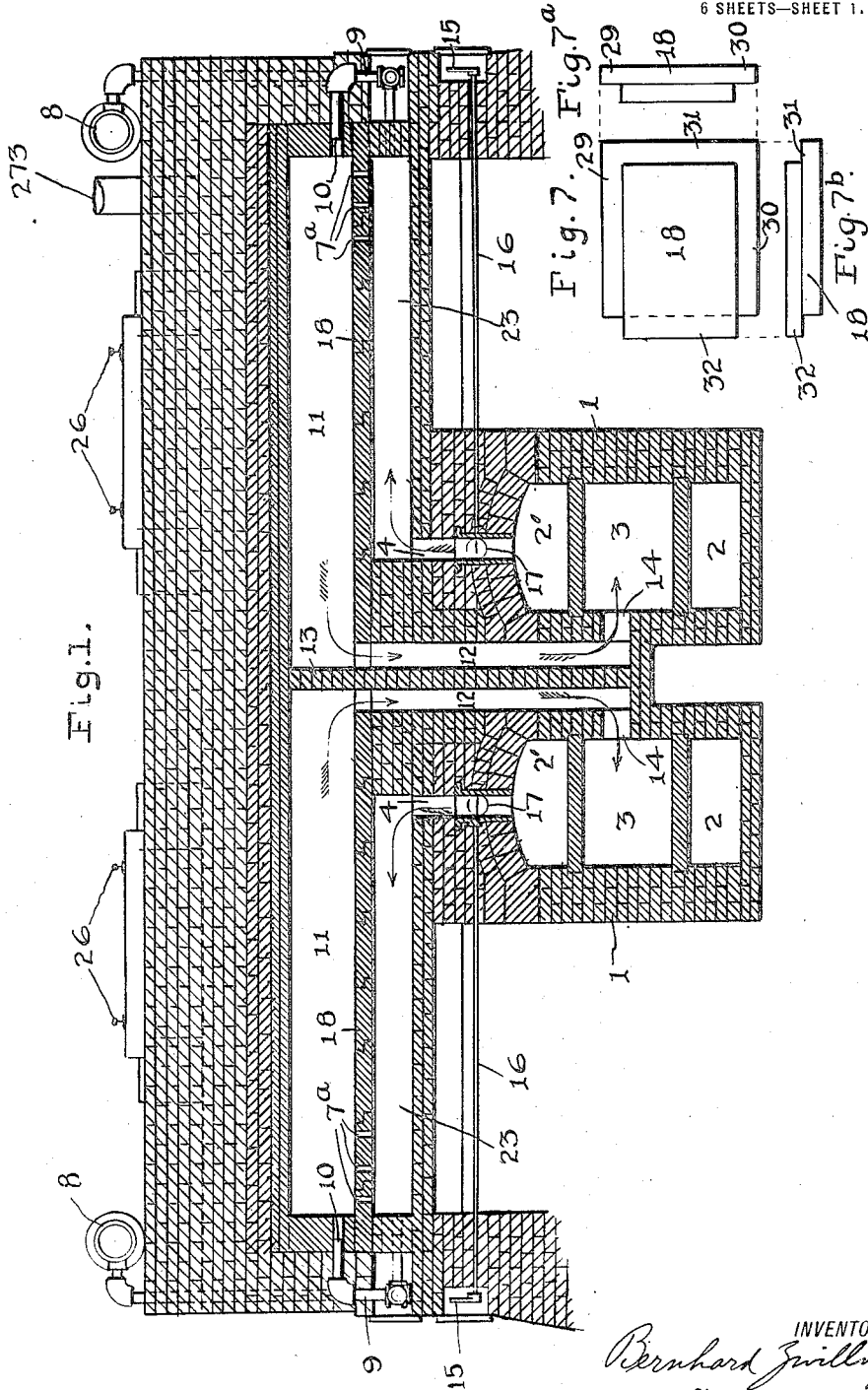


1,428,622.

B. ZWILLINGER, DEC'D.
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SOLE HEATED COKE OVEN.
APPLICATION FILED FEB. 24, 1920.

Patented Sept. 12, 1922.

