

Aug. 29, 1933.

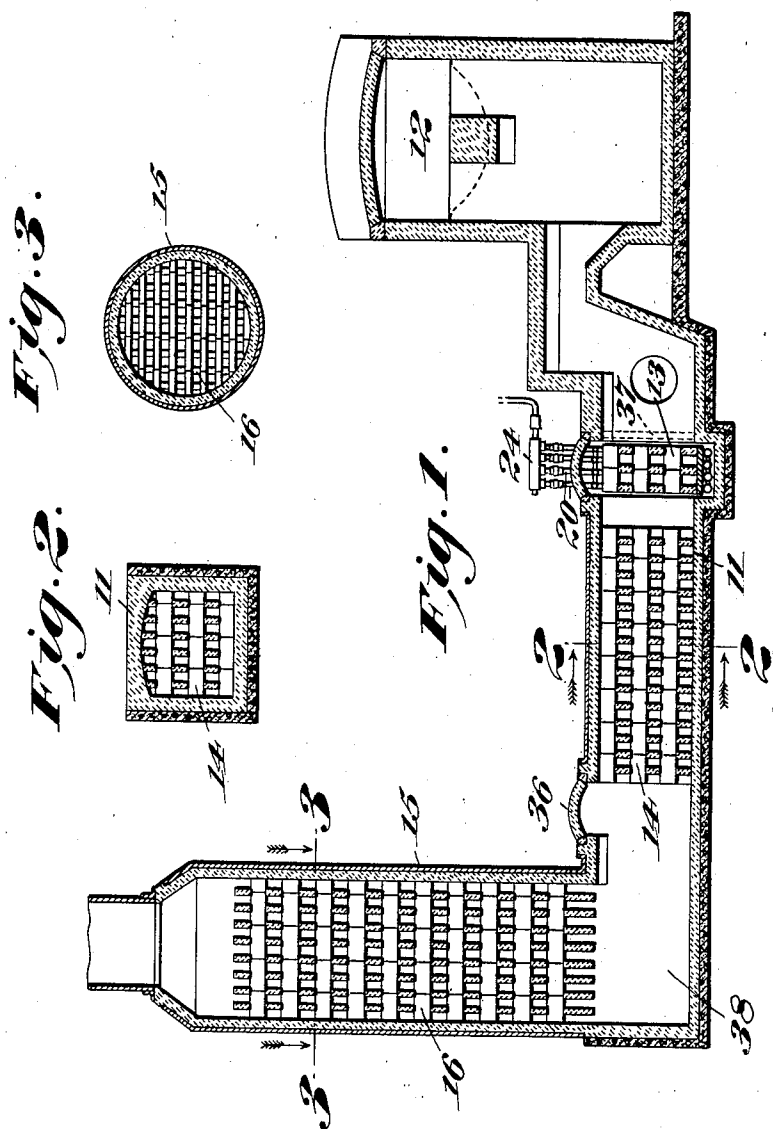
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1,924,936

