Oct. 11, 1938. H. VANDERWERP 2,132,709

ROTARY KILN

Filed Nov. 30, 1934 6 Sheets-Sheet 1

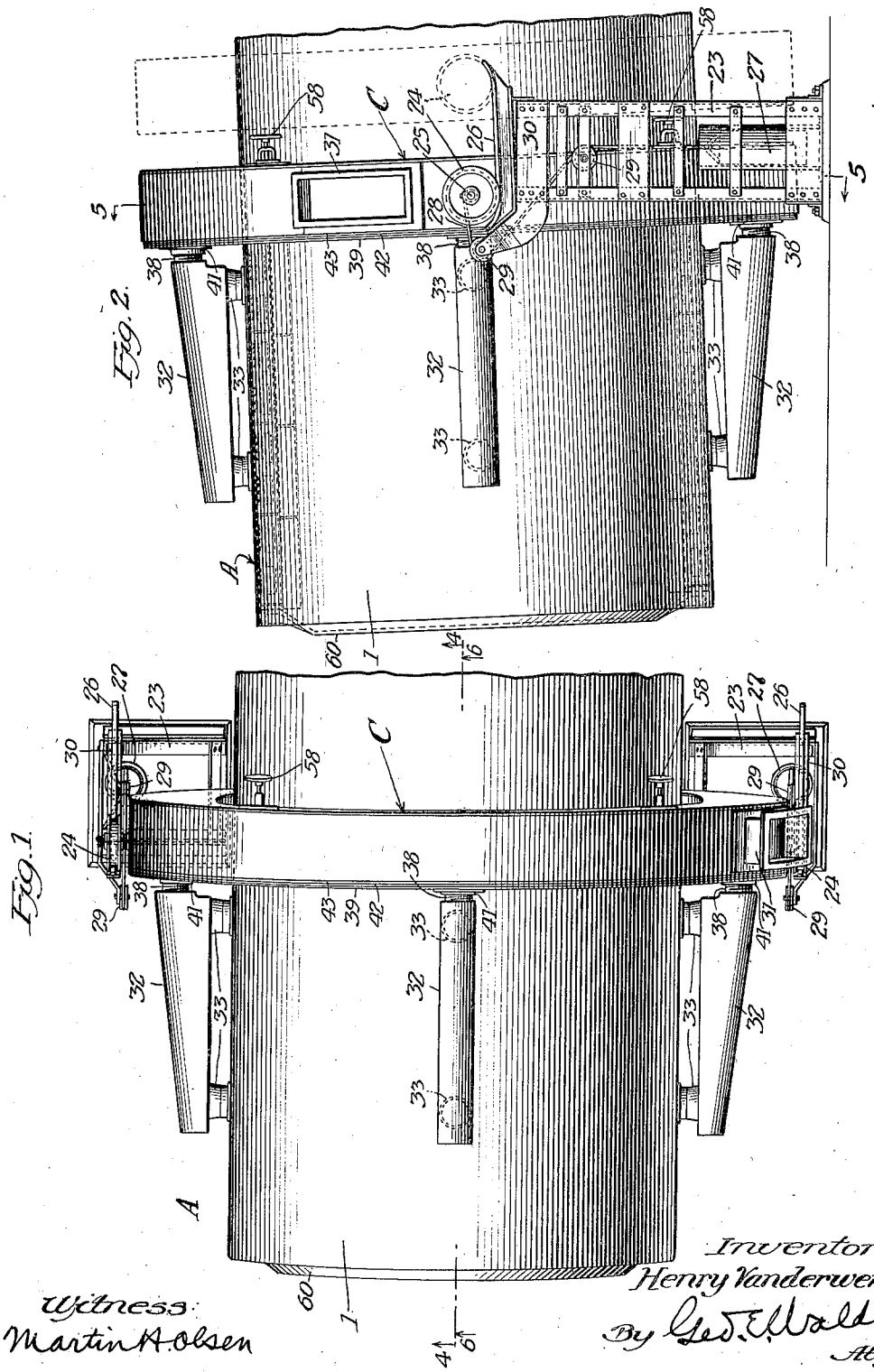


Fig. 2.

Fig. 1.

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Oct. 11, 1938. H. VANDERWERP 2,132,709

ROTARY KILN

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Fig. 3.