6 SHEETS—SHEET 1.



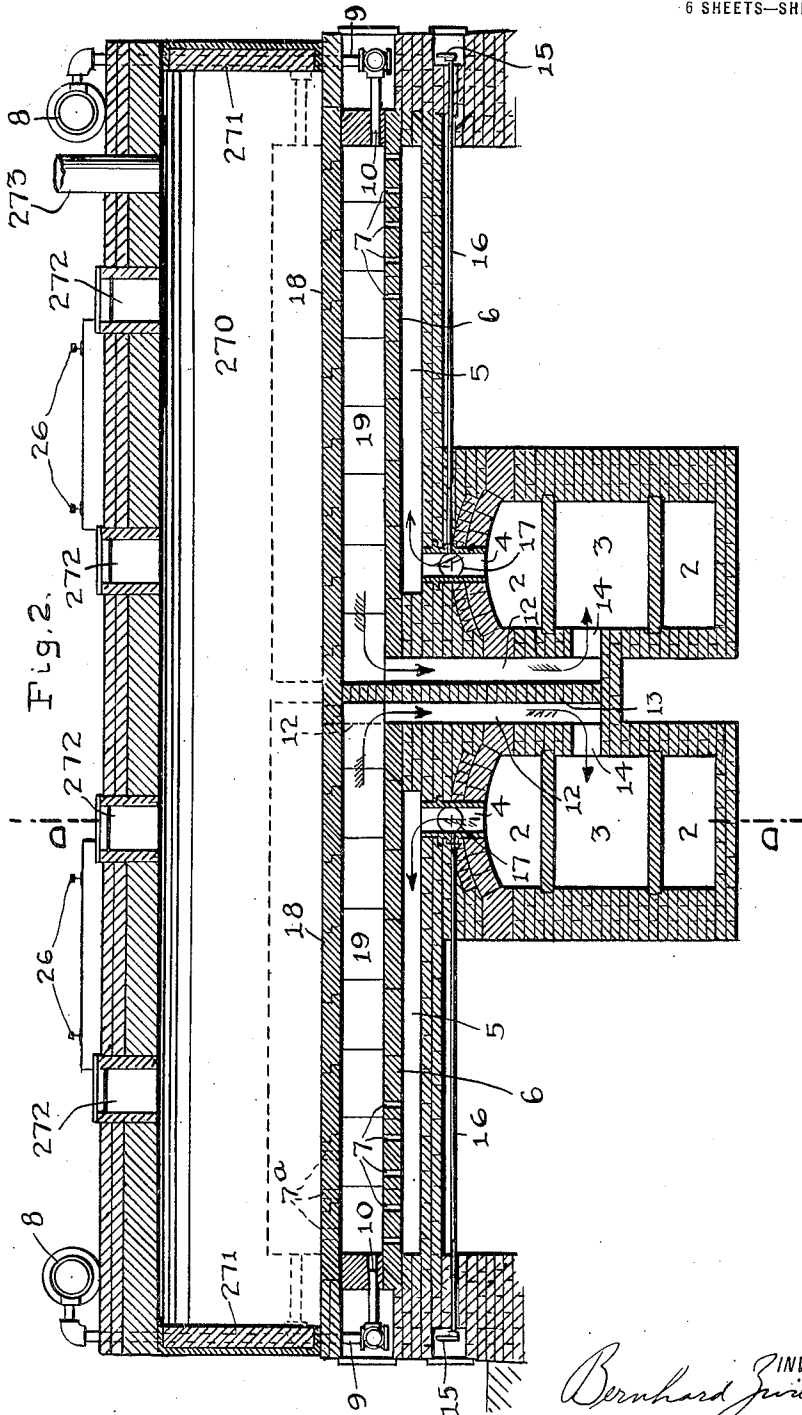
INVENTOR
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6 SHEETS—SHEET 2.



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6 SHEETS—SHEET 3.

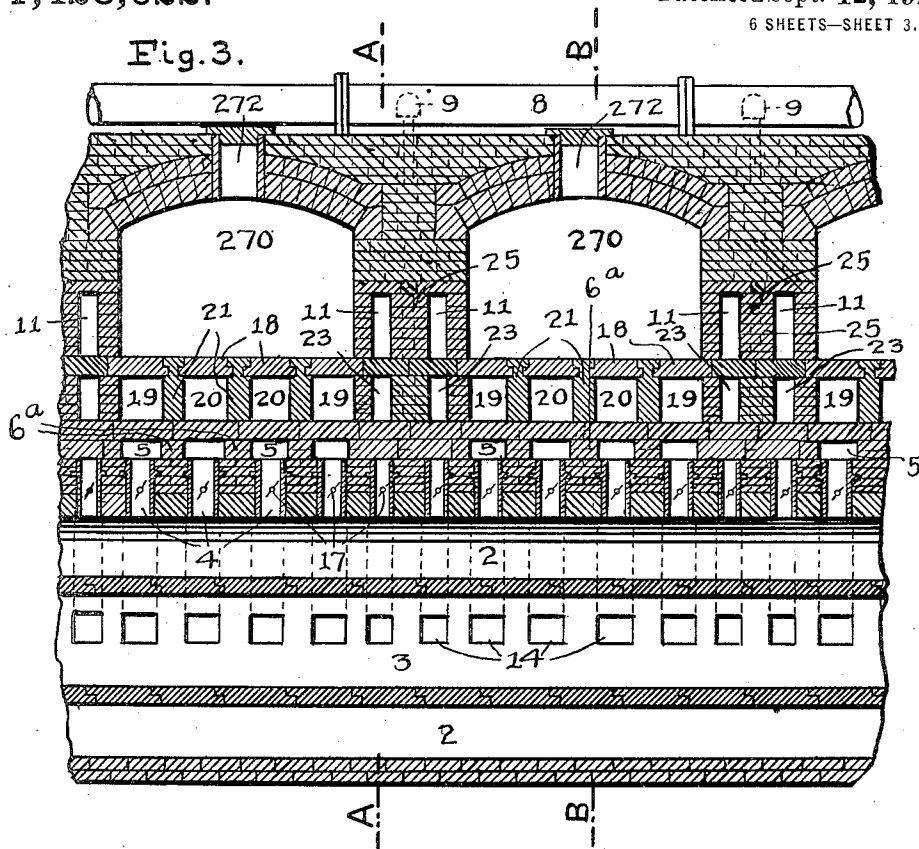
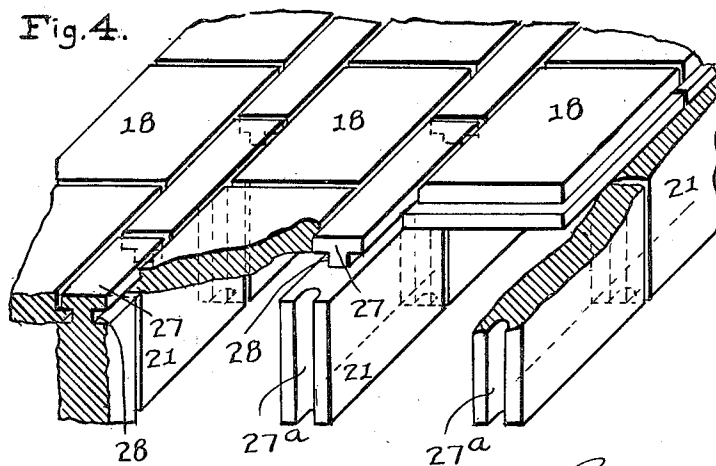


Fig. 4.