FURNACE CONSTRUCTION

Filed Aug. 22, 1931

4 Sheets-Sheet 1



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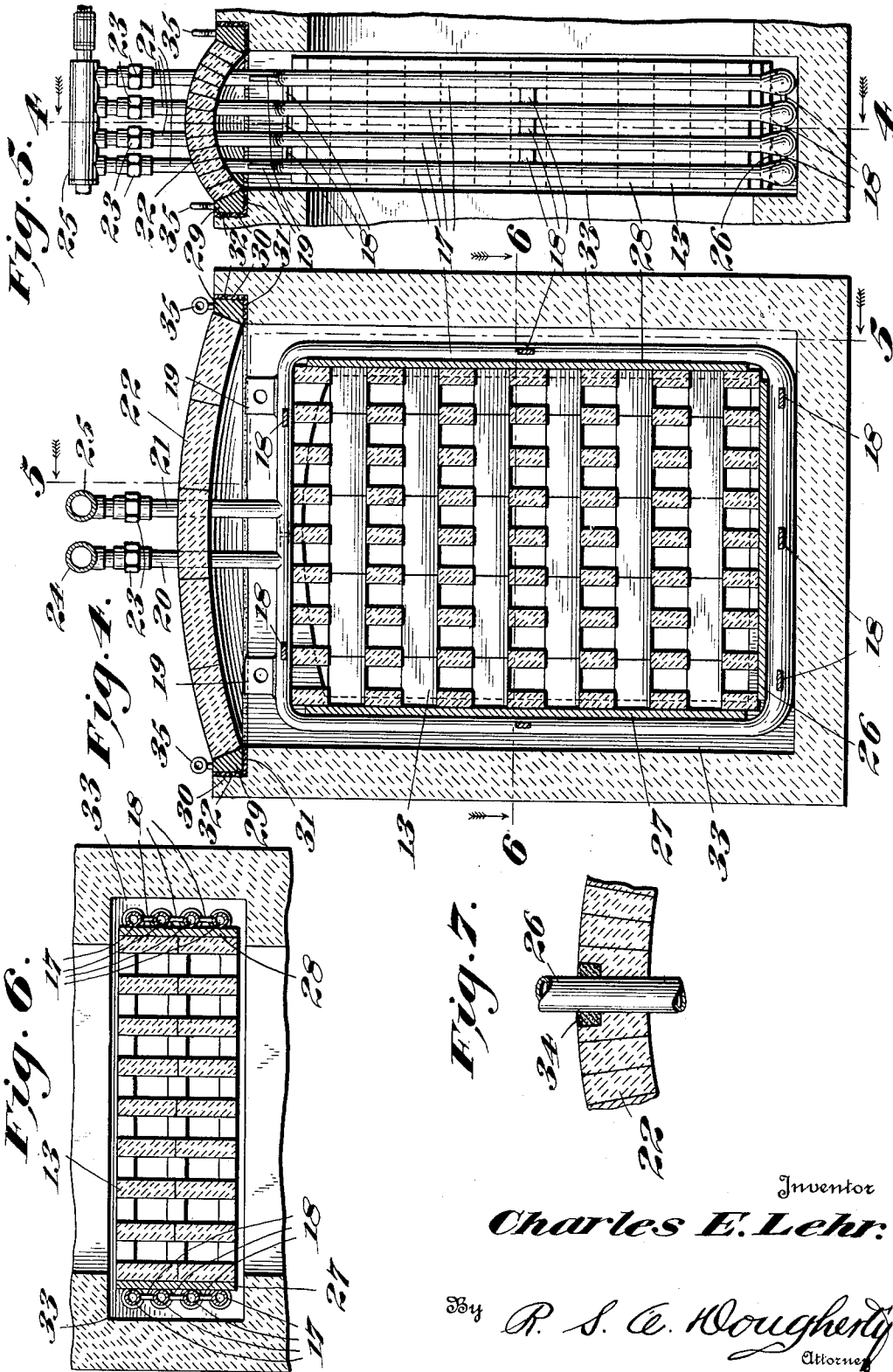
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Filed Aug. 22, 1931

