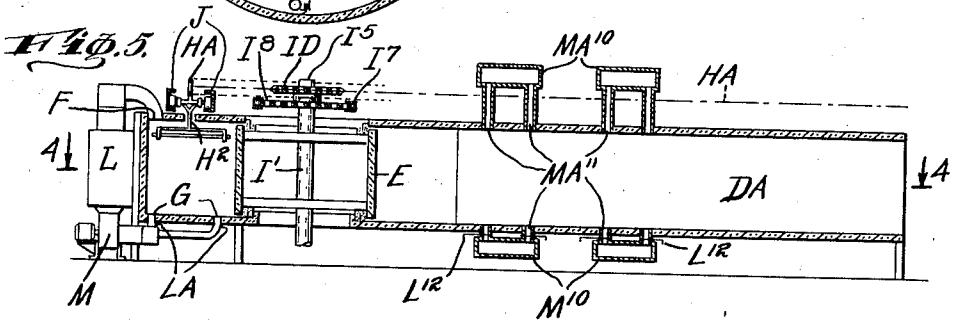
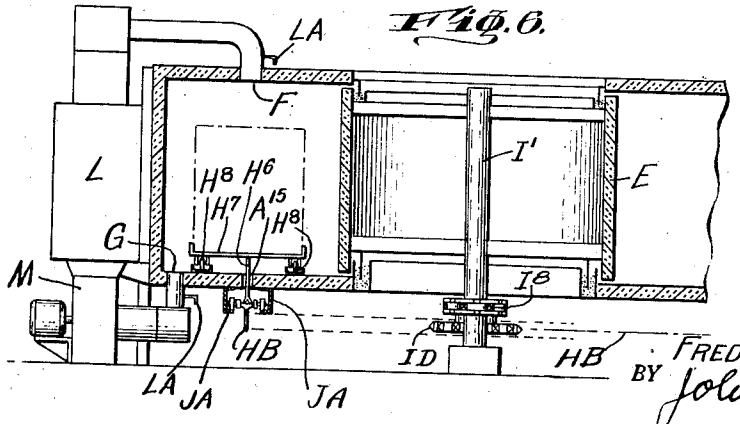


Fig. 6.



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Sept. 15, 1942. F. O. HESS 2,295,732

CONTINUOUS KILN

Filed April 30, 1938 4 Sheets-Sheet 3

Fig. 7.

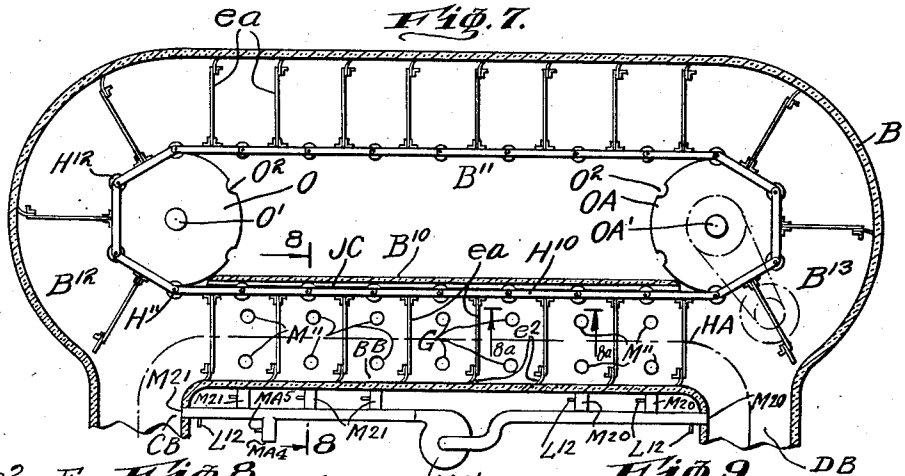


Fig. 8.

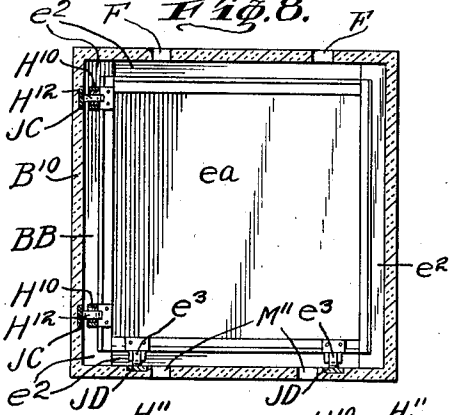


Fig. 9.

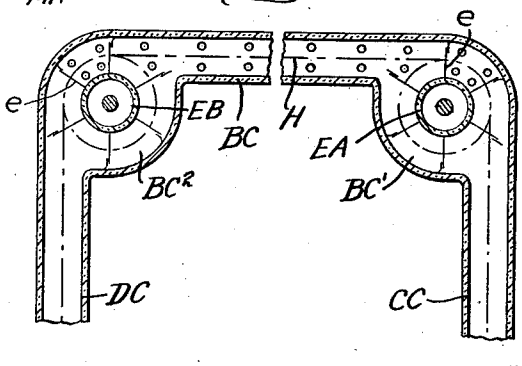


Fig. 8a.

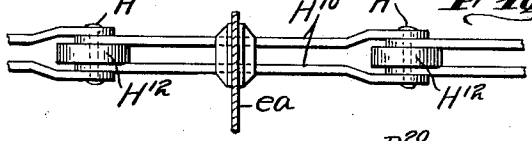


Fig. 11.

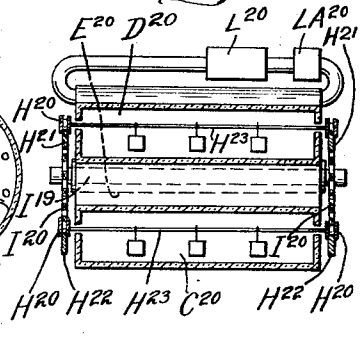


Fig. 10.

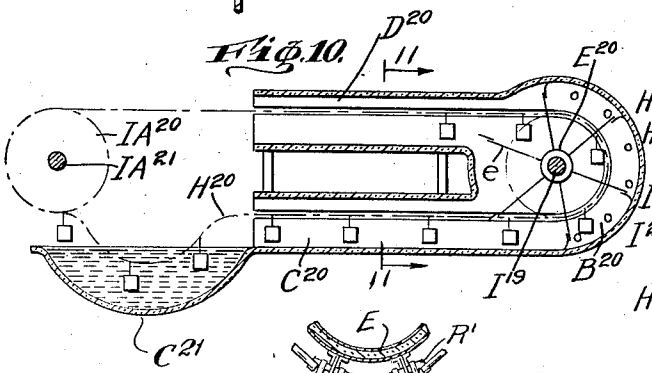
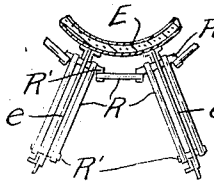


Fig. 12.