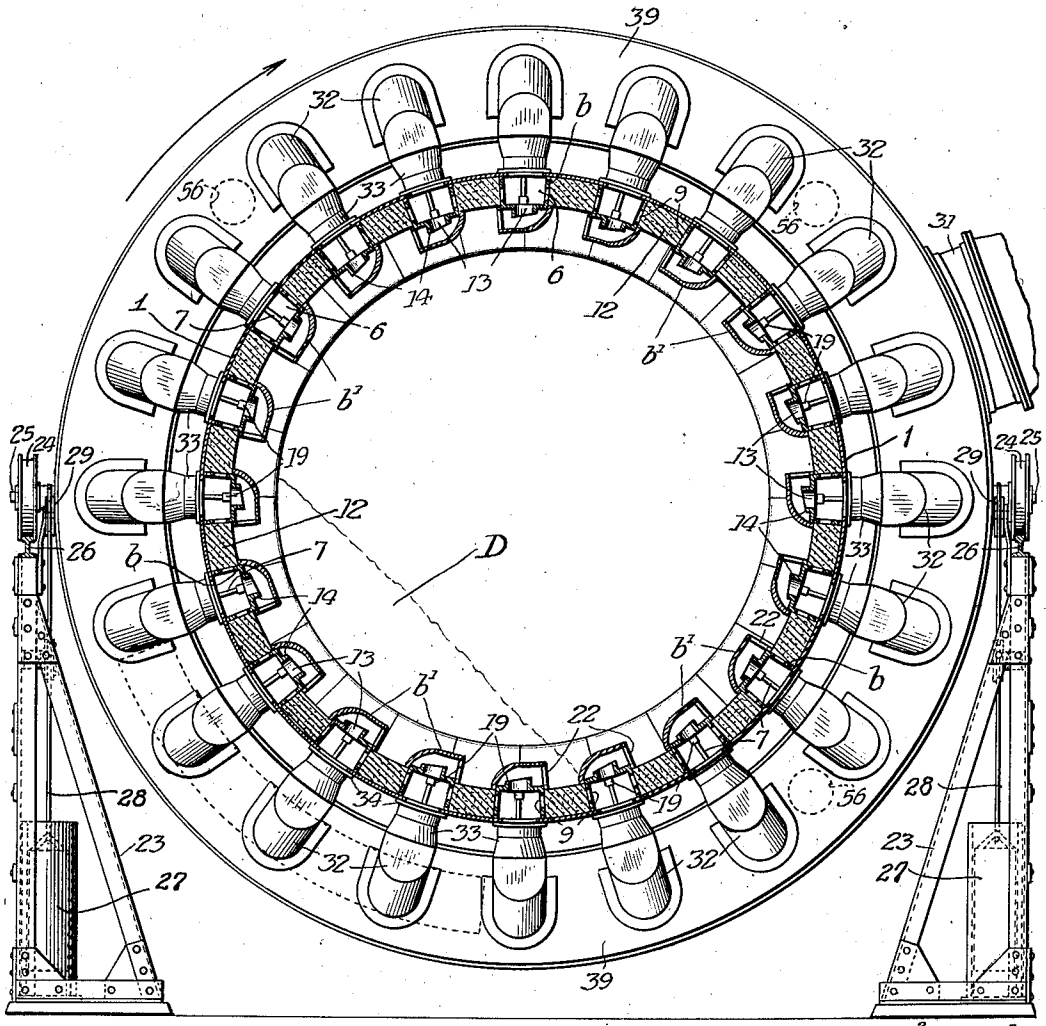


Fig. 11.

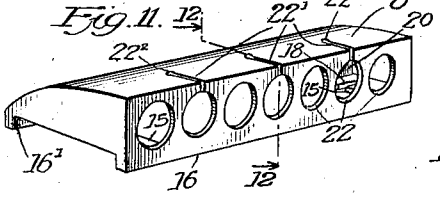
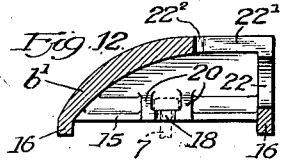


Fig. 12.



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Martin A. Olsen.

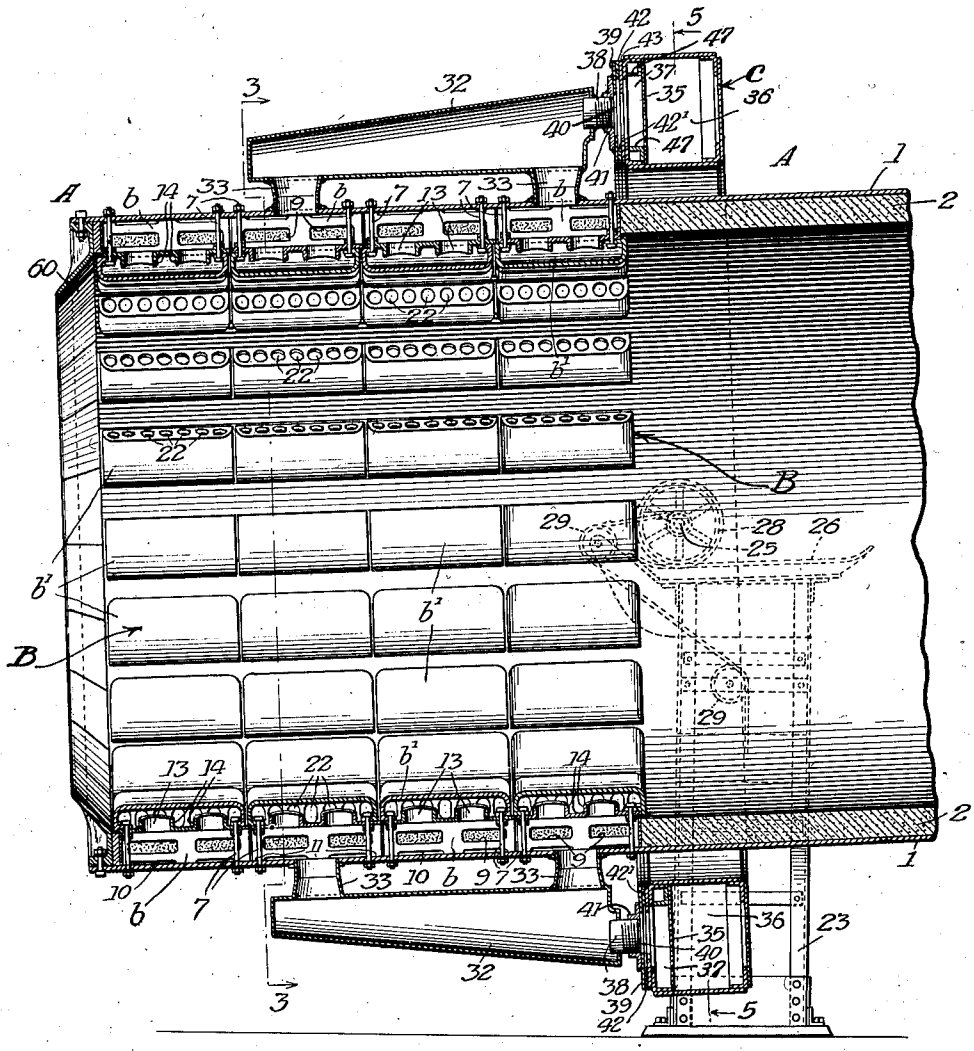
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ROTARY KILN

Filed Nov. 30, 1934 6 Sheets-Sheet 3

Fig. 4.



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ROTARY KILN

Filed Nov. 30, 1934 6 Sheets-Sheet 4

Fig. 5.