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6 SHEETS—SHEET 4.

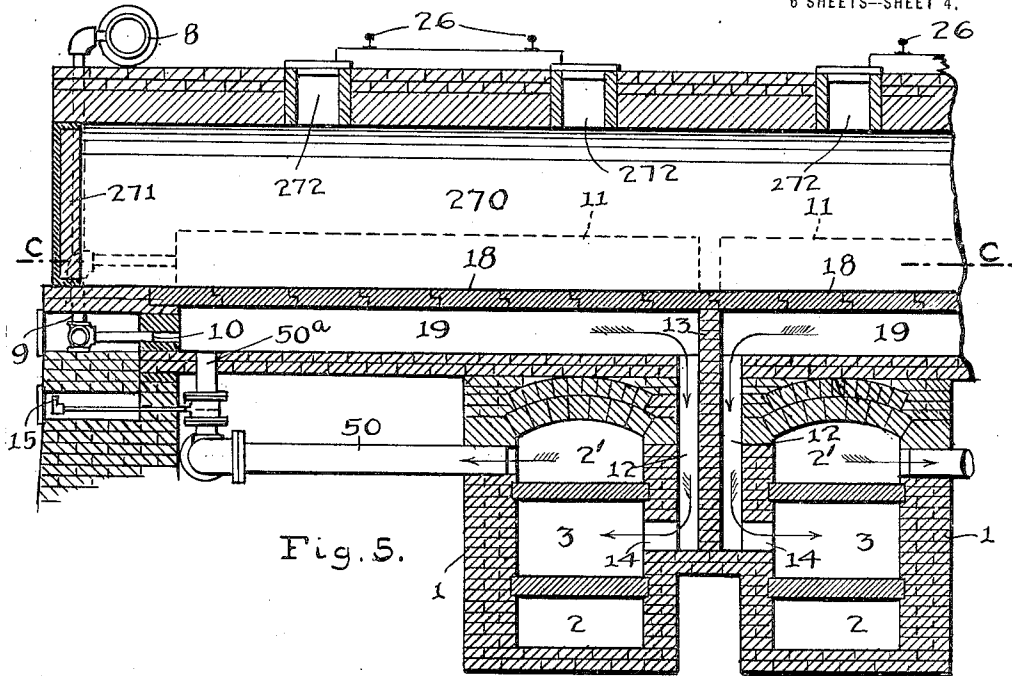


Fig. 5.

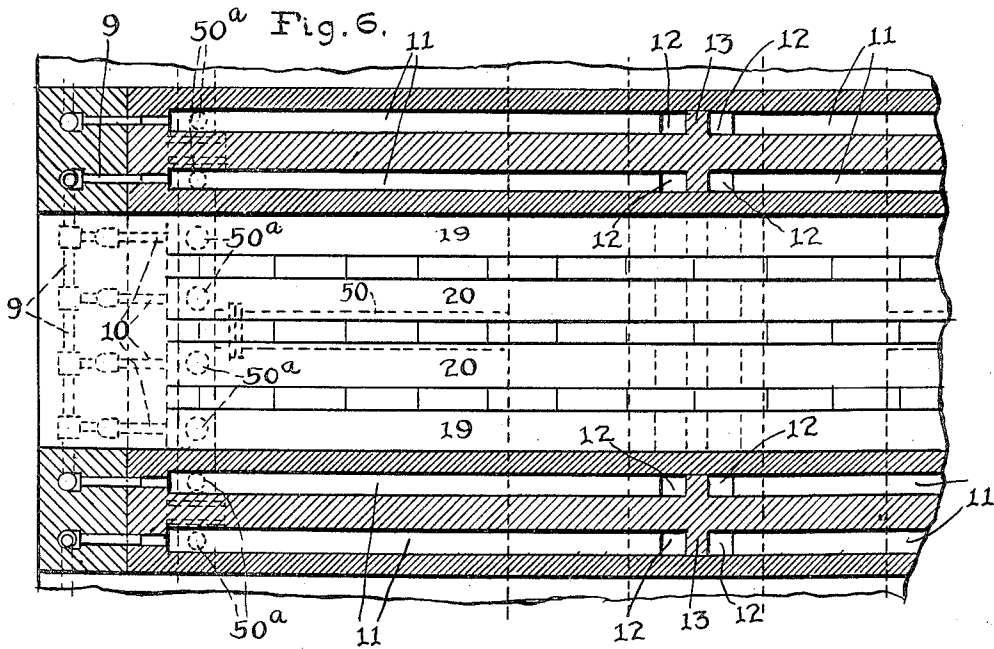


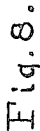
Fig. 6.

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6 SHEETS--SHEET 5.



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6 SHEETS--SHEET 6.

Fig. 9.