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Sept. 15, 1942. F. O. HESS 2,295,732

CONTINUOUS KILN

Filed April 30, 1938 4 Sheets-Sheet 4

Fig. 13.

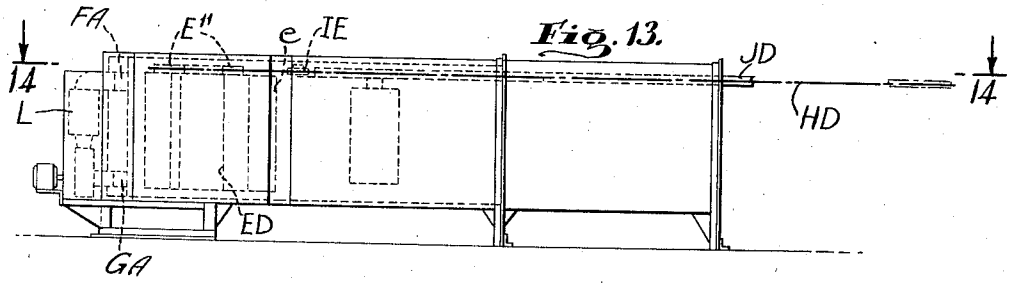


Fig. 14.

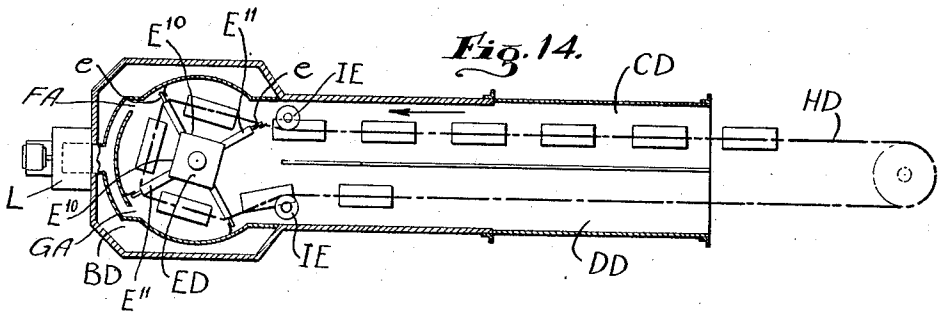


Fig. 15.

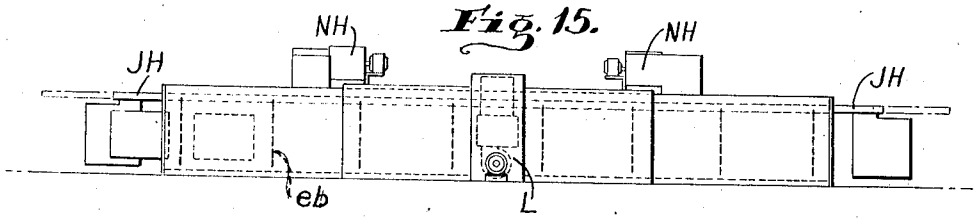
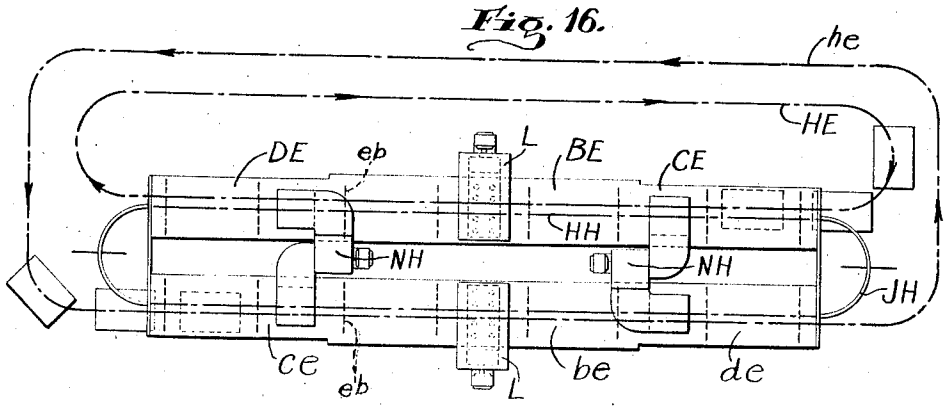


Fig. 16.



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Patented Sept. 15, 1942

2,295,732

UNITED STATES PATENT OFFICE

2,295,732

CONTINUOUS KILN

Frederic O. Hess, Philadelphia, Pa., assignor to The Selas Company, Philadelphia, Pa., a corporation of Pennsylvania

Application April 30, 1938, Serial No. 205,254

16 Claims. (Cl. 34—86)

The primary object of the present invention is to provide an improved continuous kiln or oven, adapted for use in subjecting goods to special temperature or atmospheric conditions. My improvements are particularly adapted for use in heating goods of widely varying kinds, under conditions making a rapid variation in and accurate control of the goods temperature desirable. My improvements are especially well adapted for use in heating goods to temperatures ranging from 300° to 1600° F. The uses for which the invention may be advantageously employed, include the enamelling or glaze coating of metal and ceramic wares or objects; the drying or baking of cores, brake linings, and insulating materials; the drying of articles coated with lacquer and synthetic coatings, and lithographing, japanning, and paint drying operations, and particularly such operations involving a polymerizing action; the roasting of coffee, peanuts, cocoa beans, etc.; the drying and baking of chemicals and foodstuffs, such as dough, noodles, and spaghetti; the drying of wires; the heating of metal to be drawn; soft soldering operations; and the smoking of meats.

An important practical object of the present invention is to provide a continuous kiln or oven suitable for the purposes mentioned above, of such construction as to have a low heat storage capacity, but with a housing having good heat insulating properties so that the kiln or oven may be operated automatically during periods alternating with relatively short periods in which the supply of heat to the kiln or oven is cut off. In particular, it is an object of the invention to provide a kiln which can be started into operation and brought up to working temperatures in a few minutes or half an hour or so, so that it is practical to permit the kiln to cool down at the end of each day, when twenty-four hour a day operation is not practically desirable.

The invention, in a preferred form, is characterized by the movement of the goods treated along an elongated goods pathway through the kiln or oven, by a suitable goods conveyor system, and by the movement of spaced apart baffle or partition members along a continuous path including a portion external to the goods pathway and a portion coinciding with the goods pathway, or, as is preferable in most cases, coinciding with an intermediate portion only of said pathway, and a portion external to said pathway. Said members moving along the goods pathway, divide the latter into a plurality of separate travelling compartments. The baffles or partition members are given their movements by a conveyor system, mechanically interconnected with the first mentioned conveyor system, so that as each compartment moves through the goods pathway it may enclose a corresponding goods unit or mass. As each compartment is thus progressively advanced along the goods pathway or an intermediate portion thereof, the goods within the compartment may be subjected to different temperature conditions, and, in some cases, to different atmospheric conditions.

