Dec. 14, 1965 J. J. WEBBER 3,223,135

COMBUSTION AIR HEATER FOR REGENERATIVE FURNACE

Original Filed March 7, 1962 3 Sheets-Sheet 1

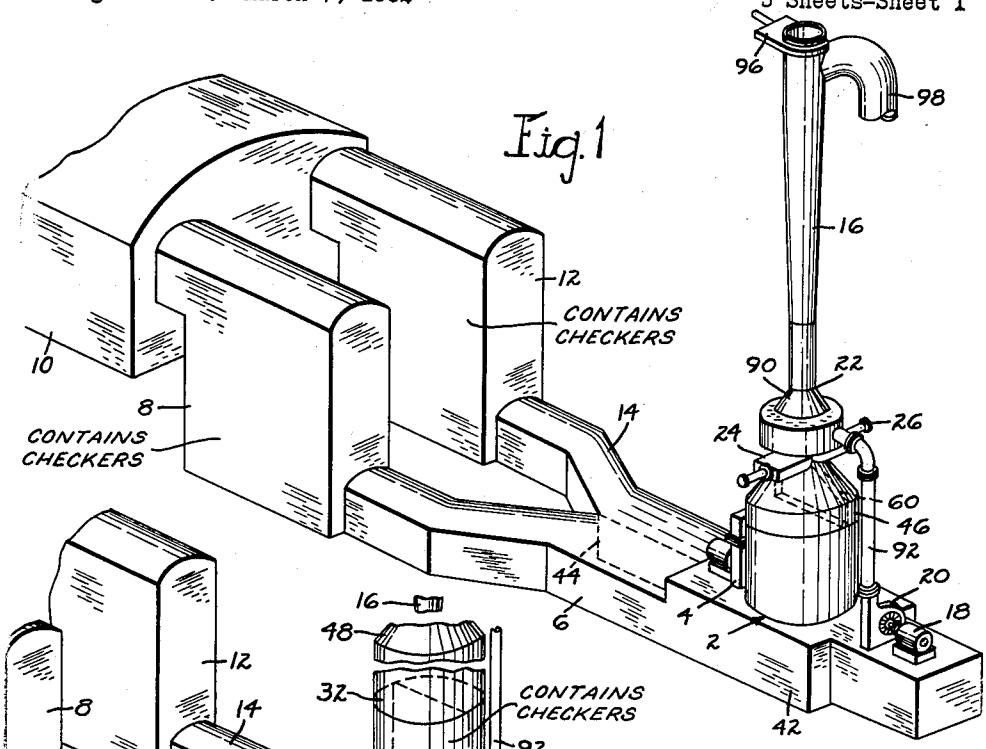


Fig. 1

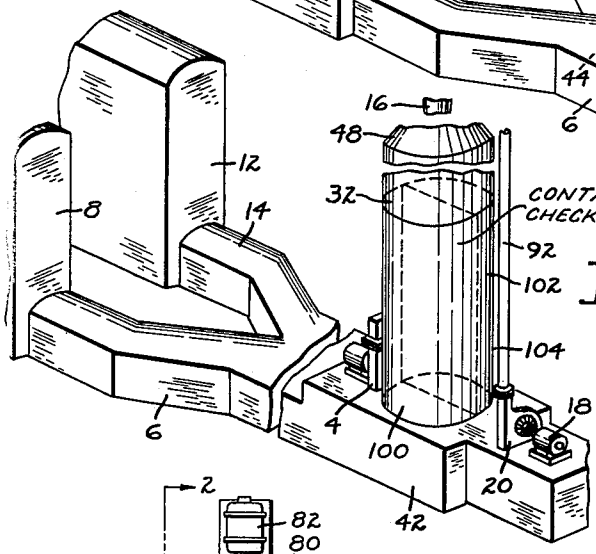


Fig. 6

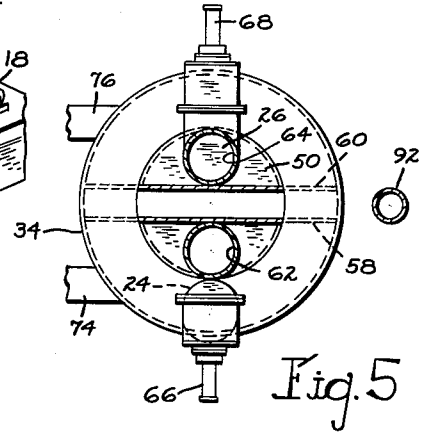


Fig. 5

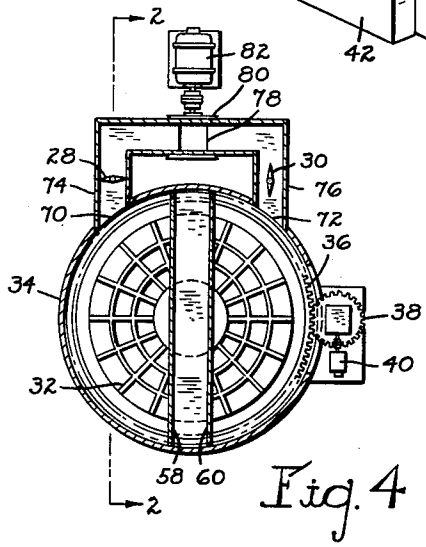


Fig. 4

INVENTOR.
John J. Webbe
BY
Russell, Chittick & Pfund
Attorneys

Dec. 14, 1965 J. J. WEBBER 3,223,135

COMBUSTION AIR HEATER FOR REGENERATIVE FURNACE

Original Filed March 7, 1962 3 Sheets-Sheet 2

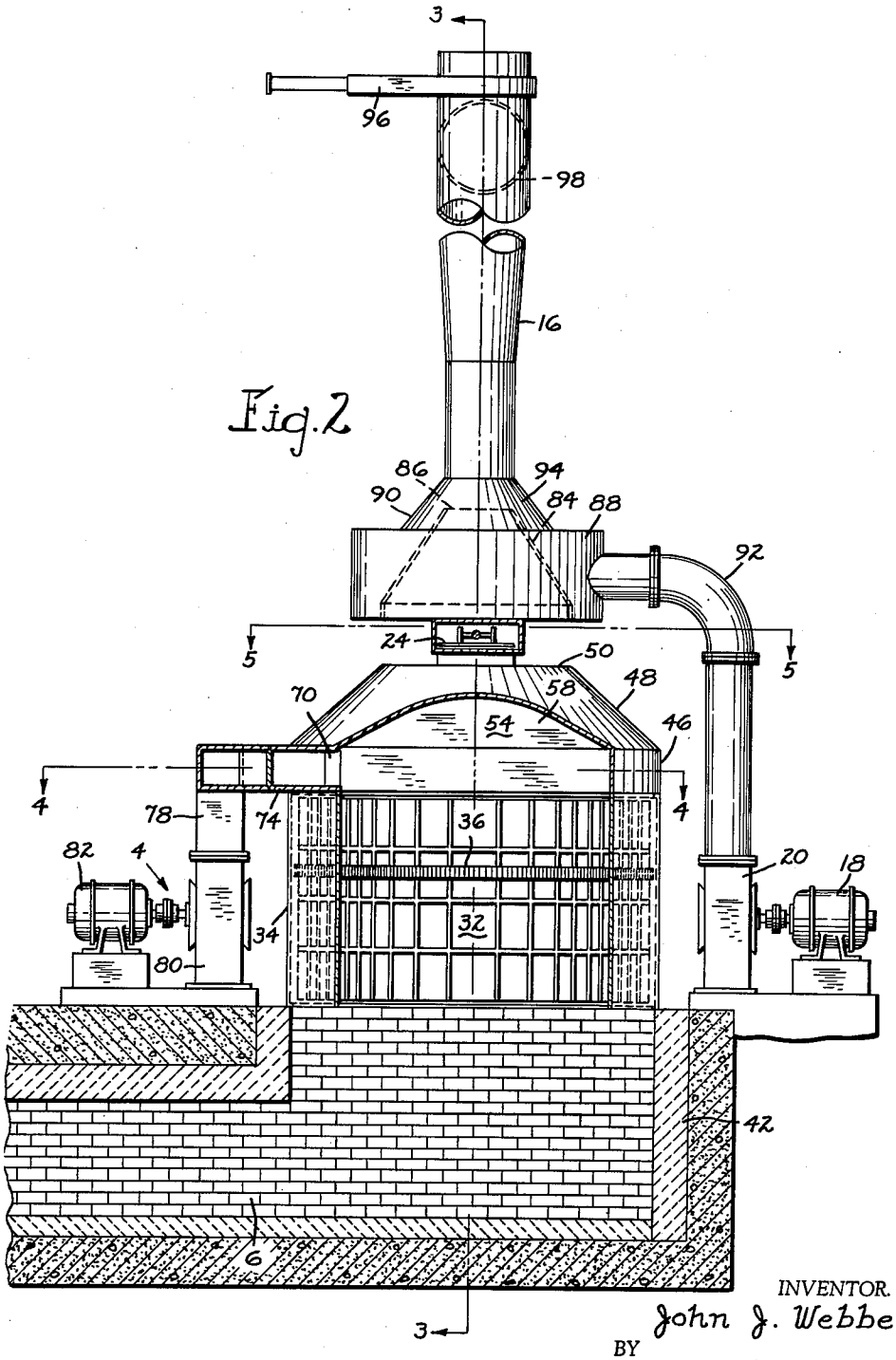


Fig. 2

INVENTOR.
John J. Webber
BY
Russell, Chittick & Pfund
Attorneys

Dec. 14, 1965 J. J. WEBBER 3,223,135

COMBUSTION AIR HEATER FOR REGENERATIVE FURNACE

Original Filed March 7, 1962 3 Sheets-Sheet 3

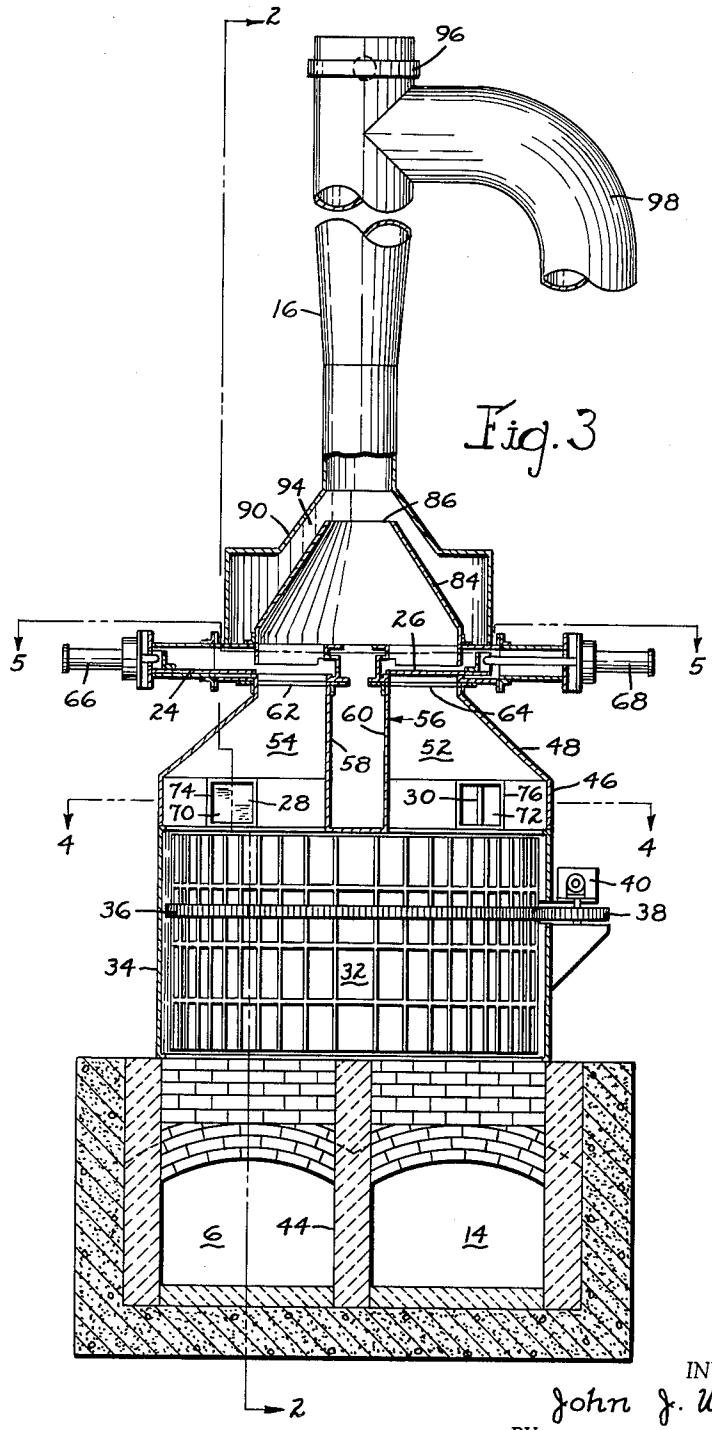


Fig. 3

INVENTOR.
John J. Webber
BY
Russell, Chittick & Pfund
Attorneys

United States Patent Office 3,223,135 Patented Dec. 14, 1965

3,223,135

COMBUSTION AIR HEATER FOR REGENERATIVE FURNACE

John J. Webber, Holden, Mass., assignor to Morgan Construction Company, Worcester, Mass., a corporation of Massachusetts

Continuation of application Ser. No. 178,051, Mar. 7, 1962. This application Sept. 22, 1964, Ser. No. 400,628
1 Claim. (Cl. 158—4.5)

This is a continuation of my co-pending application Serial No. 178,051 filed March 7, 1962 and now forfeited.