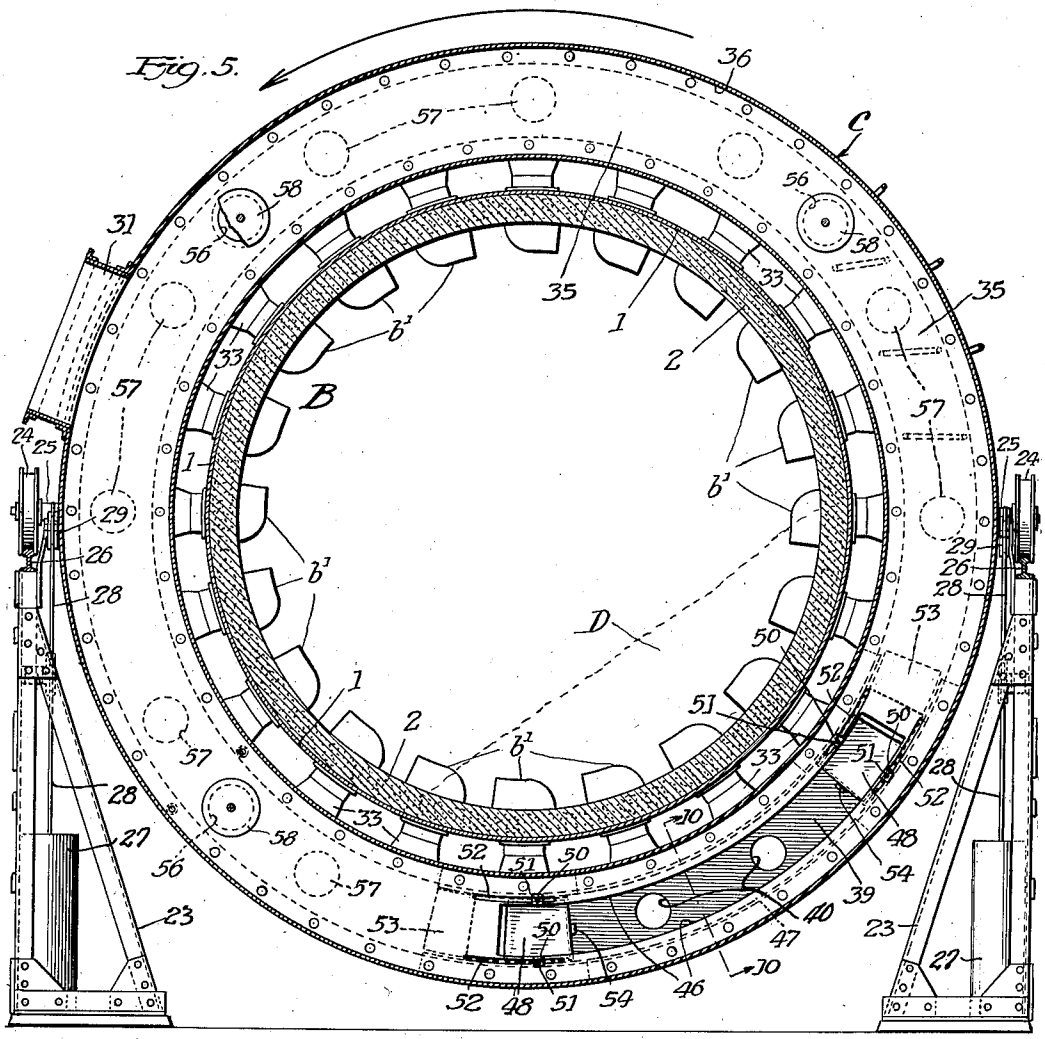


Fig. 18.

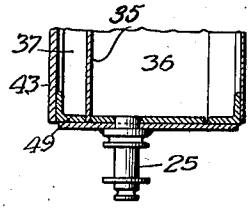


Fig. 19.

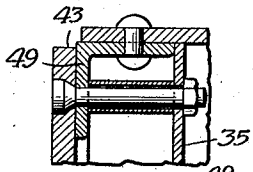


Fig. 20.

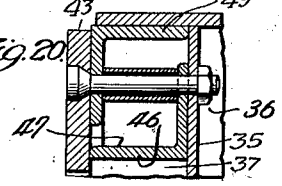


Fig. 21.

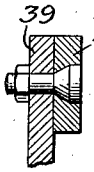
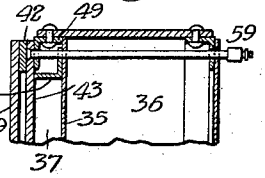


Fig. 22.



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ROTARY KILN

Filed Nov. 30, 1934 6 Sheets-Sheet 5

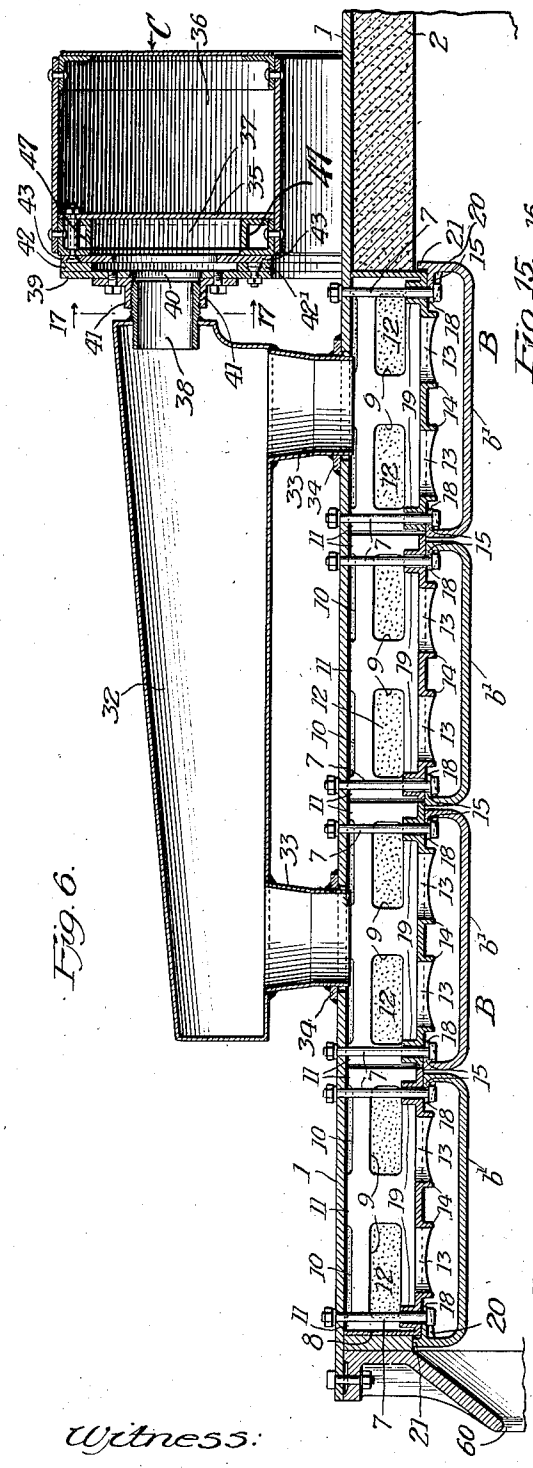


Fig. 6.

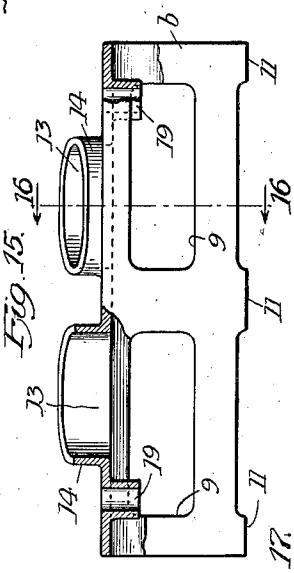


Fig. 15.