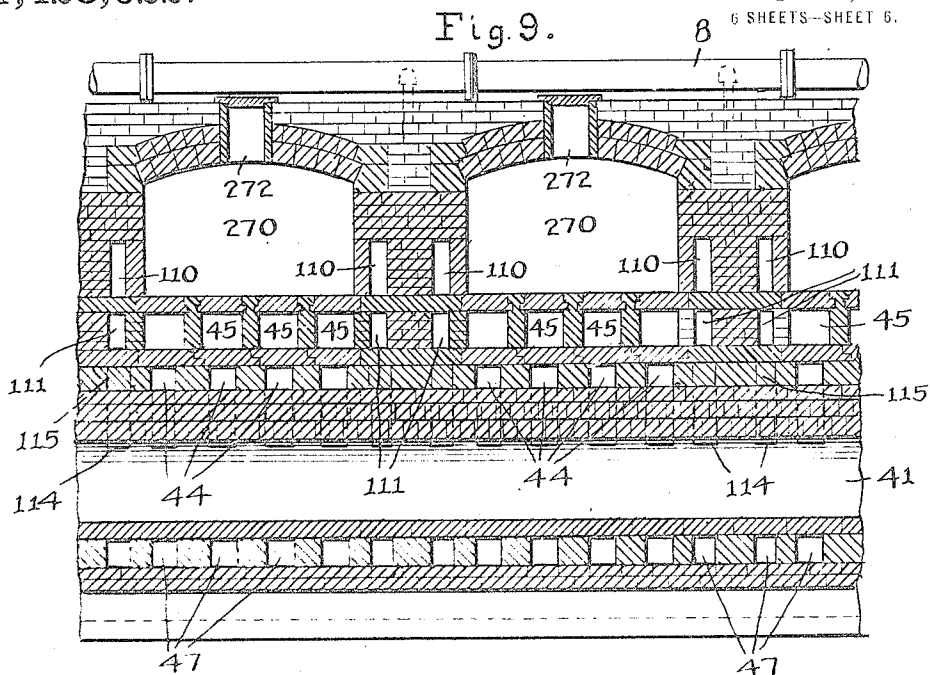
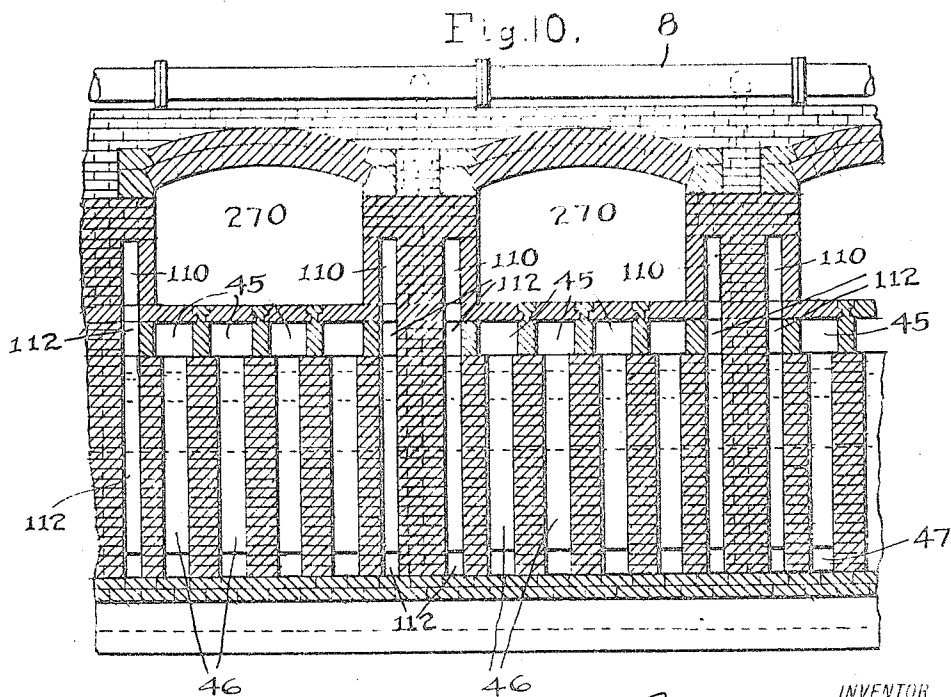


Fig. 10.



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UNITED STATES PATENT OFFICE.

BERNHARD ZWILLINGER, OF NEW YORK, N. Y.; KLARA ZWILLINGER ADMINISTRATRIX OF SAID BERNHARD ZWILLINGER, DECEASED.

SOLE-HEATED COKE OVEN.

Application filed February 24, 1920. Serial No. 360,757.

To all whom it may concern:

Be it known that I, BERNHARD ZWILLINGER, a citizen of the United States, residing in the city, county, and State of New York, have invented certain new and useful Improvements in Sole-Heated Coke Ovens, of which the following is a specification.

This invention relates to improvements in ovens for making coke, gas and by-products especially adaptable for ovens of rectangular shape with sealed oven chamber and with sole heating shown and described in my pending application of March 22, 1919, Serial No. 284,376.

The objects of my invention are to improve the heating means of said rectangular oven in a very simple and efficient manner, to shorten the time of carbonization and to include the quality of the coke.

In my co-pending application I have shown an underfired oven with sealed oven chamber which is heated from both ends by applying the heat to the sole of the ovens only.

While I consider this to be an important advantage, I have found that by providing the sole-heated oven also with heated side walls heated from both ends and a recuperator for preheating the air for both the side wall and sole firing flues, the flues of the side walls and of the sole discharging directly into the waste main of the recuperator, I can accomplish various marked improvements. In the first place by applying heat from both ends and from three sides instead of one, I am enabled to impart a larger quantity of heat to the mass to be coked in a given time and in a more economical manner. Furthermore the temperature will be raised to a degree suitable for the production of a metallurgical coke and simultaneously the time required for carbonizing the charge will be, by the aid of heating the side walls, considerably shortened. Or, in other words, a larger tonnage is obtainable.

Another object of introducing the duplex side wall heating in combination with the sole-fired low-chambered ovens is to eliminate spongy ends at the side walls.

Other objects of my invention are to pre-heat the air for combustion to a higher de-

gree and introduce said air for combustion in a more efficient manner in order to obtain a perfect combustion.

Another object of my invention is to construct a gas-tight bottom, which will allow a larger transfer of heat, has a greater stability and is more economical to construct than hitherto.

Another object is to provide a preheating apparatus and in particular a recuperator which will preheat the air for one-half of both the sole flues and the side flues of the oven.