In a preferred mode of practicing the invention, the temperature and atmospheric conditions to which the goods are subjected as they move along the goods pathway, are determined and controlled by moving a heated gaseous medium across the goods pathway between stationary inlet and outlet ports in the walls of said pathway. Said ports may be so distributed, and so associated with medium moving means, that the temperature and atmospheric conditions in each compartment may vary definitely and in a predetermined manner as the compartment is moved through its different positions.

Since the temperature in every part of said intermediate portion of the goods pathway is ordinarily appreciably above atmospheric temperatures, an advantage is had by enclosing and heat insulating that portion of the continuous pathway for the baffles or partition members which is not coincident with the goods pathway.

In some cases, the barriers or partitions forming the front and rear walls of the moving compartments are advantageously in the form of vanes extending radially away from the axis of a revolving support. In such case, the goods pathway comprises a portion curving about the axis of said support. Other arrangements may be employed, however, and in some cases, the baffles or partitions are advantageously moved into and out of the goods pathway at the inlet end and outlet end, respectively, of said intermediate portion, through openings formed in a stationary wall of the goods pathway, by a conveyor system forming no part of the goods pathway wall. In another arrangement, each barrier is moved in one direction through one kiln chamber, and in the opposite direction through a second, or twin kiln chamber alongside the first kiln chamber.

In a preferred form of the present invention, means are provided for effecting a continuous circulation of air between the portions of the goods pathway at the inlet and exit ends of an intermediate portion, whereby said air cools the goods passing away from said intermediate por-

tion, and preheats the goods passing to said intermediate portion.

In some cases, the goods conveyor system employed may be individual to and constitute a mechanical unit element of the improved kiln. In other cases, the goods may be moved through my improved kiln or oven by a plant conveyor system, employed to progressively advance goods through the various apparatus units and operation stations of a manufacturing plant of a common mass production type.

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 and described preferred embodiments of my invention.

Of the drawings:

Fig. 1 is a plan view partly in section on the line 1—1 of Fig. 2, of an oven or kiln constituting one embodiment of the present invention;

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

Fig. 3 is a horizontal section on the line 3—3 of Fig. 1 of an oven;

Fig. 4 is a horizontal section through a kiln constituting a second embodiment of the present invention, the section being taken on the line 4—4 of Fig. 5;

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

Fig. 6 is a section taken similarly to Fig. 5, through a portion of an oven or kiln differing slightly from that shown in Figs. 3 to 5;

Fig. 7 is a diagrammatic sectional elevation of another kiln embodiment of the present invention;

Fig. 8 is a section on the line 8—8 of Fig. 7;

Fig. 9 is a diagrammatic plan view of a portion of an oven or kiln constituting still another embodiment of the present invention;

Fig. 10 is a somewhat diagrammatic elevation, partly in section of apparatus including a kiln or oven constructed in accordance with the present invention and combined with means for coating articles dried or baked in the heater;

Fig. 11 is a section on the line 11—11 of Fig. 10; and

Fig. 12 is a partial horizontal section illustrating the use of electrical heating means;

Fig. 13 is a diagrammatic elevation of another form of kiln;

Fig. 14 is a section on the line 14—14 of Fig. 13;

Fig. 15 is an elevation of still another form of kiln; and

Fig. 16 is a plan view of the kiln shown in Fig. 15.

In the embodiment of the invention illustrated in Figs. 1, 2, and 3, A represents the housing of a continuous heating kiln or oven housing which encloses a chamber B and inlet and outlet passages C and D. The chamber B is in the form of a short vertical cylinder, and the passages C and D communicate each at one end with the chamber B, the passages extending tangentially away from the chamber B, and diverging slightly from one another. Mounted within the chamber B and coaxial with the latter, is a rotatable body E, shown as a hollow cylinder, which is provided with radially extending vanes *e*. The latter extend into engagement with the top, bottom and curved outer walls of the chamber B, so that in conjunction with the body E, they divide the space surrounding the member into a plurality of compartments, which rotate with the body E about the axis of the latter.

Each such compartment, once during each revolution of the member E, moves past, and is in open communication at its outer end with, the inlet passage C. As each compartment moves in the counterclockwise direction, away from the inlet passage C, the vane *e* forming the rear wall of the compartment, engages the peripheral or curved wall of the chamber B, and the compartment is then segregated from all other portions of the space within the housing A. This segregation is maintained as the compartment moves angularly about the axis of the body E, until the vane *e* forming the front wall of the compartment, moves away from the peripheral wall of the chamber B, and opens the outer end of the compartment to the outlet passage D.

While each compartment is thus segregated, the temperature and atmospheric conditions within the compartment may be definitely regulated or controlled, and may be kept definitely different from the temperatures and atmospheric conditions then maintained in other compartments, and in the inlet and outlet passages C and D. In particular, the temperature and atmosphere within the compartment may be determined by moving heated air through the compartment between inlet ports F and outlet ports G formed in the end or top and bottom walls, respectively, of the chamber B, at rates or temperatures which may be different in different angular positions of the compartment.

In the apparatus shown in Figs. 1 and 2, the goods heated or otherwise treated in the compartments, are moved progressively along a goods pathway comprising inlet and exit end portions formed by the passages C and D, respectively, and an intermediate portion formed by the arc-shaped space between the body E, and a portion of peripheral wall of the chamber B, extending angularly about the axis of the chamber B from the inlet passage C to the outlet passage D.

The goods treated may be moved along said pathway by a goods conveyor which may be of any suitable type, and as shown, comprises an endless chain conveyor H running about sprocket-wheels I and IA. The conveyor H comprises roller elements H′ running along a trackway J, and depending goods supporting arms H^2. The latter extend down into the goods pathway through a slot A′ formed in the top wall of the housing A, approximately midway between the vertical sides of the end portions C and D of the goods pathway, and midway between the curved inner and outer vertical walls of the intermediate arc-shaped portion of the goods pathway within the chamber B. As shown, the sprocket-wheel I is coaxial with the chamber B and element E, and is carried by a shaft I′ which supports and rotates the body E. The two sprocket-wheels IA are supported on vertical shafts IA′, located adjacent the ends of the passages C and D, and between and tangential to the adjacent portions of the slot A′. As shown, the track J comprises a channel bar at each side of the slot A′. In the arrangement shown in Figs. 1 and 2, the shaft I′ is rotated at a suitable speed by a motor K, driving the shaft through a speed reducing connection K′ which may be of customary commercial type and includes a worm K^2 in mesh with and rotating a worm gear I^2 carried by the shaft I′. The vanes *e* and goods supports H^2 are thus

moved with the same angular speed along the coincident portions of the pathways for the goods and for the vanes *e*. Ordinarily, the supports H^2 and vanes *e* are preferably so spaced, that each support H^2 will be approximately midway between the two vanes *e*, which form the front and rear walls of the compartment in which the lower portion of that support, and the goods supported by it, move through the portion of the path of travel of the compartment, in which the latter is segregated.