4 Sheets-Sheet 2



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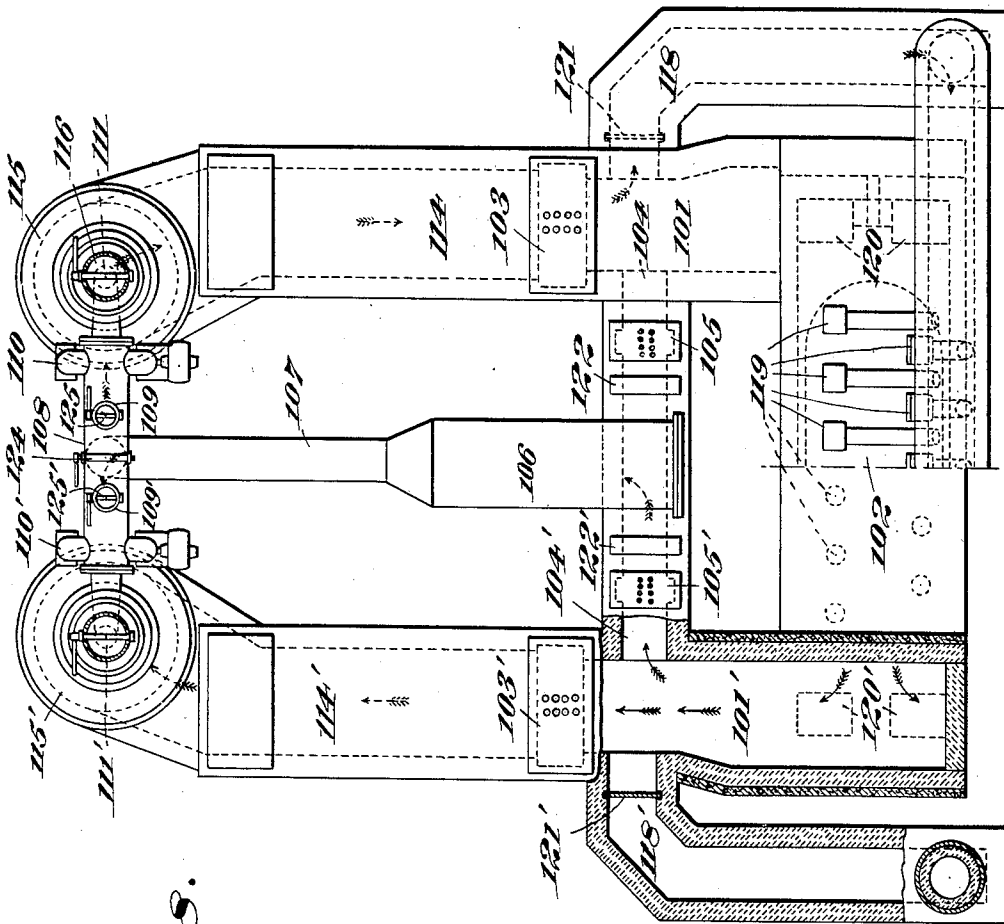


Fig. 8.