Another object of my invention is to provide a recuperator for sole-fired ovens having their waste mains and air preheating chambers arranged horizontally, the waste main being located beyond and at one side of the air passageway.

With these and other objects in view the invention consists in certain features described and illustrated in the accompanying drawings and pointed out in the claims, it being understood that various changes in the form or minor details within the scope of the claims may be resorted to without departing from or sacrificing any of the advantages of the invention.

In the drawings, Fig. 1 is a vertical section of the oven on line A—A of Fig. 3, passing through a duplex side heating wall.

Fig. 2 is a vertical section on line B—B of Fig. 3.

Fig. 3 is a cross section on line D—D of Fig. 2.

Fig. 4 is a fragment of the sole with its specially constructed sole plates.

Fig. 5 is a vertical section showing the air once pre-heated and duplex side wall combustion flues.

Fig. 6 is a horizontal section on line C—C of Fig. 5, illustrating the vertical side wall combustion flues of two adjacent ovens.

Figs. 7, 7^a and 7^b show detail views of the sole plate or sole brick.

Fig. 8 is a vertical section through the coking chamber illustrating my underfired oven in combination with my improved recuperator.

Figs. 9 and 10 are cross sections on line E—E and F—F respectively of Fig. 8.

In the oven construction as shown in Fig.

1 and Fig. 2 illustrating a vertical section of the duplex combustion flues at one side of the oven. 1 is the air preheating device or recuperator, with its air heating channels 2, 2' and waste main 3. This is constructed as in my co-pending application No. 284,376. 4 is an air conduit leading into air superheating channel 5 whose upper wall 6 lies below the combustion flue 19 of the oven and is provided with a number of air holes 7, 7' at both ends of the oven. Return gas pipe 8 with its branches 9 and gas nozzles 10 supply the gas to the combustion flues at the bottom and at the side of the oven. Side wall combustion flues 11 and waste gas channels 12 are separated by wall 13 and individually connected by conduit 14 with the waste main 3. Thus a duplex system of side wall combustion flues is provided. One set is utilized for each half of the oven. All combustion flues are provided with spy holes (not shown.) By means of regulatable gas ports 10 and regulatable air conduits 4, the latter regulated by handle 15 connected by rod 16 to air valve 17, all easily accessible, the heat of each individual flue can be properly controlled. As shown in Fig. 3 horizontal combustion flues 19, 19 and 20, 20 beneath the sole will heat the charge placed upon same. These flues consist of vertical walls 21 and sole plates 18 which will be described in detail later on. It will be noticed that beneath each horizontal combustion flue 19, 20 I have located an air superheating chamber 5, and beneath the side combustion flues 11 I have located an air superheating chamber 23 for the purpose of utilizing a considerable part of the heat for superheating the air which otherwise would be conducted into the foundation or to the pillars 25 placed between the ovens, by means of which pillars the tracks 26 are carried. I have designated the chambers 5 and 23 by the expression superheating chamber in order to distinguish the two modes of preheating the air. When compared with the mode of heating shown in Fig. 5 and in my co-pending application it is obvious that in the form of the invention illustrated in Figs. 1 to 3, the air leaving air channels 2 is already in a preheated state because of the heat received from the recuperator, but by impinging on the very hot vertical walls 6^a and horizontal wall 6 in Fig. 2 it is heated again in the superheating chambers to a far higher degree before entering through the air holes 7^a and 7 into the combustion flues 11, 11, 19, 20. The preheating devices 1 in the form of the invention illustrated lie between the ends of the ovens and extend transversely of the ovens.

The air which has been superheated is introduced into the combustion flues in such manner that the air and gas will impinge on each other at right angles, whereby an in-

imate mixture is accomplished and improved combustion is secured, as can be seen from Figs. 1 and 2.

The undersole firing flues consist of two systems for heating the sole. They form a duplex system. In the form illustrated the separating wall 13 separates the two flue systems. Two adjacent recuperators may be used. Each recuperator may serve one-half of both the horizontal and side wall heating flue systems.

Owing to the fact that the air will reach a high temperature I prefer to use channels made of refractory material as is shown in Figs. 1 and 2, instead of metallic conduits for conducting it.

The two combustion flues at each side of the oven 11, 11, being heated from both ends, will greatly assist in maintaining a high heat in oven chamber 270, and at the same time eliminate spongy ends at the side walls. The top of the side combustion flue should always be level with the charge and its height depends on the physical characteristics of the coal, i. e., in carbonizing a shrinking coal it will be somewhat lower, while with an expanding coal it is higher. By the introduction of side walls heated from both ends, in combination with duplex sole-heating, a very substantial increase of actual heating surface is obtained.

Referring now to Figs. 4 and 7, 7^a and 7^b which illustrate the improved bottom or sole of the oven, 21 is a wall brick which standing upright is of such shape as to form a T head 27 on top. Otherwise the body is a regular prism with tongues and grooves 27^a. The T head 27 projects over the body of the brick 21 partly at one end, while at the other end of the body of the brick, it falls short. If the wall bricks 21 are placed lengthwise in such a manner that the projecting end of the T 27 fills up the space left by the shortened end of the T, the joints between the bodies of the bricks and the joints between the T heads are broken and also made tight. The joints between the wall bricks 21 are covered by the T heads and by the sole bricks 18. The sole or floor consists of a number of tiles or bricks, all of the same special shape 18. The tile is characterized by this feature: that all four sides 29, 30, 31, 32 project. The projecting sides 29, 30 which run along lengthwise of the entire vertical wall project into the grooves 28 formed by the T head 27 and in this manner make a gas-tight joint. The sole tile 18 is also provided with projecting ends in an alternating way, i. e., the projecting end of 31 of the sole tile is produced by the lower part of the plate, while the projecting end 32 is formed by the upper part of the sole plate 18. In this way the vertical and horizontal joints running along the length and width of the flues are broken.