In Figs. 1 and 2, no means are illustrated for passing hot air or other medium into the chamber B through the ports F and out of the latter through the ports G. As will be apparent, such means may take various forms. Advantageously, for many purposes, the means comprise an air heater L and a circulating fan M arranged as shown in Figs. 5 and 6, so that the fan draws air or other gaseous medium away from the goods pathway B, through the ports G, and passes it through the air heater L and thence back into the goods pathway through the ports F. The air heater employed may be of any usual or suitable form, and, advantageously, in some cases, is of the type, and of one of the forms, disclosed and claimed in my copending application, Serial No. 194,062, filed March 5, 1938. One form of the heater shown in the last mentioned application, comprises a burner adapted to burn a combustible air and fuel gas mixture supplied to the burner, and to deliver products of combustion into admixture with the air or other fluid heated in the heater. Another form of heater disclosed in said prior application, is heated by the combustion of fuel gas effected in such manner that the products of combustion do not mix with the fluid medium to pass through the heater to be heated therein. Of the two heaters of my said prior application, only the second mentioned one is adapted for use in such an oven as is shown in Figs. 1 and 2, when the passage of products of combustion into the kiln or oven chamber is objectionable. Ordinarily it is desirable to provide means for regulating the air flow between the heater L and the different ports F and G or some of them, as by means of a damper LA associated with each such port as shown in Fig. 5.

If, as will be the case in most uses of the invention, goods are subjected to a heat treatment in the kiln, heat can be economized, and other advantages obtained, by transferring heat from the goods moving through the outlet passage D to the goods moving through the inlet passage C, thereby respectively preheating and cooling the goods in the inlet and outlet passages. Heat may thus be transferred by a continuous circulation of the air or other gaseous medium forming the atmosphere of the passages C and D, from the passage D into the passage C, and thence back to the passage D. Thus, as shown in Fig. 3, a conduit M including a fan M', has its inlet end connected to the passage D through a port M^2 in the bottom wall of the latter and has its outlet end connected to the passage C through a port M^3 in the bottom wall of the latter, while a second conduit MA including a fan MA' has its inlet end connected to the passage C through a port MA^2 in the top wall of the latter, and has its outlet end connected to the passage D through a port MA^3 in the top wall of the latter. Through spill outlets M^4 and MA^4 each provided with a throttling damper the fans M' and MA' can discharge into the atmosphere, or into stack connections (not shown) such portions of the gaseous medium withdrawn from either or both of the passages C and D as may be desirable. Such spillage of the medium withdrawn from the inlet passage C is ordinarily essential when the goods give off vapors or gases when being preheated.

In the mechanical construction of the kiln shown in Figs. 1, 2 and 3, and other kilns illustrated herein, the usual practices and expedients of the art may be employed. As shown in Figs. 1 and 2, the kiln housing is supported in a structural metal frame work including columns A^2. To insure the relatively good heat insulation and relatively small heat storage capacity desired, I may advantageously form the housing of inner and outer shells A^3 and A^4 of sheet metal, separated from one another by a space receiving any known or suitable light weight material *a*, having good heat insulating properties. Each of the vanes *e* may consist of a flat piece of sheet metal, the horizontal and vertical dimensions of which are somewhat smaller than the corresponding dimensions of the compartments which it separates. As shown, each rectangular vane plate is reinforced at its edges as by means of angle bars *e'*. The reinforcement at the edge of the vane *e* adjacent the body E, is utilized in connecting the vane to said body. The reinforcing parts *e'* at the other three edges of the vane, support flexible metallic wiper or vane extension parts e^2, which resiliently engage the top, bottom and peripheral wall of the chamber B.

To avoid leakage between the ends of the body E, and the top and bottom walls of the chamber B, sand seals may be employed. Thus, as shown in Fig. 2, an annular sand containing trough N is secured to the inner wall of the body E adjacent its upper end, and a cylindrical member N' depending from the top wall of the chamber B, extends into the sand in the trough N. Adjacent the lower end of the member E, the latter is provided at its inner side with an annular metallic member NA including a horizontal upper portion, and a depending cylindrical portion which extends into the sand in an annular sand seal trough NA' carried by the bottom wall of the chamber B.

In Figs. 4 and 5, I have illustrated an embodiment of the present invention, generally similar in type to that shown in Figs. 1, 2 and 3, but differing from the latter in respect to the form of the goods pathway and in respect to the goods and partition conveyor systems. The kiln shown in Figs. 4 and 5 comprises inlet and outlet passages CA and DA, respectively, relatively longer than the passages C and D of the construction first described, and arranged parallel to one another, and separated only by a common wall portion of the housing, and the arc-shaped intermediate portion of the goods pathway is of greater angular extent in the kiln of Figs. 4 and 5, than in the kiln first described.

The conveyor HA for moving goods through the kiln shown in Figs. 4 and 5, is shown as extending away from the ends of the inlet and exit passages CA and DA, and may be a plant conveyor used to move goods through apparatus or operating stations, in addition to and quite different from the apparatus shown in Figs. 4 and 5. In the use of such conveyors, it is customary to drive them by power driven gear devices distributed along the length of the conveyor path of movement, such as the device IC, shown in Fig. 4, which are not necessarily directly associated with any goods treating apparatus through which the goods are moved by the conveyor. The

conveyor may be exactly similar in construction to the conveyor H, but as shown, is wholly guided in its movements along the goods pathway through the kiln by the track J, without engagement with sprocket wheels, like the sprocket-wheels I and IA of the construction first described.

In the arrangement shown in Figs. 4 and 5, however, the conveyor HA does engage and rotate a sprocket-wheel ID carried by a vertical shaft I^5 parallel to the shaft I' of the partition supporting member E of the kiln. The shaft I^5 carries a second sprocket gear I^6, which, through a sprocket chain I^7 drives a sprocket wheel I^8 secured to the shaft I' and thereby rotates the drum member E and partition *e* of the kiln shown in Figs. 4 and 5, in proper timed relation with the movement of the conveyor HA.

In Figs. 4 and 5, the conduits M and MA of the construction first described, are replaced by conduits M^{10} and MA^{10}, each connected by a plurality of pipe branches to corresponding ports M^{11} in the top or bottom walls, respectively, of the passages CA and DA. In some cases, the branches M^{11} may be provided with individual dampers L^{12}.