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4 Sheets-Sheet 4

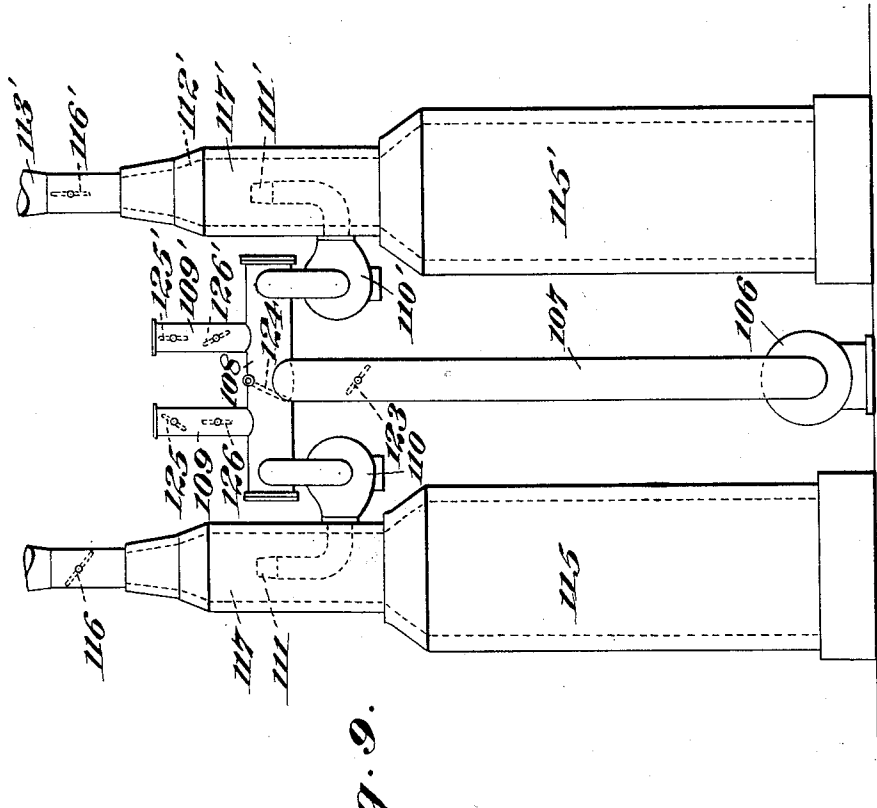


Fig. 9.

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UNITED STATES PATENT OFFICE

1,924,936

FURNACE CONSTRUCTION

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Application August 22, 1931. Serial No. 558,688

10 Claims. (Cl. 263—15)

My invention has for its object the improvement in the construction of regenerative chambers of open hearth furnaces, to permit of easy removal and replacement of portions thereof which become clogged with particles precipitated from the gases, and the arrangement of the construction and flow of air and gases so that a more efficient and convenient utilization can be made of the excess heat in the outflowing gases beyond that required for preheating purposes. In addition other objects are attained which will be made apparent in the following description. The invention relates more particularly to furnaces where fuel is admitted through the roof of the furnace and where the outflowing gases leave the furnace at a temperature higher than in the usual practice.

In the accompanying drawings I have shown more or less diagrammatically for purposes of illustration only embodiments of this invention, it being understood that the drawings do not define the limits of the invention as changes may be made in the construction of different elements without departing from the spirit of the invention.

Fig. 1 is a vertical section through an open hearth furnace and one of its communicating flues and stacks.

Figs. 2 and 3 are cross sections through the flue and stack respectively, taken on lines 2—2 and 3—3 of Fig. 1.

Figs. 4—6 are sections through a removable unit of checker work forming a portion of the regenerative system.

Fig. 7 is a detail of such removable unit.

Fig. 8 is a plan, partly in section, of an open hearth furnace and its communicating flues together with a waste heat boiler used in conjunction therewith.

Fig. 9 is an elevation of the stacks and contiguous portions of the apparatus shown in Fig. 8.

In Fig. 1, 11 is one of a pair of flues which communicate with the opposite ends of an open hearth furnace 12. It will be understood that the arrangements and appurtenances associated with each of these flues are identical, and that they are used alternately for the passage of burned and unburned gases respectively, so that the illustration and description of one such unit will apply to both. Flue 11 contains two horizontal checker sections 13 and 14, the latter being of considerable length and of ordinary construction, while the former is of special design and construction to facilitate its quick and easy removal and replacement. At its far end flue 11

communicates directly with stack 15 of circular section which is filled for a considerable portion of its height with checker work 16.

Referring to Figs. 4—6 which illustrate the construction of removable checker section 13, the four closed rectangles of pipe 17 are built into a box-like unit by welded spacers 18 and are provided at the corners with perforated pulling plates 19. Water inlet and outlet pipes 20 and 21 are connected to each of the loops of pipe 17 and pass upwards through the arched cover 22 on the upper side of which the various pipes are connected through unions 23 to headers 24 and 25. The latter are, through flexible couplings connected to water supply and drain. At the top of each of the loops 17, between the connections to inlet and outlet pipes, an internal diaphragm is welded to cause the circulation of water to pass around the loop.

Metal plates 26, 27, and 28 are laid against the bottom and side portions of the pipe loops and a checker work of highly refractory brick is built up inside as nearly to the top of the loops as possible. The cover 22 is built with an arched construction of silica brick inside the rectangular metal frame 29. It rests along its edges in a recess in the brickwork of the flue, but is separated from contact with this brickwork by a layer of one half inch of refractory sand 31, which prevents fusion. Around the sides of the cover luting material is packed as shown at 32. Fig. 7, a section of the arched brick-work of the cover taken along one of the vertical pipes, shows the circular recess 34 around each pipe which is packed with luting material.