The construction as illustrated and described offers a floor of great stability owing to the fact that the sole plates are firmly held in place by the T-shaped top and as the vertical joints are broken with respect to the horizontal joints the entire floor is made air and gas-tight.

Moreover, I make use of only one layer of the sole plates for the construction of the floor or sole. The transfer of heat is therefore more efficient and the cost of construction more economical than with two tiles as shown in my pending application. There is also another disadvantage avoided by the use of a floor constructed by one layer of sole plates instead of two sole plate layers, namely, in the event that one of the plates of the two sole plate structures is warped or should get warped while in use the surfaces not fitting each other closely, might produce a "gas-pocket" or dead gas films which decrease the heat conductivity.

Referring to Figs. 5 and 6, an oven type is illustrated which is simpler in construction than that shown in Figs. 1, 2 and 3, inasmuch as the superheating chambers underneath the sole and side combustion flues are eliminated. The air being preheated in air channel 2', is led through pipe 50 and its branch pipes 50^a to the end of the oven into the sole combustion flues, 19, 19 and 20, 20 and also into the side combustion flues 11 and 11 located at both ends of the oven. The heating gas is supplied from pipe 8 with its branches 9 and gas nozzles 10, also to the sole combustion flues 20, 20, 19, 19 and side combustion flues 11 and 11.

It will be noticed from the arrangement of the gas and air nozzles that the air and gas are impinging at each other at right angles to secure an intimate mixture and perfect combustion. The side combustion flues 11, 11 and sole flues 19, 20 are individually connected by conduits 12 and 14 with the waste main 3. The purpose of connecting each down-take individually with the waste main is to secure a better draft system throughout an entire battery of ovens and to avoid congestion of the burned gases at different points in the oven proper as well as in the battery.

In view of the fact that each individual combustion flue is provided with means for regulating the quantity of gas and air required, I can attain the aforesaid purpose with desired accuracy. The oven chamber 270, in every figure, is sealed so as to avoid admission of air and is closed by doors 271 at its ends, and is provided with fuel openings 272 and a pipe 273 for the by-products. The manner in which the oven is charged and operated, the construction of the sealed oven chamber and the way in which the necessary air and gas for combustion is provided for the ovens has been fully de-

scribed and illustrated in my co-pending application.

Fig. 8 represents an underfired oven with a recuperator illustrating another embodiment of my invention, which offers certain advantages over the air preheating device shown in the preceding views. The advantages of the recuperator illustrated in Fig. 8 reside principally in a more efficient transfer of heat from the waste gases to the air. The air in the recuperator of Figs. 1, 2 and 5 is heated from two sides only. In the construction shown in Fig. 8 where the air is surrounded from three sides by hot gases, a better utilization of the heat contained in the waste gases is accomplished.

Moreover, the recuperator of Fig. 8 is self contained, the air chambers are built into a structure separate and apart from the waste main which latter forms a separate structure and has a higher stability. The air chambers 40 and 41 are separated by a vertical wall 42. Air chamber 40 is connected with a suitable fan, not shown, the air being driven through 40, turning around at the end of the battery and from there going through air chambers 41 and being discharged by openings 43 into a plurality of superheating air passages 44, one for each combustion flue, where it is again heated to a higher temperature and escapes through a number of ports 50 (controlled by slide valve 51) into the combustion flues 45. The burnt gases leaving flues 45 stream through vertical waste gas flue 46, then through waste flue 47, which is connected with waste gas main 48 as indicated by the arrows. The heated gases are thus lead around the inside wall of the air chambers of the recuperator and underneath them. The waste main is located at the other side of the air chambers and the top of the air chambers carries the superheating passageways. The air is thus thoroughly preheated. The vertical division wall 49 separates the two recuperators. The waste main 48 of each recuperator is located beyond and at one side of the air passageways 40, 41 looking from the middle toward the ends of the oven. The air for the duplex side flues is preheated the flues being connected to the recuperator of Fig. 8 as illustrated in Figs. 9 and 10.

The air for the duplex side vertical flues 110 is preheated by sole flues 111. Vertical channels 112 descend from the side flues 110 to the return waste channels on their way to the waste main 48 of the recuperator. The duplex side flues are supplied with gas by pipes 113 and with preheated air from air chamber 41 through channels 114 to one end of horizontal flue 111 extending under the combustion flue 110 and entering the combustion flue through ports 115 at the end remote from the discharge end of the flue.

I desire to have it distinctly understood that while in my present application and also in my previous application Serial No. 284,376, still pending, I have shown a means of preheating the air by the use of a recuperator, I do not confine myself to the use of an air preheating device of this type solely but I can also combine the rectangular oven with a checkerwork preheater or regenerator if I so prefer. The method of carbonizing the charge, of supplying the heat and of preheating the air disclosed in my present and in my co-pending application will be made the subject of a separate patent application.

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

1. In a sole-fired coke oven with by-product recovery having a sealed oven chamber, a plurality of separate and independent combustion flues located beneath the sole, air and gas ports located at or near each end of the oven for supplying gas and air to said flues in combination with duplex side combustion flues located at both sides of the oven with gas and air ports at or near each end of said side flues, thereby effecting the carbonization of the charge from three sides of the coking chamber.

2. In a sole-fired coke oven with by-product recovery a sealed oven chamber, a plurality of parallel, adjacent separate and independent straight combustion flues located beneath the sole, independent duplex side combustion flues located at both sides of the coking chamber, channels connecting each combustion flue with a waste main or mains, whereby each flue discharges its products of combustion by a direct path into said waste main or mains and gas and air ports at or near each end of the combustion flues, thereby effecting the carbonization of the charge from three sides of the coking chamber.