It may sometimes be advantageous to locate the external portion of the goods conveyor system beneath, instead of above the kiln or oven housing as in the arrangement shown, by way of example, in Fig. 6. In Fig. 6, the conveyor chain HB, runs on a track comprising a trackrail JA beneath the kiln housing at each side of a slot A^{15} in the bottom wall of the goods pathway. The conveyor HB comprises uprising parts H^6 which extend through the slot A^{15}, and as shown move goods supporting members H^7, within the goods pathway, and comprising wheels H^8 running on trackrails within the goods pathway and supported by the bottom wall of the latter. The member E of Fig. 6 may be driven by the conveyor HB, in the manner in which the member E of Figs. 4 and 5 is driven by the conveyor HA.

Because of the considerable length or cross section of the intermediate portion of the goods pathway required in some cases, or for other reasons, it may be advantageous in some cases to replace the partition supporting member E of the arrangements shown in Figs. 1 to 6, by other conveyor means for moving the compartment supporting partitions along the intermediate portion of the goods pathway. Thus, for example, as shown in Figs. 7 and 8, partition members *ea* may be given their movements by a conveyor of the endless chain type. The kiln or oven shown in Figs. 7 and 8 comprises inlet and exit sections CB, and DB, respectively, extending transversely away from an intermediate section BB, at the ends of the latter. The section BB is separated by a wall B^{10} from a chamber B^{11} which communicates through ports or openings B^{12} and B^{13}, with the goods pathway at the inlet and exit ends, respectively, of the section BB. The compartment separating partition members *ea* are moved through the port B^{12} into the goods pathway section BB, thence through the latter to the port B^{13}, through the latter into the chamber B^{11}, and through the latter back to the port B^{12}.

As shown, the partitions *ea* are rigidly connected to upper and lower conveyor link members H^{10}, the latter being connected by pivots H'' to form upper and lower conveyor endless chain elements. The upper chain element runs over a pair of upper sprocket wheels O and OA carried by vertical shafts O' and OA', respectively adjacent the ports B^{12} and B^{13} and the lower chain element runs over lower sprocket wheels O and OA carried by said shafts. Each pivot H'' serves as the supporting shaft for a corresponding wheel H^{12}. The sprocket wheels O and OA as shown are formed with peripheral notches O^2 spaced apart so that each two adjacent notches of each sprocket wheel may receive the wheels H^{12} connected by each link H^{10}, as that link is turned about the corresponding shaft O' or OA'. The shafts O' and OA' and their wheels O and OA are so positioned, relative to the wall B^{10} and ports B^{12} and B^{13}, that one side or run of the endless chain conveyor is within the goods pathway, and the other side or run is in the chamber B^{11}. Furthermore, the positions of the sprocket wheels O and OA are such that the portion of each conveyor chain extending between the two sprocket wheels O and OA at the same level within the goods pathway section BB, is tangential to each of said wheels, and is parallel to the wall B^{10}, and has its wheels H^{12} in engagement with a corresponding trackrail JC carried by said wall.

As shown, each partition *ea* is secured to a corresponding link H^{10} of the upper conveyor chain, midway between the ends of the link, and is similarly secured to the directly subjacent link H^{10} of the lower chain. As will be apparent, the resilient engagement of the wiper e^2 at the edge of each vane *e* remote from the conveyor, acts, when the vane is in the goods pathway, in the direction to hold the wheels H^{12} at the ends of the links H^{10} to which the vane is secured, against the trackrails JC. As shown, each of the links H^{10} is connected to a corresponding vane *ea*, but the vanes may be spaced apart by a distance equal to two or more times the length of a single link, when this is desirable. Part or all of the weight of the vanes and conveyor mechanism may be supported by wheels e^3 secured to the vanes *e* adjacent their lower ends and running on trackrails JD, carried by the bottom walls of the goods pathway section BB and the chamber B^{11}.

The goods are moved along the goods pathway of Figs. 7 and 8 by a goods conveyor HA, which may be exactly like that of the kiln shown in Figs. 4 and 5. Furthermore, as shown, the goods conveyor HA is connected to and rotates the partition conveyor shaft OA', as the goods conveyor of Figs. 4 and 5 is connected to and rotates the shaft I'. The goods pathway section BB may have ports F and G in its top and bottom walls, respectively, distributed along the length of the section as conditions make desirable. Heated air may be moved through the separate goods compartments within the section BB in communication with corresponding ones of said ports F and G, by means including one or more fans and air heating air heaters like the fan and air heater M and L of Fig. 5.

The type of oven shown in Figs. 7 and 8 is well adapted for use when the goods unit or masses handled are of relatively large size, as, for example, when each goods unit is an automobile body moved through the section BB to dry or bake a coating previously applied to the body. The arrangement shown in Figs. 7 and 8 may be used advantageously, also, when the goods units or masses treated require a goods pathway having a cross section much smaller than that required for an automobile body, but where it is desirable to have the intermediate section of the kiln elon-

gated, so that it may be segregated into more compartments than can be readily provided between vanes carried by a revolving body, like the previously mentioned bodies E.

A kiln of the type shown in Figs. 7 and 8 is adapted for use for different purposes and in different ways. Its entire intermediate section BB may be used as a heating section with little or no difference in the temperature and atmospheric conditions in the different segregated goods compartments in the section, or alternatively, more or less of the preheating and cooling actions may be effected in end portions of the intermediate section, while a short central portion is used as the heating or high temperature zone of the kiln.

To adapt the kiln to the last mentioned operation, the heat transfer fan MA' shown in Fig. 7, has three separate damper controlled inlet branches M^{20}, one opening to the outlet section DB, and the others to be portions of the section DB, forming the two right hand compartments shown in Fig. 7. The outlet piping of the fan MA' of Fig. 7, comprises four damper regulated branches M^{21}, one being connected to the inlet section CB, and the other three being respectively connected to the portions of the section BB, which form the three left hand segregated goods compartments of Fig. 7, when the vanes *ea* occupy their positions shown in Fig. 7. The fan, corresponding to the fan M' of Fig. 3 for withdrawing gases from the kiln portions to which the fan MA' delivers gases, and for passing more or less of the gases withdrawn to the portions of the kiln from which the fan MA' withdraws gases, is not shown in Fig. 7.

By suitable adjustment of the dampers L^{12} shown in Fig. 7, it is possible to maintain definite, and if need be, definitely different temperature conditions in the portions of the kiln to which the four different branches M^{21} deliver gases.

The arrangement shown diagrammatically in Fig. 9 comprises parallel spaced apart inlet and outlet passages CC and DC, respectively, and a transverse passage BC, connected at one end to the passage CC through a chamber BC' and connected at its other end to the passage DC by a chamber BC^2. In the chamber BC' is mounted a rotating member EA, carrying vanes *e*, which engage the curved peripheral walls of the chamber and thus provide a goods pathway portion divided into compartments separated by vanes *e*, through which the goods are moved by a conveyor H from the inlet passage CC into the passage BC. Similarly, a rotating member EB carrying vanes *e* is mounted in the chamber BC^2 so that the vanes may separate a goods pathway section connecting the passages BC and DC into segregated compartments. The members EA and EB may be mounted on shafts carrying sprocket wheels, engaged by the conveyor H, as the latter engages the sprocket wheel I of the kiln shown in Figs. 1 to 3.