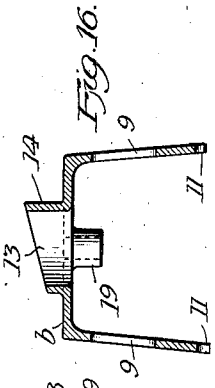


Fig. 16.

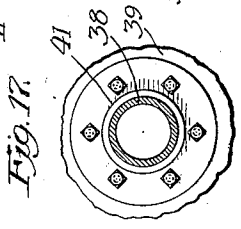


Fig. 17.

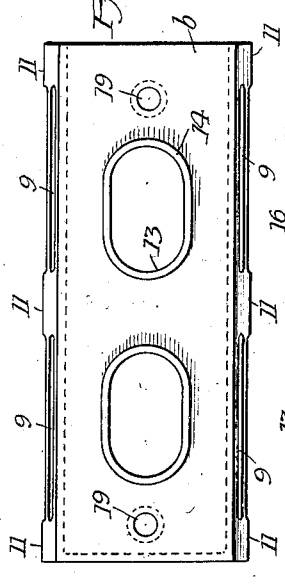


Fig. 13.

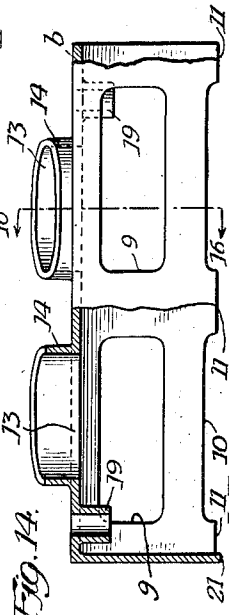


Fig. 14.

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ROTARY KILN

Filed Nov. 30, 1934 6 Sheets-Sheet 6

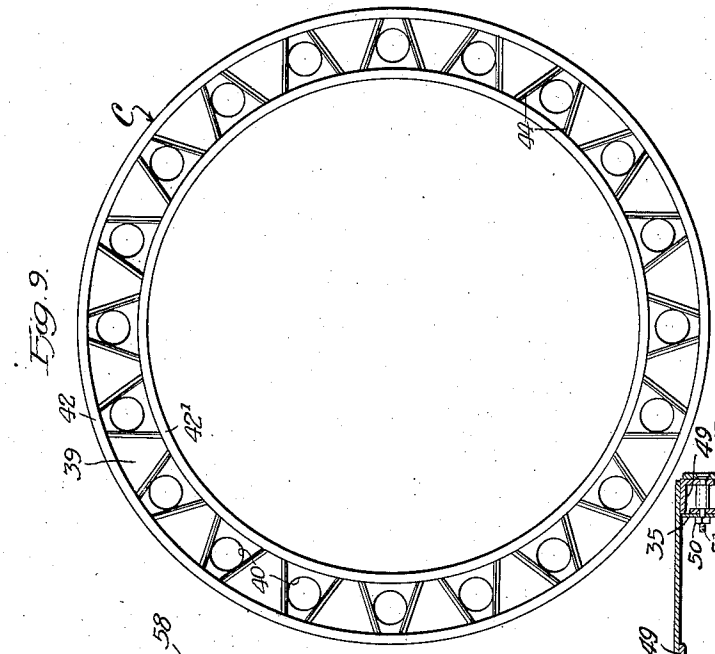


Fig. 9.

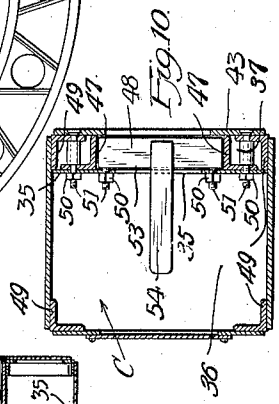


Fig. 10.

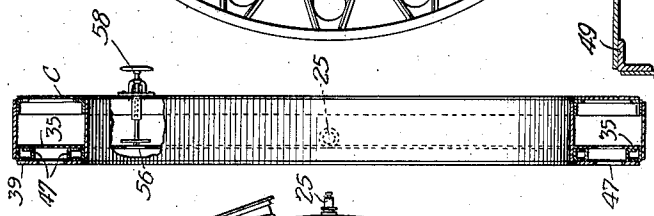


Fig. 8.

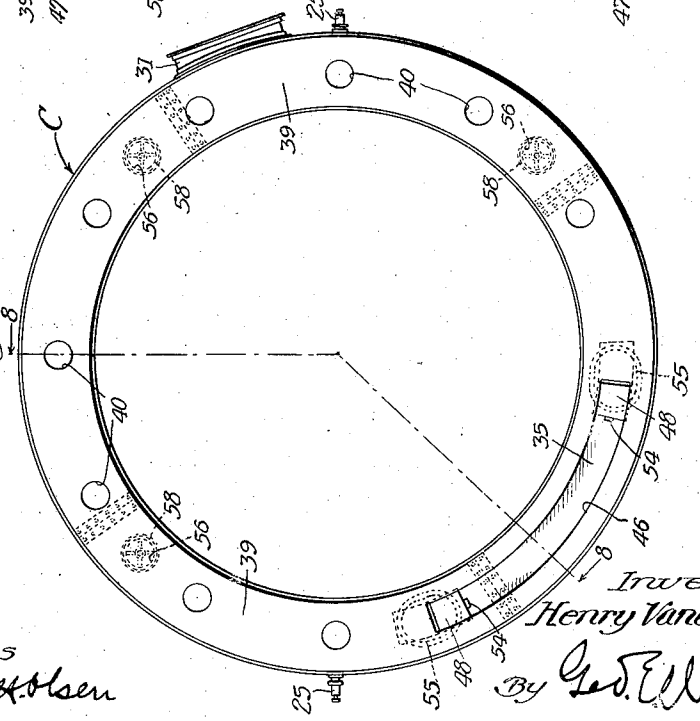


Fig. 7.

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Patented Oct. 11, 1938 2,132,709

UNITED STATES PATENT OFFICE

2,132,709

ROTARY KILN

Henry Vanderwerp, Cleveland, Ohio

Application November 30, 1934, Serial No. 755,397

5 Claims. (Cl. 34—6)

This invention relates to rotary kilns of the type commonly used for producing cement clinker, and relates particularly to combination heat recuperators and clinker coolers for such kilns, designed and adapted for pre-heating air delivered to the kiln for combustion purposes and at the same time, cooling the clinker discharged from the kiln.