3. In a sole-fired oven with sealed oven chamber the combination of duplex sole flue systems with duplex side flue systems located on opposite sides of the oven, being provided with gas and air ports at or near opposite ends of both the sole and side flue systems for supplying heat to said flues, a preheating device including a waste main located underneath the combustion flues, said device serving the members of both the sole and side flue systems and channels for connecting said halves of the side and sole flue systems with the waste main of the preheating device.

4. In a sole-fired oven with sealed oven chamber, the combination of duplex sole flue systems with duplex side flue systems located on opposite sides of the oven, said flues being provided with gas and air ports at or near opposite ends of both the sole and side flue systems for supplying heat

to said flues, a pair of recuperators, each including a waste main, located underneath the combustion flues, said pair of recuperators serving the members of both the sole and side flue systems and channels for connecting said halves of the side and sole flue systems with the corresponding waste main of the recuperators.

5. In a sole-fired coke oven with sealed oven chamber heated from below and from both sides of the coking chamber a plurality of separate and independent combustion flues forming a duplex system running beneath the oven sole and running along the side walls of the coking chamber, a transverse division wall for separating the sole flues into two systems and means at both ends of the oven for introducing gas and air to the flues.

6. In a sole fired oven having an oven chamber provided with a pusher and a discharge end, said oven chamber sealed against the admission of air and having a sole constructed to receive the charge in a horizontal layer, two systems of sole and two systems of side combustion flues for carbonizing the charge, means for introducing gas and air to the flues from both ends of the oven, and means for preheating the air.

7. In a sole-fired coke oven with by-product recovery having a sealed oven chamber, a set of sole and side combustion flues for carbonizing the charge, a pair of recuperators for preheating the air running crosswise of the oven battery and located underneath the combustion flues and horizontal flues located beneath the oven sole and extending lengthwise of the oven chambers for again preheating it to a higher degree, and means for introducing gas and air to the flues from both ends of the oven.

8. In a sole-fired coke oven with by-product recovery having a sealed oven chamber and constructed to receive the charge in a horizontal layer, a duplex system of flues beneath the sole and a duplex system of flues at the side of the oven so as to carbonize the charge from beneath the sole and from both sides of the coking chamber, and gas and air ports at or near both ends of the oven, said ports arranged so that the gas and air impinge on each other at substantially right angles.

9. In a sole-fired by-product coke oven with sealed oven chamber a sole for the oven chamber consisting of one layer of tiles, said tile on each of its four sides being provided with tongues, a vertical brick for supporting said sole, said brick being provided with a T shaped top, the T shaped top providing grooves into which the tongues fit, thereby making a gas-tight floor as described.

10. In a sole-fired by-product coke oven with sealed oven chamber a sole for the oven chamber consisting of one layer of tiles, said

tile on each of its four sides being provided with tongues, vertical bricks for supporting said sole, said bricks being provided with T shaped tops projecting at one end of their base, said tops being shortened at the opposite ends, the T shaped tops providing grooves into which the tongues fit, thereby breaking the vertical and horizontal joints lengthwise and across the width of the tiles making a gas-tight floor as described.

11. In a sole-fired by-product coke oven, a sealed oven chamber, two systems of separate and independent combustion flues located beneath the sole, two systems of side combustion flues located at each side of the oven, with gas and air ports at or near each end of the oven for supplying air and gas to the flues and thereby effecting the carbonization of the charge from three sides, a pair of recuperators beneath the oven, each recuperator including a waste main and an air passageway, said waste main located beyond and at one side of the air passageway, and channels for each recuperator for leading the waste gases from the combustion flues along the other side of and underneath the air passageway to the waste main.

12. In an underfired by-product coke oven a sealed oven chamber, two systems of separate and independent combustion flues located beneath the sole, two systems of side combustion flues located at each side of the oven, with gas and air ports at or near each end of the oven for supplying air and gas to the flues and thereby effecting the carbonization of the charge from three sides, a pair of recuperators beneath the oven, each recuperator including a waste main and an air passageway, said waste main located beyond and at one side of the air passageway, a superheating air passage for each flue system receiving the air from the said air passageway and extending under the combustion flues and channels for each recuperator for leading the waste gases from the combustion flues along the other side of the air passageway and underneath it to the waste main.

13. In an underfired by-product coke oven a sealed oven chamber, two systems of separate and independent combustion flues located beneath the sole, one system for each half of the oven, with air and gas ports at or near each end of the oven for supplying air and gas to the flues, a pair of recuperators beneath the oven and extending crosswise of the oven battery, each recuperator including a waste main and an air passageway, said waste main located beyond and at one side of the air passageway, and one or more channels for each recuperator for leading the waste gases from the combustion flues along the other side of and underneath the air passageway to the waste main.

14. In an underfired by-product coke oven

a sealed oven chamber, two systems of separate and independent combustion flues located beneath the sole, one system for each half of the oven, with air and gas nozzles at or near each end of the oven for supplying air and gas to the flues, a pair of recuperators beneath the oven and extending crosswise of the oven battery, said recuperators being adjacent to each other and separated by a vertical division wall, each recuperator including a waste main and one or more air passageways, the waste main being located beyond and at one side of the air passageways, a plurality of superheating air passages, one from each combustion flue, receiving the air from the said air passageways and extending under the combustion flues and channels for each recuperator for leading the waste gases from the combustion flues along the other side of the air passageways and underneath them to the waste main.