The kiln shown in Fig. 9 may be formed with ports in its top and bottom walls and connected by air moving and heating means, as are the ports F and G of the constructions previously described. With the arrangement shown, the same temperature and atmospheric condition may be maintained at all points along the length of the passage BC, so that the latter may subject the goods moving therethrough to a sort of soaking pit for equalizing action for the period required for the movement of the goods therethrough. That period will be dependent, of course, upon the length of the section BC, which may be made whatever conditions make desirable.

In the form of the invention shown in Figs. 10 and 11, the oven or kiln chamber comprises an inlet passage C^{20} and an outlet passage D^{20} parallel to the passage C^{20} and a chamber B^{20}, through which the delivery end of the passage C^{20} is connected to the inlet end of the passage D^{20}. The chamber B^{20} is generally cylindrical about a horizontal axis and within the chamber is mounted a member E^{20}, supported and rotated by a horizontal shaft I^{19} and carrying vanes *e* which engage the curved peripheral walls of the chamber B^{20} as the vanes *e* shown in Fig. 1 engage the curved peripheral walls of the chamber B.

As shown, goods are moved through the kiln or oven shown in Figs. 10 and 11 by an endless conveyor comprising an endless conveyor chain H^{20} at each side of the oven which runs amound sprocket wheels I^{20} carried by the shaft I^{19} and about sprocket wheels IA^{20} carried by a horizontal shaft IA^{21}, outside of the oven and spaced far enough away from the entrance end of the passage C^{20} to permit the goods moved by the conveyor to dip into a coating path held in a trough or open top receptacle C^{21} in front of the entrance end of the passage C^{20}. Between each sprocket wheel I^{20} and IA^{20}, at each side of the kiln, are suitably shaped upper and lower trackrails H^{21} and H^{22}, providing trackways for the upper and lower runs of the corresponding endless conveyor chain. The goods moved by the conveyor are suspended from rods or shafts H^{23}, each connected at one end to a link of the conveyor chain at one side of the kiln and at the other end to a link in the conveyor chain at the other side of the kiln. The shaft IA^{21} may be driven in any suitable manner, as, for example, by such means as are shown in Fig. 2, for driving the shaft I'.

For kiln uses, in which the kiln atmosphere or the high kiln temperatures desired make it undesirable or impractical to heat the kiln with heating means of the kind hereinbefore described, the kiln may be provided with electrical or other heating means of suitable form. Thus, for example, in a kiln including a rotating element like the previously mentioned elements E, EA and EB, that element may support electrical heating elements or resistors R, supported on insulated supporting elements R', carried by the rotating body or its compartment supporting vanes or carried in part by the vanes and in part by the body as shown in Fig. 12.

The kiln arrangement shown in Figs. 13 and 14 comprises inlet and exit passages CD and DD, respectively, connected by a chamber BD, and differs from the kiln shown in Figs. 4 and 5, essentially only in that the trackway JD for the goods conveyor HD is located in, instead of above, the goods pathway, and in the form of the rotatable body ED, and in that the heater L communicates with the chamber BD through ports FA and GA in a vertical wall of that chamber. The latter is polygonal instead of cylindrical in outline. As shown, the body ED has four sides E^{10}, and the compartment separating vanes *e* are located in axial planes extending through the corners of the body. The body ED carries parts shown as arms E^{11} above the vanes *e*, which engage the portion of the conveyor HD within the chamber BD, so that through much of its movement within the chamber BD, the section of

the conveyor adjacent each side E^{10} of the member E, is parallel to said side.

As shown, guide rolls IE for the conveyor HD are provided adjacent the junctions of the passages CD and DD with the chamber BD. By the use of conveyor tension means of known type, the goods conveyor HD may be kept under suitable tension, notwithstanding the slight tendency to a change in tension as a result of the slight variation in the angular relation of the portions of the conveyor adjacent but at opposite sides of each roll IE, as the distance between that roll and the adjacent arm E^{11} varies with changes in the angular position of the arm.

The arrangement shown in Figs. 13 and 14 is especially advantageous for use in handling relatively large work bodies as it reduces the diameter of the chamber BD required to accommodate work bodies of a given size, and to provide proper clearance space between each work body and the adjacent side of the body ED, and between each work body and the curved outer wall of the chamber BD.

In Figs. 15 and 16, I have illustrated the use of the invention in a twin kiln arrangement comprising two side by side kiln chambers. One of the kiln chambers comprises an inlet or preheating section CE, an intermediate heating section BE and a kiln section DE, the three sections being arranged in a straight line and respectively alongside similar cooling, heating and preheating sections *de*, *be*, and *ce*, respectively, of the other kiln chamber. Goods are moved through the till kiln chambers at the same speed but in opposite directions. As shown, the goods are moved through the kiln chamber CE—BE—DE by an endless conveyor HE, and are moved through the kiln chamber *ce—be—de* by a separate endless conveyor *he*. Heat may be supplied to each of the heating chambers BE and *be*, by one or more air heaters L or in any other suitable manner.

In accordance with the present invention, the intermediate portion, at least, of each of the kiln chambers of Figs. 15 and 16, are separated by elements *eb* into a series of travelling work or goods receiving compartments moving in a direction and with a speed corresponding to the direction and speed of goods movement through the chamber. As shown in Figs. 15 and 16, the partition elements *eb* are moved by a conveyor HH along a continuous pathway comprising two side by side portions, one formed by one and the other by the second of the two kiln chambers, so that the full length of each kiln chamber is divided up into travelling compartments by the partition elements *eb*. As shown, the conveyor HH runs along a continuous track or guideway JH including a portion within and adjacent the top of each kiln chamber.

Fans NH are advantageously provided to effect a continuous kiln atmosphere circulation back and forth between the preheating section CE and cooling section *de*, and between the preheating section *ce* and the cooling section DE.

With the apparatus shown in Fig. 7, and to a considerable extent with all of the forms illustrated, it is possible to positively control and regulate temperature conditions not only in the intermediate high temperature portion of the tunnel or kiln chamber, but also in the preheating portion of the chamber. Within wide limits, it is possible to give practically any form desired to the curve representing either the temperature of the goods, or of the kiln chamber, at different point along the length of the latter. In particular, it is possible to increase the preheating temperature gradually and to subject the goods to an abrupt increase in intensity of the heating effect impressed on them, as they pass from the preheating section into the heating section of the kiln.

Such control of the preheating action of the kiln is of much practical importance in some cases. For example, in drying and hardening coatings on articles coated with a material comprising a considerable volatile solvent constituent, I have found it practically desirable to expose the articles to quite moderate preheating temperatures, until all or practically all of the solvent material has been evaporated and expelled from the coatings. Thereafter the coatings may be set and hardened in a short time, by subjecting them to a much higher heating temperature.