As regards its general features and excepting as hereinafter may be particularly described and pointed out, the combination recuperator and cooler of the present application is of the same general type as that which forms the subject-matter of my pending application, filed October 3, 1932, and numbered serially 635,991, to which reference is here made as to features herein shown, but not fully described.

In addition to the objects sought to be attained by the apparatus of my said prior application, No. 635,991, objects of the present invention are to provide an improved construction and arrangement of the means for controlling the volume of air supplied to the kiln for supporting combustion of the fuel charge, for regulating the temperatures in the kiln, for cooling the clinker discharged from the kiln, whereby a volume of air may be supplied to the kiln in excess of the volume supplied by any other apparatus for the purpose, of which I have any knowledge, and to prevent cracking and breaking of metallic portions of the recuperator and cooler exposed within the kiln by contraction and expansion due to the high temperatures and excessive variations in temperatures to which they will be subjected in operation.

To attain the objects thereof, a combination recuperator and cooler embodying my invention and improvements, comprises the various features, combinations of features and details of construction hereinafter described and claimed.

In the accompanying drawings, in which the invention is fully illustrated,

Figure 1 is a top plan view of the material discharge end of a rotary kiln to which a combination recuperator and cooler embodying my invention and improvements is applied.

Figure 2 is a side elevation of the structure shown in Fig. 1.

Figure 3 is a sectional elevation substantially on the line 3—3 of Fig. 4.

Figure 4 is a sectional elevation substantially on the line 4—4 of Fig. 1.

Figure 5 is a sectional end view substantially on the line 5—5 of Fig. 2, the supporting standards for the wind-box being shown in elevation.

Figure 6 is an enlarged, fragmentary, sectional side view on the line 6—6 of Fig. 1.

Figure 7 is a detached view of the wind-box from the left side of Fig. 8.

Figure 8 is a sectional view of the wind-box substantially on the line 8—8 of Fig. 7, broken away in part.

Figure 9 is a detached face view of the blast-ring for supplying air from the wind-box to the manifolds.

Figure 10 is an enlarged, sectional elevation, substantially on the line 10—10, Fig. 5.

Figure 11 is a detached, perspective view of a tuyère block forming part of the means for supplying air to the kiln.

Figure 12 is a sectional view of said tuyère block on the line 12—12 of Fig. 11.

Figure 13 is an enlarged, detached plan view of an extreme end, flue-forming member.

Figure 14 is a side view of said member, partly in section.

Figure 15 is a view, similar to Fig. 14, of an intermediate flue-forming member.

Figure 16 is a sectional view of the line 16—16 of either Fig. 14 or 15.

Figure 17 is a fragmentary detail sectional view on the line 17—17 of Fig. 6, showing the means for mounting the blast-ring on the nipples secured to the manifolds supported on the shell of the kiln; and

Figures 18 to 22, inclusive, are fragmentary views illustrating structural details of the wind-box.

Describing the invention with reference to the drawings, in which for purposes of clear and definite illustration, I have shown my invention and improvements applied to a well known type of kiln for producing cement clinker, designated as a whole A, and which comprises a usual rotary shell 1, having a lining 2 of suitable refractory material, which for reasons presently apparent, terminates at a distance from the clinker discharge end of the kiln.

Considered generally, all of the foregoing features and devices are old and well known in the art, and will readily be understood by persons familiar with the construction and operation of such apparatus, from an inspection of the drawings without a description thereof in detail.

To effect the object of the invention as it relates to the provision of a combination recuperator for pre-heating air supplied to the kiln for combustion purposes and for cooling clinker about to be discharged from the kiln, circumferentially spaced, longitudinal air flues 6 are pro-

vided on the inner surface of the shell 1 of the kiln A, between the lower end of the lining 2 and the discharge end of the kiln, and which form a series extending entirely around the kiln. For purposes of convenient reference, said combination recuperator and cooler is designated as a whole B.

In what I now consider preferable construction, see particularly Figs. 3 to 6, said air flues 6 are formed by hollow castings designated as a whole *b*, preferably made of suitable heat resisting steel alloy, corresponding sides of which are open, as shown, and which are adapted to be secured to the inner side of the shell 1 by bolts 7, as shown and as presently described, with the edges of their lateral sides in contact with the inner surface of the shell 1, which closes the open sides thereof and, also, forms the outer sides of the flues. Also, excepting the remote ends of the extreme flue castings of each air flue 6—which are closed by end walls 8—the ends of all flue castings are open, as shown, see Figs. 13 to 16.

Also, to save metal and to reduce the weight thereof, openings 9 are formed in the lateral sides of said castings, and to save fitting, the edges of the lateral sides of said flue castings are cut out, as shown at 10, thus providing only three relatively short supports 11 for said castings at each side thereof.

Also, as said flue castings *b* are installed for use, the areas of the shell 1 of the kiln exposed in the spaces between adjacent series of said flue castings—and which otherwise would be exposed directly to the intense heat in the kiln, are lined, as shown at 12. Said lining, may be of the same general character as the lining 2 used for lining other parts of the kiln, but may consist of any suitable or desired material. As shown, the linings 12 are of substantially the same thickness as that of other parts of the kiln, the relation being such that the surfaces thereof exposed within the kiln will be positioned between the sides of the flues remote from the shell 1 of the kiln, and the adjacent sides of the openings 9, thus closing said openings and, also, to a large extent, protecting said castings from the excessive operating temperatures in the kiln to which they would otherwise be exposed.

As shown, the flue castings *b* are provided with holes or openings 13 directed inwards towards the center of the kiln and, for reasons presently explained, are surrounded by flanges or nozzles 14, and mounted on the exposed sides of said flue castings *b* so as to cover said nozzles 14, are what may be referred to as tuyère blocks, designated as a whole *b'*. Said tuyère blocks preferably are made of suitable heat resisting steel alloy, are hollow and, as regards their general construction and arrangement will readily be understood from an examination of the drawings without a description thereof in any considerable detail. Briefly described, flanges 15 are formed on the ends of said tuyère blocks which project inwards over and rest in contact with the sides of the flue castings on which said tuyère blocks are mounted, respectively, and formed at the lateral sides of said tuyère blocks, are flanges 16, which embrace corresponding sides of said flue castings, as clearly shown, see Figs. 11 and 12. As shown, see particularly Figs. 3 and 6, both the flue castings *b* and the tuyère blocks *b'* are secured to the shell of the kiln, by the bolts 7 which extend through open ended holes or slots 18 in the flanges 15, and bolt holes formed in bosses 19 on the flue castings *b*, and in the shell of the kiln, being inserted into engagement with said slots and holes from within the kiln. Also, said bolts are held from turning while nuts are being threaded thereto, by webs 20 formed on the flanges 15, arranged to embrace the heads of said bolts, as shown, see Figs. 5, 6, 11 and 12.