15. In a horizontal underfired coke oven with by-product recovery a sealed oven chamber, two systems of separate and independent horizontally arranged, parallel straight combustion flues located beneath the sole, gas and air ports at or near each end of the oven for supplying air and gas to the flues, a pair of recuperators beneath the oven, one recuperator for each half of the oven, said recuperators extending crosswise of the oven battery and each recuperator including a waste main and an air passageway, the waste main being located beyond and at one side of the air passageway, a plurality of channels for each recuperator, said channels being separate and independent from each other, there being one channel for each combustion flue and each channel having a vertical and horizontal portion arranged to lead the waste gases from the combustion flues around the inner side of and underneath the air passageway and discharging into the waste main and a plurality of separate and independent superheating air passageways one arranged under each combustion flue and extending lengthwise thereof, each of said superheating passageways receiving the heated air from the air passageway of the recuperator and discharging it through the air ports at the front of the combustion flue.

16. In a horizontal underfired coke oven with by-product recovery a sealed oven chamber, two systems of separate and independent horizontally arranged, parallel straight combustion flues located beneath the sole, gas and air ports at or near each end of the oven for supplying air and gas to the flues, a pair of recuperators beneath the oven, one recuperator for each half of the oven, said recuperators extending crosswise of the oven battery and each recuperator including a waste main and an air passageway,

the waste main being located beyond and at one side of the air passageway, a plurality of channels for each recuperator, said channels being separate and independent from each other, there being one channel for each combustion flue and each channel having a vertical and horizontal portion arranged to lead the waste gases from the combustion flues around the inner side of and underneath the air passageway and discharging into the waste main and a plurality of straight separate and independent superheating air passageways one arranged under each combustion flue and extending the entire length thereof, each of said superheating passageways having a portion extending above the air passageway and receiving the heated air from the air passageway of the recuperator and discharging it through the air ports at the front of the combustion flue.

17. In a sole fired by-product coke oven provided with doors at its opposite ends for sealing the oven chamber, said oven chamber being heated from below and from both sides, the sole of the oven chamber being adapted to receive the charge to be coked, in a horizontal layer, the combination of two systems of flues for the sole of the oven and two systems of flues for the side of the oven, transverse separating means for separating the two systems of flues, means for introducing gas and air to the flues from both ends of the oven and means for preheating the air.

18. In a sole fired coke oven provided with doors at its opposite ends for sealing the oven chamber, said oven chamber being heated from below and from both sides, the sole of the oven chamber being adapted to receive the charge to be coked, in a horizontal layer, the combination of two systems of flues for the sole of the oven and two systems of flues for the side of the oven, transverse separating means for separating the two systems of flues, means for preheating the air, and means for discharging the waste combustion gases from the said flues below the oven sole.

19. In a sole fired coke oven provided with doors at its opposite ends for sealing the oven chamber, said oven chamber being heated from below and from both sides, the sole of the oven chamber being adapted to receive the charge to be coked, in a horizontal layer, the combination of two systems of flues for the sole of the oven and two systems of flues for the side of the oven, transverse separating means located midway between the oven ends for separating the two systems of flues, gas and air ports for the inlet end of each flue, means for preheating the air, means for discharging the waste combustion gases from said flues respectively on opposite sides of the

said transverse separating means and below the oven sole, at the middle of the oven.

20. In a sole fired coke oven, a sealed oven chamber, two systems of separate and independent combustion flues located beneath the sole, a transverse division wall, midway of the oven, for separating the two systems, and two sets of gas and air ports, each set adjacent to an end of the oven, for supplying gas and air to the flues.

21. A distillation oven comprising an oven chamber, open at both ends, said ends provided with doors for sealing the oven chamber against the admission of air, said oven chamber being also provided with a sole constructed to receive the charge in a horizontal layer, a plurality of flues underneath the sole of the oven for heating it, a transverse dividing means for separating the flues into two systems, and means adjacent the inlet ends of the flues and at both ends of the oven, for supplying gas and air to the flues.

22. A distillation oven comprising an oven chamber, open at both ends, said ends provided with doors for sealing the oven chamber against the admission of air, said oven chamber being also provided with a sole constructed to receive the charge in a horizontal layer, a plurality of flues underneath the sole of the oven for heating it, a transverse dividing means for separating the flues into two systems, means adjacent the inlet ends of the flues and at both ends of the oven, for supplying gas to the flues and a plurality of horizontal air flues for preheating the air, said air flues extending parallel and adjacent to the sole flues and supplying heated air to the inlet ends thereof.

23. A distillation oven comprising an oven chamber, open at both ends, said ends provided with doors for sealing the oven chamber against the admission of air, said oven chamber being also provided with a sole constructed to receive the charge in a horizontal layer, a plurality of flues underneath the sole of the oven for heating it, a transverse dividing means for separating the flues into two systems, means adjacent the inlet ends of the flues and at both ends of the oven, for supplying gas to the flues, a plurality of horizontal air flues for preheating the air and means extending transversely of the oven sole for separating said air flues into two systems, said air flues extending parallel and adjacent to the sole flues and supplying heated air to the inlet ends thereof.

24. A distillation oven comprising an oven chamber, open at both ends, said ends provided with doors for sealing the oven chamber against the admission of air, said oven chamber being also provided with a sole constructed to receive the charge in a horizontal layer, a plurality of flues underneath

the sole of the oven for heating it, a trans-
verse dividing means for separating the flues
into two systems, means adjacent the inlet
ends of the flues and at both ends of the
5 oven, for supplying gas to the flues, a plu-
rality of horizontal air flues for preheating
the air and means extending transversely
of the oven sole for separating said air flues
into two systems, said air flues extending
10 parallel and beneath the sole flues and sup-
plying heated air to the inlet ends thereof.

25. A sole fired coke oven with by-product
recovery having a sealed oven chamber and
provided with a duplex side combustion flue.

In testimony whereof, I have signed my 15
name to this specification, in the presence
of two subscribing witnesses.

BERNHARD ZWILLINGER.

Witnesses:

WM. F. BISSING,
J. RENITZ.