The unit built up as described fits into a recess 33 of the brickwork of the flue so formed that the bottom, sides and top portions of the loops of pipe are all outside the normal section of the flue and thus escape direct impingement of the highly heated gases.

When it is desired to replace this unit, unions 23 are first disconnected from pipes 20 and 21, the cover 22 is lifted off by means of suitable rings 35, the checker unit is hoisted out by means of plates 19, a second unit held in readiness is then lowered into place, the layer of sand is replaced around the edge of recess 33 and the cover lowered over the pipe ends and settled onto its seat. The orifices for the pipes and the sides of the cover are then luted, and water connections established.

Between horizontal checker section 14 and vertical section 16 a space 38 of empty flue is interposed, part of which is directly underneath the

vertical checker section. This space acts as a dust chamber to collect dust settling from the gases and dropping from the checker section above.

5 The checker sections in chamber 14 and in stack 15 provide the major portion of the regenerative system, the stack having about 70% and the horizontal chamber 30% of such checker work. The section of the stack is round and that
10 of the horizontal chamber approximately rectangular. It is necessary to use highly refractory brick in section 13 and checker chamber 14, but brick of lower quality is satisfactory in the stack.

15 Numerous decided advantages are present in the operation and behavior of a furnace of this type. It has been observed that the most serious clogging by particles of dirt carried over by the burned gases occurs in the first foot or two of
20 the checkerwork. In an open hearth furnace construction in which the gases from the furnace make their first passage vertically downward through the checker-chamber, a collection of dirt in the upper layers takes place, but it is difficult to remedy the condition by replacing only
25 these upper layers, since, in removing them, dirt and broken bricks drop down and clog the lower spaces. It is thus usually necessary to remove all of the checkerwork in the chamber, an operation which is obviously slow and costly. With
30 the removable unit as shown, however, such a renewal can be carried out in a very short time and does not interfere with the regular operation of the furnace.

35 The checkerwork in chamber 14 is subjected to a high temperature and also a considerable amount of clogging takes place, but this latter to a much less degree than would be the case in the absence of removable section 13. Easy access to this chamber is obtained by removal of
40 section 13 and in addition a man hole 36 is provided for this purpose. Further it is possible after removal of section 13 to block off the heat of the furnace by installing a temporary bulkhead of any sort as shown by dotted lines 37 and
45 thus reach and clean this checkerwork by means of an air jet or by other means, if complete removal of the checkerwork is unnecessary.

50 The checker-chamber in stack 15 may be considered a permanent installation as it works at lower temperature and receives practically no dirt from the gases, this having been precipitated by previous checker sections.

55 The complete system of checkerwork thus consists of three separate portions each distinct in their functions and operation. That in the stack may be considered permanent, and serves the function merely of heat storage and transfer. That in the horizontal chamber is readily accessible for renewal and may be renewed at the
60 end of every campaign or may merely be cleaned and thus last for several campaigns. Its function is both for heat storage and transfer and to precipitate thoroughly the dust in the gases.
65 That in the removable section which may be replaced at the end of a campaign or several times during the campaign, serves to precipitate the major portion of the flue dust, and thus protect section 14, its heat storage and transfer function
70 being of only secondary importance. The convenience in maintenance with this arrangement is obvious and in addition it produces a substantial saving in labor and the cost of refractories.