As shown, also, the lengths of said tuyère blocks are so proportioned and they are secured to the flue castings *b* in such relation that the flanges 15 will extend over and close any spaces between the ends of adjacent flue castings, thus preventing granular pieces of clinker from falling into said flue castings through spaces between the ends of said tuyère blocks, or the spaces between the ends of adjacent flue castings may be closed by metal plates, not shown. As shown, also, see Fig. 6, shoulders 21 formed at the remote ends of the extreme tuyère blocks *b'*, by engagement with the ends of the corresponding flue castings, operate to define the approximate positions of said tuyère blocks and thus facilitate installation thereof.

Also, assuming that the kiln rotates in the direction indicated by the arrow Fig. 3, the "leading" sides of the tuyère blocks *b'* are rounded on a rather long radius and merge into the outer sides of said tuyère blocks, as shown, while their "following" sides are positioned in planes which intersect substantially in the axis of rotation of the shell of the kiln, and formed in said "following" sides of said tuyère blocks are discharge openings 22, which, as shown, are directed against the rounded "leading" sides of adjacent rear tuyère blocks. In the preferable construction shown, each tuyère block *b'* is provided with a plurality of discharge openings, which, as shown, are round but may be of any desired shape and size, or each tuyère block may be provided with only a single relatively large discharge opening.

In operation, the tuyère blocks *b'* are exposed directly to the high temperatures used in calcining or sintering the material in the kiln, which by expansion and contraction thereof, develops internal stresses in said tuyère blocks, which it is found, causes them—and particularly the sides thereof exposed within the kiln—to crack and often to break, requiring that they be replaced while they are otherwise serviceable.

I have found in practice that this tendency to crack and break, to a very large extent, can be overcome by forming slots 22' in the sides thereof exposed within the kiln, extending from the "following" edges thereof towards their "leading" edges, and which preferably are extended in the "following" walls of said tuyère blocks so as to cut into the discharge openings 22. In accordance with what I consider a preferable relation for usual purposes, the slots 22' are about three inches (3") long, by one-quarter of an inch (¼") wide, and terminate, at their closed ends in substantially round holes 22^2.

As shown, also, the flanges or nozzles 14 which surround the air discharge holes or openings 13 in the flue castings are higher at their "following" than at their "leading" sides.

With a recuperator B, comprising the elements described, and mounted in the manner and relation specified, it is obvious, that, under usual operating conditions, any tendency for granular material to pass from the kiln into said recuperator will be negligible.

In accordance with the present invention, air

under pressure is adapted to be supplied to the recuperator and cooler B, and discharged therefrom into the kiln A, by means as follows:—Surrounding the shell 1 of the kiln in proximate relation to the zone thereof to which the recuperator and cooler is applied, and in spaced relation to the shell of the kiln, is an annular wind-box designated as a whole C, which, as shown, is movably supported on fixed frames or standards 23 erected at opposite sides of the kiln, so as to be movable in both directions, axially of the shell 1 of the kiln. As shown, said wind-box is supported directly by wheels 24 rotatably mounted on opposite sides thereof—being, as shown, mounted on studs or trunnions 25 secured thereto—and which are arranged to run on tracks 26 supported on the frames or standards 23, the treads of which are inclined at substantially the same angle and in the same direction as the axis of rotation of the shell of the kiln. For reasons presently apparent, said wind-box is maintained yieldingly at the limit of its movement in the direction of the discharge end of the kiln, by means of weights 27 suspended by cables 28 secured to opposite sides of said wind-box and which run over sheaves 29 rotatably mounted on brackets 30 secured to the frames or standards 23 and on said standards, as shown.

In operation, air under pressure is supplied to the wind-box C through connection of a flanged fitting 31 thereon with a source of air supply, not shown, and from said wind-box to the recuperator and cooler B, by means as follows:—Supported in proximate, spaced relation to the zone of the shell 1 of the kiln A, in which said recuperator and cooler is installed, are manifolds 32, which are supported by and communicate with said recuperator and cooler through nipples 33 opposite ends of which are connected into holes formed respectively, in said manifolds and in the shell 1 of said kiln, and which rigidly support said manifolds in fixed position relative to the shell of the kiln, the relation being such that said nipples will communicate directly with the flues 6 formed in the recuperator and cooler by the flue castings b, and such also that nipples which communicate with the same manifolds will communicate with the same flues 6. As shown, each manifold 32 is connected with the shell 1 of the kiln by two nipples 33, but this relation may be varied, as desired, to meet requirements.

In accordance with what I now consider preferable construction, said manifolds 32 and nipples 33 are made of suitable sheet metal, as sheet steel, the ends of said nipples connected to said manifolds being welded or otherwise secured thereto, and their opposite ends being connected to the shell of the kiln by means of sheet metal collars or flanges 34 secured thereto, see Fig. 6, and which conform to the curvature of the shell 1, preferably being welded to said nipples and, also, to the shell of the kiln. To save fitting, the ends of said nipples secured to the shell of the kiln are loosely fitted to holes formed in said shell, leakage of air around said nipples being prevented by the collars or flanges secured thereto.

The wind-box C is made of suitable sheet metal, is rectangular in cross-section—its front and rear sides being flat and subsantially parallel and positioned in planes, which, respectively, are substantially perpendicular to the axis of rotation of the shell of the kiln, and which, excepting for limited bodily movement thereof axially of the shell of the kiln, is stationary.

The interior of the wind-box C is divided by a diaphragm or partition 35, into compartments 36 and 37, the air supply fitting 31 communicating directly with the compartment 36, and the compartment 37 communicating with the manifolds 32 by means comprising nipples 38 corresponding ends of which, respectively, are welded or otherwise rigidly secured in holes or openings formed in the proximate ends of the manifolds 32 with their ends projecting into said manifolds a short distance, say for usual purposes, about two inches (2''), thereby providing a trap which will operate, in an obvious manner, to prevent granular material from passing from said manifolds into said nipples and thence into the wind-box C.

As shown, the means of communication between the wind-box C and the manifolds 32 also comprises a blast-ring 39, which is secured to the nipples 38 and is provided with ports 40, each of which is in open communication with the bore of a nipple 38 and which are adapted to be brought into communication with ports formed in the wind-box, in continuous succession during operation, by rotation of the kiln A.