While in accordance with the provisions of the statutes, I have illustrated and described the best forms of embodiment 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 the apparatus disclosed without departing from the spirit of my invention as set forth in the appended claims and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

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

1. In a continuous kiln, the combination with a kiln having a goods inlet, a goods outlet, and a passage forming a goods pathway extending between said inlet and outlet, of a plurality of partition elements, means for moving said elements along a continuous path including an intermediate portion only of said pathway and a return portion external to said pathway, means enclosing said return portion of said path, the said elements within said intermediate portion at any one time extending across said pathway and dividing the intermediate portion thereof into a plurality of separate goods receiving compartments, each separated from an adjacent compartment by one of said elements, means for conveying goods through the kiln, and means for maintaining higher temperatures in said intermediate portion of said pathway than in the portions thereof between said intermediate portions and said inlet and outlet and for maintaining different atmospheric conditions in different compartments, comprising ports in the walls of said passage and means for passing gases of different temperatures and compositions into and thence out of different compartments through said ports.

2. In a continuous kiln, the combination with a kiln having a goods inlet, a goods outlet, and a passage forming a goods pathway extending between said inlet and outlet and comprising an intermediate portion and an end portion between said intermediate portion and said inlet and an end portion between said intermediate portion and said outlet, means for moving goods along said pathway, partition elements and means separate from the first mentioned means and operating in timed relation with the first mentioned means to move said partition elements in regularly spaced relation along a continuous path including said intermediate portion only of said goods pathway and including a portion external to the goods pathway, means enclosing said return portion of said path, the said partition elements within said intermediate portion at any

one time extending across the goods pathway and dividing the latter into a plurality of spaced apart goods receiving compartments, and kiln heating and cooling means adapted to maintain temperatures substantially above atmospheric temperature in said intermediate portion of said pathway and to maintain lower temperatures in the said end portions of said pathway.

3. In a continuous kiln, the combination with a kiln having a goods inlet, a goods outlet, and a passage forming an elongated goods pathway extending between said inlet and outlet, and comprising a portion longitudinally intermediate of, and displaced longitudinally of said pathway from inlet and outlet end portions of said pathway, of a plurality of partition elements, means for moving said elements successively into said pathway at the end of said inlet portion adjacent said inlet end portion thence through said intermediate portion of said pathway and out of said pathway at the end of said intermediate portion adjacent said outlet end portion, each of said elements when moving through said intermediate portion extending across the pathway and segregating the portion thereof in front of the element from the portion of said pathway behind the element, means for conveying goods through the kiln, means comprising ports in the walls of said passage for passing gases into and out of said segregated portions of the goods pathway, and means for heating goods passing through the intermediate portion of the goods pathway and means for transferring heat to the goods passing from the kiln inlet to said intermediate portion from the goods passing to the kiln outlet from said intermediate portion.

4. In a continuous kiln, the combination with a kiln having a goods inlet, a goods outlet, and a passage forming an elongated goods pathway extending between said inlet and outlet, and comprising a portion longitudinally intermediate of, and displaced longitudinally of said pathway from inlet and outlet end portions of said pathway, of a plurality of partition elements, means for moving said elements successively into said pathway at the end of said inlet portion adjacent said inlet end portion thence through said intermediate portion of said pathway and out of said pathway at the end of said intermediate portion adjacent said outlet end portion, each of said elements when moving through said intermediate portion extending across the pathway and segregating the portion thereof in front of the element from the portion of said pathway behind the element, means for conveying goods through the kiln, means comprising ports in the walls of said passage for passing gases into and out of said segregated portions of the goods pathway, and means for heating goods passing through the intermediate portion of the goods pathway and means for transferring heat from the goods passing away from to the goods passing to said intermediate portion through the respective inlet and outlet end portions of the goods pathway comprising a fan having its inlet connected to said inlet end portion and its outlet connected to said outlet end portion and a second fan having its inlet connected to the last mentioned end portion and its outlet connected to said inlet end portion.

5. In a continuous kiln, the combination with a kiln housing enclosing a cylindrical chamber and two passages opening into said chamber, a rotatable body within and coaxial with and of smaller radial extent than said chamber and separated from the outer wall of said chamber by an annular space, the two passages merging into the two ends of an arc shaped portion of said space, said portion forming an intermediate section and said passages forming inlet and outlet end portions of an elongated goods pathway, vanes carried by and extending away from said body and adapted to divide said space portion into a plurality of goods receiving compartments, means for circulating gases through said compartments and means for moving goods through said pathway and for giving rotative movements to said body in timed relation to the goods movement.

6. In a continuous kiln, the combination with a kiln having a goods inlet, a goods outlet, and a passage forming an elongated goods pathway extending circularly about an axis between said inlet and outlet, and comprising a portion longitudinally intermediate of, and displaced longitudinally from, inlet and outlet end portions of said pathway, a body revolving about said axis and having a peripheral wall which forms a concave wall of said intermediate portion and having a plurality of vane partition elements extending outwardly from said peripheral wall and moved by the rotation of said body successively into said pathway at the end of said intermediate portion adjacent said inlet end portion thence through said intermediate portion of said pathway and out of said pathway at the end of said intermediate portion adjacent said outlet end portion, each of said elements when moving through said intermediate portion extending across the pathway and segregating the portion thereof in front of the element from the portion of said pathway behind the element, means for conveying goods through the kiln, ports in the walls of said passage and means for passing gases into and out of said segregated portions of the goods pathway through said ports.

7. In a continuous kiln, the combination with a kiln having a goods inlet, a goods outlet, and a passage forming an elongated goods pathway extending between said inlet and outlet, and comprising a portion longitudinally intermediate of and displaced longitudinally of said pathway from inlet and outlet end portions of said pathway, and comprising two cylindrical chambers forming portions of said pathway spaced away from one another and from said inlet and outlet, and a separate rotatable body in each of said chambers and coaxial therewith, each of said bodies being of smalle rradial extent than the said chamber in which it is received, said intermediate and inlet end portions of said pathway being connected by and forming end extensions of an arc shaped portion of said pathway between the outer wall of one of said chambers and the periphery of the said body therein, and said intermediate and outlet end portions of said pathway being connected by and forming end extensions of an arc shaped portion of the space between the peripheral wall of the second of said chambers and the periphery of the said body therein, each of said bodies having vanes extending outwardly therefrom into contact with the said outer wall of the corresponding chamber and adapted when moved by the rotation of said body through the corresponding arc shaped portion to divide the latter into a plurality of separate goods receiving compartments, means for conveying goods through the kiln, and means comprising ports in the walls of said passage for passing gases into and out of segregated portions of the goods pathway.