75 Figs. 8 and 9 show the arrangement of furnace and flues in which the principles described above

are embodied in combination with a waste heat boiler for the efficient utilization of the excess heat of the gases. In these figures 101 and 101' are flues communicating with ports at the ends of the open hearth furnace 102. In the illustration the air is caused to enter the furnace through flue 101 and the burnt gases to leave through similar flue 101', but the flow may be reversed by the operation of suitable dampers which are shown in the illustration and will be more fully
80 described. Part of the burnt gases in 101' passes through the removable checker section 103' and another part is conducted through the by-pass 104', the additional checker section 105' of removable construction such as shown in Figs. 4-7,
85 the fire tube boiler 106, the duct 107 and into header 108. Into this header outside air is also admitted through the intake pipe 109' and the mixture drawn out by the fan 110' and forced through nozzle 111' and throat 112' to the stack
90 113'. The main portion of the gas, after passing removable checker section 103' is drawn through horizontal checker chamber 114', vertical checker chamber 115' and passes to the stack, the suction for causing this flow being induced by the action
95 of nozzle 111' and throat 112'.

Air for combustion enters at intake pipe 109, is drawn through fan 110, forced through nozzle 111, impinges against damper 116, passes down through chamber 117, vertical checker chamber 105
100 115, horizontal checker chamber 114, removable checker section 103, into flue 101, through duct 118 and into the furnace through burners 119. The courses of the air and gases are indicated by arrows.

110 Dampers 120 are provided at the point of communication of flue 101 with the end of the furnace chamber and similar dampers 120' the positions of which are indicated by dotted lines, at the point of communication of flue 101', with
115 the opposite end of the furnace chamber. Further dampers 121 and 121' are provided in ducts 118 and 118' and dampers 122 and 122' in ducts 104 and 104'. In the operating condition illustrated, dampers 120, 122 and 121' are closed
120 while 120', 122' and 121 are fully open. A control damper 123 in duct 107 serves to regulate the relative percentage of gas by-passed through boiler 106 and flue 114; dampers 122 and 122' being always either fully closed or open. A swinging
125 damper 124 at the junction of duct 107 and header 108 connects this duct alternatively with the one or the other end of header 108. In each of the intake pipes 109 and 109' two dampers are provided 125 and 125' and 126 and 126',
130 dampers 126 and 126' for the control of air used for forcing the gases up the stack and dampers 125 and 125' for the control of air for combustion purposes. These latter dampers are provided with orifices for the more accurate control of
135 small volumes of flow.

For bringing about a flow in the reverse direction through the system, dampers 120', 122' 121 and 116' are closed, dampers 120, 122, 121' 126', 116 and 125 are opened, swinging damper 124 is
140 shifted to its opposite position and dampers 125' and 126 are set in their proper positions for regulation.

In this arrangement including the waste heat boiler, all the advantages of dividing the checker-
145 work and in the use of a removable checker section are obtained for the major portion of the gases, while the use of a removable checker section in the by-passes insures that an unrestricted flow of comparatively clean gases passes through
150

the waste heat boiler. This system differs from the usual one used with open hearth furnaces, where it is common practice to pass the whole of the gases through a boiler after they have travelled through the checker chambers, and is particularly suited to the type of furnace where the air and fuel are introduced through a number of burners in the roof of the furnace. In this type of furnace the gases are at a somewhat higher temperature on leaving the furnace than is usually customary, and there is a greater portion of waste heat available. Particularly is this true where liquid fuel is employed and the volume of gases per unit of heat developed is considerably less than in the usual practice. It has been found that in an ordinary open hearth furnace the gases leave the furnace at a temperature in the neighborhood of 2500° F. while in furnaces equipped with burners in the roof it may be several hundred degrees hotter. Therefore, a portion of the flow is ample for heating the checkerwork. The use of high temperature gases directly in the furnace has the advantage that a small boiler working under more favorable conditions can be used. Whereas in the ordinary case where all of the gases pass through the boiler after leaving the checker chambers the boiler ordinarily develops about 85% of its rating, with the by-pass arrangement the boiler will develop about 250% of its rated horsepower. The arrangement is particularly suitable also where forced draft is employed, owing to the simplicity with which it fits into the system, whereas with such furnaces the attempt to pass all of the gases through a waste heat boiler after they leave the checker chambers is accomplished with such difficulties that in practice this boiler is often omitted. The gases from the boiler are cooled not only by the boiler itself but by the large admixture of air through the intake pipe and may thus be safely handled by the fan.