In the preferable construction shown, the blast-ring 39 is secured to the nipples 38 in such manner that it will have capacity for limited adjustment endwise thereof for adjusting the positions of the manifolds 32 and blast-ring 39 relative to each other. To provide for such adjustment, the nipples 38 have screw-threaded engagement with the bores of tubular fittings 41 detachably secured to said blast-ring and arranged to be secured thereto in different angular adjustments. As shown, the fittings 41 are secured to the blast-ring 39 by means of bolts inserted through holes formed in base flanges on said fittings, which have threaded engagement with corresponding holes in the blast-ring 39, all of said holes being arranged equal, angular distances apart—say sixty degrees (60°)—whereby said bolts will be interchangeable in said bolt holes, thus providing for securing said fittings to said blast-ring in different angular positions, and providing for limited adjustment of the wind-box C and the manifolds 32 towards and from each other, to facilitate installation of said manifolds.

In accordance with the invention, see Figs. 4 and 6, leakage of air from the wind-box C past the blast-ring 39, is prevented by means of annular wear-rings 42, 42', secured to the inner and outer marginal edges of said blast-ring, and which extend entirely around the same, one inside and the other outside of the ports or openings 40, and with which the outer side of the rear wall 43 of the wind-box—which for purposes of convenient references may be designated the wear-plate—is held yieldingly in contact by the weights 27, applied to said wind-box, which, necessarily, must be sufficiently heavy to counteract the force of an unbalanced air pressure in the wind-box tending to force said wind-box away from said blast-ring 39 and the wear-rings 42, 42', thereon, which would operate, in an obvious manner, to cause leakage of air between the rear wall or wear plate 43 of the wind-box and said blast-ring.

As shown, also, the ports or openings 40 in the blast-ring 39, with which the open ends of different manifolds 32 communicate, as heretofore explained, are blocked-off at both sides by suitable barriers 44, arranged to confine air passing from the wind-box to a manifold, to prevent it from passing laterally into the space defined by the wear-rings 42, 42' between the blast-ring 39 and the proximate wall of the windbox, and entering manifolds other than those which are

in communication with the port or opening in the wind-box designed for supplying air under pressure to said manifolds from said wind-box in usual operation, which would result in seriously impairing operation of the kiln, as it relates to pre-heating air intended for combustion purposes and for cooling clinker discharged from the kiln. What I now consider preferable barriers for the purpose, consist of angle-bars made of relatively soft metal, as brass, a flange of each of which is riveted or otherwise secured to the blast-ring **39** and the other flanges of which, respectively, extend substantially at right angles to the side of said blast-ring to which said angle bars are secured, the initial height of said projecting flanges being slightly greater than the thickness of the wear-rings **42**, **42'**. Thus, as first installed, the outer edges of said flanges will contact with the adjacent wall of the wind-box C and will prevent contact of the wear-rings with the rear wall or wear plate of the wind-box, but will quickly be worn down to a height equal to the thickness of said wear rings by rotation of the shell of the kiln. As shown, also, said angle-bars **44** are installed with their opposite ends in contact with said wear-rings **42**, **42'**, respectively, so as to form tight joints therewith. As shown, also, the angle-bars which thus block-off the ports in said manifolds, converge outwards at angles of about 45 degrees to each other, and symmetrically with reference to radial lines of said blast-ring through the centers of said ports respectively.

In accordance with the invention, see Fig. 5, air under pressure admitted to the chamber **36** of the wind-box C is delivered to the manifolds **32** through a port **46** formed by registering openings in the diaphragm **35** and in the rear wall or wear plate of the wind-box, said port openings being circular and their axes being coincident with the axis of rotation of the blast-ring **39** and positioned at the same radial distance from the axis of rotation of said blast-ring as the tubular fittings **41** on the blast-ring **39**. As shown, the port **46** is positioned substantially symmetrically, circumferentially of the shell **1** of the kiln, with the angle of repose of the body of clinker D therein, in operation, the relation being such that the tuyère blocks *b'* which are in communication with the port **46** at any given time, will be covered by the deep body of clinker which over-lies the sector of said angle of repose. As shown, also, said port **46** is of such length that more than one manifold will communicate therewith at the same time, said port being made sufficiently large to insure an adequate supply of air to the manifolds **32** to meet contemplated operating requirements.

As shown, the space between the diaphragm **35** and the rear wall of the wind-box is closed, in register with opposite edges of the port openings therein, respectively, by angles **47**, secured to the diaphragm **35**, and which are bent to conform to the curvature of the said port openings **46** and which form substantially tight joints with said diaphragm and wind-box wall.

As shown, also, opposite ends of the space between said angles **47** are closed by dampers **48**, which are slidably fitted to said space with suitable operating clearance, and are separately adjustable to provide for varying the operative length of the port openings **46** and to vary the circumferential position thereof relative to the angle of repose of the bed of clinker D, within limits. In what I now consider preferable construction, best shown in Figs. 19 to 22, inclusive, the side and end plates of the wind-box are connected by corner angles **49** to which they are riveted or otherwise connected so as to form tight joints, and the diaphragm **35** is connected to the rear wall of the wind-box by bolt and spacing sleeve construction, as will clearly be understood from the drawings without a description thereof in detail.

Also, in what I now consider preferable construction, the dampers **48** are made of suitable sheet metal, are rectangular in shape and are adapted to be secured in adjusted positions by means of nuts **50** threaded to studs **51** secured in said dampers adjacent opposite lateral edges thereof, which project through slots **52** formed in the diaphragm **35** concentric with the axis of rotation of the blast-ring **39**, as will readily be understood, adjustment of the dampers **48** in both directions, and thus the length of the port **46**, being limited by contact of the studs **51** with the ends of the slots **52**.

As shown, also, see Fig. 5, plates **53** are secured to the sides of said dampers, respectively, proximate the diaphragm **35**, said plates conforming in width and curvature to the width and curvature of said dampers and being secured thereto with their proximate ends flush with the corresponding ends of the dampers to which they are secured, respectively, and being of such length that, when said dampers are in their positions of nearest operating approach to each other, the remote ends of said plates will cover and close any portions of the port opening **46** in the diaphragm **35** which may extend beyond the remote ends of said dampers proper, respectively. Also, for convenience in adjusting said dampers, they are provided with handles **54** on their proximate ends, see Fig. 10, which project through the port opening **46** in the diaphragm **35** into the compartment **36** of the wind-box and will be conveniently accessible for manipulating said dampers to adjusting the same, by removing the cover plates **55** of hand-holes formed in the front wall of the wind-box, indicated in diagram in Fig. 7.