8. In a continuous kiln, the combination with a kiln having a goods inlet, a goods outlet and a goods passage forming a goods pathway extending between said inlet and said outlet and having a wall for said passage formed with a slot extending longitudinally of said pathway, means for moving goods along said pathway from said inlet to said outlet, said means comprising a conveyor external to and extending longitudinally of said pathway and provided with goods advancing parts distributed along its length and extending into said pathway through said slot, a plurality of partition elements, means separate from and operating in timed relation with the first mentioned means for moving said elements in succession along an intermediate portion of said goods pathway and into and out of the latter at the ends of said intermediate portion respectively adjacent said inlet and outlet, each of said elements being adapted on its movement along said intermediate portion of the goods pathway to separate goods compartments respectively in front and back of said element, and means comprising ports in the wall of said passage for passing gases into and out of said compartments.

9. A continuous kiln combination as specified in claim 5, in which the rotatable body is of hollow cylindrical form with a vertical axis and in which the top and bottom walls of the chamber are formed with openings in register with the bore of said hollow body, and which comprises sand seal parts carried by said body and walls cooperating to prevent gas leakage through the joint space between the end portions of said body and adjacent portions of said walls, and means for circulating gases through said openings and the intervening portion of said bore.

10. In a continuous kiln, the combination with a kiln having a goods inlet, a goods outlet, and a passage forming an elongated goods pathway extending between said inlet and outlet, and comprising a portion longitudinally intermediate of, and displaced longitudinally of said pathway from inlet and outlet end portions of said pathway, of a plurality of partition elements, means for moving said elements successively into said pathway at the end of said inlet portion adjacent said inlet end portion thence through said intermediate portion of said pathway and out of said pathway at the end of said intermediate portion adjacent said outlet end portion, each of said elements when moving through said intermediate portion extending across the pathway and segregating the portion thereof in front of the element from the portion of said pathway behind the element, means for conveying goods through the kiln, means comprising ports in the walls of said passage for passing gases into and out of said segregated portions of the goods pathway, in which each partition element comprises a body portion of sheet metal having at its edge a flanged bar reinforcement and resilient sealing means adapted to yieldingly engage the wall of said passage.

11. In a continuous kiln, the combination with a kiln having a goods inlet, a goods outlet, and a passage forming an elongated goods pathway extending between said inlet and outlet, and comprising a portion longitudinally intermediate of, and displaced longitudinally of said pathway from inlet and outlet end portions of said pathway, of a plurality of partition elements, means for moving said elements successively into said pathway at the end of said inlet portion adjacent said inlet end portion thence through said intermediate portion of said pathway and out of said pathway at the end of said intermediate portion adjacent said outlet end portion, each of said elements when moving through said intermediate portion extending across the pathway and segregating the portion thereof in front of the element from the portion of said pathway behind the element, means for conveying goods through the kiln, means comprising ports in the walls of said passage for passing gases into and out of said segregated portions of the goods pathway, in which each partition element comprises a body portion and a resilient metal edge portion adapted to bear against the passage wall alongside the intermediate portion of the goods pathway and in which said wall comprises non-metallic heat insulating material and a lining of sheet metal engaged by said edge portion.

12. A twin kiln comprising in combination two side by side kiln chambers, conveyor means for moving spaced apart work bodies through the two chambers at the same speeds but in opposite directions, a plurality of partition elements, conveyor means for moving said elements along a continuous pathway comprising a portion in each kiln chamber, the movement of the partition elements through the portion of their pathway within each kiln chamber corresponding in speed and direction to the movement of work bodies through that kiln chamber, and each element in moving through each kiln chamber extending transversely of the pathway and separating a work receiving portion of the chamber in front of the element from a work receiving portion of the chamber back of the element, and means for circulating gases through said work receiving chamber portions.

13. In a continuous kiln, the combination with a kiln having a goods inlet, a goods outlet, and a passage forming an elongated goods pathway extending between said inlet and outlet, and comprising a portion longitudinally intermediate of, and displaced longitudinally of said pathway from inlet and outlet end portions of said pathway, of a plurality of partition elements, means for moving said elements successively into said pathway at the end of said inlet portion adjacent said inlet end portion thence through said intermediate portion of said pathway and out of said pathway at the end of said intermediate portion adjacent said outlet end portion, each of said elements when moving through said intermediate portion extending across the pathway and segregating the portion thereof in front of the element from the portion of said pathway behind the element, means for conveying goods through the kiln, means comprising ports in the walls of said passage for passing gases into and out of said segregated portions of the goods pathway, and means for heating the goods passing through the intermediate portion of the goods pathway, and means for cooling the goods passing away from, and for preheating the goods passing to said intermediate portion through the respective outlet and inlet end portions of the goods pathway, comprising means for moving gases from each of said end portions to the other.

14. In a continuous kiln, the combination with a kiln having a goods inlet, a goods outlet, and a passage forming an elongated goods pathway extending between said inlet and outlet, and comprising a portion longitudinally intermediate of, and displaced longitudinally of said pathway from inlet and outlet end portions of said pathway, of a plurality of partition elements, means

for moving said elements successively into said pathway at the end of said inlet portion adjacent said inlet end portion thence through said intermediate portion of said pathway and out of said pathway at the end of said intermediate portion adjacent said outlet end portion, each of said elements when moving through said intermediate portion extending across the pathway and segregating the portion thereof in front of the element from the portion of said pathway behind the element, means for conveying goods through the kiln, means comprising ports in the walls of said passage for passing gases into and out of said segregated portions of the goods pathway, and means for heating the goods passing through the intermediate portion of the goods pathway, and means for cooling the goods passing away from, and for preheating the goods passing to said intermediate portion through the respective outlet and inlet end portions of the goods pathway, comprising means for moving gases from each of said end portions to the other, the last mentioned means including a spill outlet for the discharge from the kiln of gases or vapors expelled from the goods passing through the kiln.

15. In a continuous kiln for heating goods giving off vapors when heated, the combination with a kiln chamber having a goods inlet, a goods outlet and a passage forming an elongated goods pathway extending between said inlet and outlet, of means for moving goods through said passage, means for segregating the goods in a relatively short intermediate portion of said passage from the goods in relatively long inlet and exit end portions of said pathway, means for supplying heat to said intermediate portion of the kiln, means for moving gases from each end portion into the other without passing through said intermediate portion to preheat and expel vapors from the goods in said inlet end portion and to cool the goods in said outlet portion, and means for discharging gases from said inlet end portion.

16. In a continuous kiln for heating goods giving off vapors when heated, the combination with a kiln having a goods inlet, a goods outlet and a passage forming a goods pathway extending between said inlet and outlet, of means for moving goods along said pathway, means for segregating the goods in different portions of the pathway comprising a relatively short intermediate heating portion and preheating portions between said inlet and intermediate portion, means for supplying heat to the intermediate portion of the kiln, means for moving gases from each end portion into the other without passing through said intermediate portion, to preheat and expel vapors from the goods in said inlet end portion and to cool the goods in said outlet portion, and means for discharging gases from said inlet end portion.

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