In each of the by-pass conduits 104 and 104' a damper is provided, for reversing the flow, but the control of the volume of gas passing through the boiler is secured by a separate damper through which the gases pass regardless of whether they are being drawn at the moment from one end of the furnace or the other. This considerably simplifies the management of the system.

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

1. In combination with a furnace, a regenerator comprising a number of checker sections one of which is removable and replaceable as a unit and a flue containing said regenerator and connecting with said furnace, said flue being recessed along its bottom and sides for the reception of said removable and replaceable unit.

2. In the regenerative system for a furnace, a flue provided with a transverse opening, a checker section in said flue registering with said opening, a water cooled framework around said checker section constituting with said checker section a structure removable as a unit from said flue, a cover normally sealing said opening, water conduits connected to said water cooled framework passing through said cover, water connections at the ends of said conduits, said cover being removable upon disconnecting said connections without removal of said checker section.

3. In the regenerative system for a furnace, a flue provided with a transverse opening, a checker

section in said flue registering with said opening, a water cooled framework, comprising a plurality of spaced loops of pipe, around said checker system, constituting with said checker section a structure removable as a unit from said flue, a cover normally sealing said opening, a pair of water conduits connected to each loop of said framework, passing through said cover, water connections at the ends of said conduits, said cover being removable upon disconnecting said connections without removal of said checker section.

4. An open hearth furnace, a plurality of burners in the roof of said furnace, a checker section, a flue connecting an end of said furnace with said checker section, a waste heat boiler, a conduit from said flue to said waste boiler, a checker section in said conduit, said last named checker section being removable as a unit, a checker section in said flue, said last named checker section being removable as a unit.

5. In the regenerative system for a furnace, a discharge vent, a flue connecting said furnace with said discharge vent, a checker section in said flue, a waste heat boiler, a conduit communicating with said waste heat boiler and with said flue at a point between said furnace and said checker section, a fan, a duct connecting said waste heat boiler with the suction port of said fan, and a nozzle in said discharge vent completed to the discharge port of said fan.

6. In the regenerative system for a furnace, a pair of discharge vents, flues connecting the respective ends of said furnace with said respective discharge vents, checker sections in said flues, a waste heat boiler, by-pass conduits communicating with said waste heat boiler and with said respective flues at points between said furnace and said checker sections, a fan, associated with each of said discharge vents, a duct connecting said waste heat boiler with the suction ports of said fans, a nozzle in each of said discharge vents connected to the discharge port of said respective fan, dampers in each of the said by-pass conduits and a damper in said duct.

7. An open hearth furnace, a plurality of burners in the roof of said furnace, a checker chamber, a flue connecting an end of said furnace with said checker chamber, a waste heat boiler, a conduit from said flue to said waste boiler, a checker section in said conduit, said checker section being removable as a unit.

8. In a furnace regenerative system, a waste gas conduit having a passageway disposed to direct gases in a horizontal direction; a further passageway disposed to direct gases in a vertical direction, checker sections in each of said passageways and a dust chamber having means of access thereto intermediate said sections.

9. In the regenerative system for a furnace, a checker section comprising an apertured body of refractory material and an outer metallic frame supporting said material so as to facilitate a vertical manipulation of said section in the plane of said frame.

10. In a regenerative system for a furnace, a checker section comprising an apertured body of refractory material, a metal frame having passageways for a cooling medium said frame supporting said material so as to facilitate a vertical manipulation of said section in the plane of said frame.

CHARLES E. LEHR.

CERTIFICATE OF CORRECTION.

Patent No. 1,924,936.

August 29, 1933.

CHARLES E. LEHR.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, line 104, claim 5, for "completed" read "connected"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 24th day of October, A. D. 1933.

(Seal)

F. M. Hopkins
Acting Commissioner of Patents.