As shown, see particularly Fig. 5, the diaphragm **35** of the wind-box is provided with ports **56**, separate from the port **46**, which connect the compartments **36** and **37** of the wind-box, and formed in the rear wall or wear-plate **43** of the wind-box are ports **57**, see Fig. 5 with which the ports **40** in the blast-ring **39** are adapted to be brought into communication in continuous succession, in operation. The ports **56** are controlled by hand valves **58**. With the construction described, it is obvious that cool air may be supplied to the kiln through the tuyère blocks not covered by the body of clinker D in said kiln, to prevent over-heating of said tuyère blocks.

As shown, there are three (3) ports **56** in the diaphragm, but the number thereof may be varied, as may be desired.

In accordance with usual practice, the kiln comprises what is known generally as a firing hood for closing its clinker discharge end. However, such firing hood forms no part of the present invention and no firing hood is shown, though a hood suitable for the purpose can readily be supplied by mechanics familiar with such structures.

To prolong the life of the wear-rings **42**, **42'**, and of the rear wall of the wind-box C, against which said wear rings bear, means are prefer-

ably provided for lubricating the contacting faces thereof. What I now consider preferable means for the purpose, see Fig. 22, consists of a tubular fitting or fittings 59 controlled by an outwardly seating check valve or valves, not shown, and mounted on the wind-box C with the front end or ends thereof projecting at the front side of said wind-box, in position for making grease gun connections thereto, and with their discharge end or ends opening through the rear wall of the wind-box, and arranged to discharge grease between the contacting surfaces of said rear wall and the wear rings 42, 42' on the blast-ring 39. Fittings suitable for the purpose may be purchased commercially and need not, therefore, be shown or described in detail.

In accordance with usual practice, the kiln A comprises a nose-ring 60 secured to the clinker discharge end of the shell 1 of the kiln, said nose-ring extending inwards beyond the inner surface of the preheater and cooler B, as shown, in such relation as to increase the thickness of the bed of clinker in the kiln, as will be readily understood.

I claim:

1. A kiln comprising a rotary shell, a lining therefor, including a combination recuperator and cooler for preheating air supplied to the kiln and cooling material discharged therefrom, means for supplying air under pressure to said recuperator and cooler, comprising air distributing connections on the shell of the kiln constructed and arranged to communicate with said recuperator and cooler, a blast-ring provided with ports secured to the air admission ends of said air distributing connections with the ports thereof in communication with said air distributing connections, a wind-box mounted in association with said kiln, means for supplying air under pressure to said wind-box, a diaphragm which divides the wind-box into compartments, said diaphragm and the rear-wall of the wind-box being provided with segmental blast-openings, means for closing the space between said diaphragm and the rear-wall of the wind-box in substantial register with the corresponding edges of said blast-openings, and dampers which close the ends of said space, the relation being such that rotation of the shell of the kiln will bring the ports in the blast-ring into communication with the blast-openings of the wind-box in continuous succession during operation.

2. A kiln comprising a rotary shell, a lining therefor, including a combination recuperator and cooler for preheating air supplied to the kiln and cooling material discharged therefrom, means for supplying air under pressure to said recuperator and cooler, comprising air distributing connections on the shell of the kiln constructed and arranged to communicate with said recuperator and cooler, a blast-ring provided with ports secured to the air admission ends of said air distributing connections with the ports thereof in communication with said air distributing connections, a wind-box mounted in association with said kiln, means for supplying air under pressure to said wind-box, a diaphragm which divides the wind-box into compartments, said diaphragm and the rear-wall of the wind-box being provided with segmental blast-openings, means for closing the space between said diaphragm and the rear-wall of the wind-box in substantial register with the corresponding edges of said blast-openings and wear-rings secured to the blast-ring at radially opposite sides of the ports therein, with which the rear wall of the wind-box contacts during operation.

3. A kiln comprising a rotary shell, a lining therefor, including a combination recuperator and cooler for preheating air supplied to the kiln and cooling material discharged therefrom, means for supplying air under pressure to said recuperator and cooler, comprising air distributing connections on the shell of the kiln constructed and arranged to communicate with said recuperator and cooler, a blast-ring provided with ports secured to the air admission ends of said air distributing connections with the ports thereof in communication with said air distributing connections, a wind-box mounted in association with said kiln, means for supplying air under pressure to said wind-box, a diaphragm which divides the wind-box into compartments, said diaphragm and the rear-wall of the wind-box being provided with segmental blast-openings, means for closing the space between said diaphragm and the rear-wall of the wind-box in substantial register with the corresponding edges of said blast-openings, dampers which close the ends of said space, wear rings secured to the blast-ring at radially opposite sides of the ports therein, with which the rear wall of the wind-box contacts during operation, and barriers on the blast-ring which extend between the proximate edges of the wear-rings secured thereto and block off the ports therein at both sides thereof.

4. A kiln comprising a rotary shell, a lining therefor, including a combination recuperator and cooler for pre-heating air supplied to the kiln and cooling material discharged therefrom, said recuperator and cooler consisting of trough-shaped members secured to the shell of the kiln with the edges of their open sides in contact therewith, and arranged to form a series of flues spaced apart circumferentially of the kiln, nozzles formed on said flues, tuyère blocks supported on said flues, which extend over said nozzles, respectively, and means for securing said flue members and tuyère blocks to the shell of the kiln, comprising inwardly projecting end flanges arranged to rest on the sides of said flues remote from the shell of the kiln, provided with slots, and bolts which extend through said slots and through holes formed in said flue members and in the shell of the kiln, and means for closing the ends of said flues.

5. A kiln comprising a rotary shell, a lining therefor, including a combination recuperator and cooler for preheating air supplied to the kiln and cooling material discharged therefrom, means for supplying air under pressure to said recuperator and cooler, comprising air distributing connections on the shell of the kiln constructed and arranged to communicate with said recuperator and cooler, a blast-ring provided with ports, secured to the air distributing connections on the shell of the kiln with said ports in communication with said distributing connections, respectively, said ports being arranged in a circular series substantially concentric with the shell of the kiln, a diaphragm which divides said wind-box into compartments, said diaphragm and the rear wall of the wind box being provided with segmental blast-openings, means for closing the space between said diaphragm and the rear wall of the wind-box in substantial register with the corresponding edges of said blast-openings, and dampers which close the ends of said space.

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