This invention relates to regenerative furnaces and is particularly concerned with new and novel means for preheating air that is subsequently mixed with the fuel to be burned at the furnace.

Air preheaters of one kind or another have been in use for a long time past, particularly in connection with steel or glass furnaces. The principle of operation is to pass the hot gaseous products of combustion leaving the furnace through one or more regenerators, commonly known as checkers, in which the open brickwork therein is heated. On leaving the regenerators, the hot gases, having transferred a large part of their heat to the checkers, are then discharged to the atmosphere. After the checkers have reached a suitable determinable high temperature, the gas flow to the furnace is reversed so that the incoming fresh air is forced first through the now heated checkers to raise the air temperature to a high degree before combustion with the fuel takes place. The products of combustion now flowing out of the furnace in the opposite direction heat up another set of checkers with the gases being discharged therefrom to the atmosphere after a large part of the heat has been transferred to the checkers. When the temperature of the checkers on the present discharge side has reached a maximum, the gas flow is again reversed. This is repeated indefinitely.

In one commonly used system of combustion air preheating, there are two sets of regenerators in each flow line to and from the furnace comprised of a main checker and a secondary checker. Associated with each secondary checker is an ejector stack through which the relatively cooled burned gases are driven to the atmosphere by an independent air blast.

The present invention contemplates either (1) eliminating the two secondary checkers used in the aforementioned system and substituting in place thereof a single rotary preheater and a single related ejector stack, (2) placing the preheater in series with the primary and secondary checkers and using a single stack, or (3) utilizing the rotary preheater by itself without any intermediate checkers. In the present instance, novel means is provided for periodically reversing the flow of both the combustion air and the exhaust burned gases which simultaneously pass through the rotary preheater. That is to say, the incoming fresh air will for a period of time flow downwardly through one half of the rotary preheater while the discharging burned gases flow upwardly through the other half of the rotary preheater. Thereafter, when the checkers on the discharge side of the furnace have reached a temperature at which reversal of gas flow is indicated, the incoming fresh air will by suitable valving mechanism be caused to flow downwardly through that half of the rotary preheater which had previously been receiving the upwardly flowing discharge gas, and the discharging gas will now flow upwardly through the other side of the rotary preheater which had previously been receiving downwardly flowing fresh air.

It is recognized that rotary preheaters have heretofore been used in combination with checkers, but in all prior

constructions the ducts and valving arrangement required that the incoming fresh air flow continuously in one direction through one half of the preheater while the burned gases flowed through the other half of the preheater in the opposite direction. This necessitated the use of valving systems and brickwork which did not lend themselves readily to connection with existing main checkers or with main and secondary checkers. Hence it was relatively difficult to substitute a rotary preheater for two secondary checkers or to connect a rotary preheater in series with secondary checkers. On the other hand, the present invention, which requires reversal of flow in the rotary preheater, lends itself readily to introduction into an existing system in place of the secondary checkers or following the secondary checkers in series therewith.

Other objects of the invention will be more clearly understood as the description proceeds with the aid of the accompanying drawings in which:

FIG. 1 is a somewhat schematic perspective showing the general relation of the parts in which the secondary checkers have been omitted and the rotary preheater has been placed in series with the main checkers;

FIG. 2 is a side elevation of the rotary preheater and related duct work with the near side of the housing cut away. This section is along the line 2—2 of FIG. 3;

FIG. 3 is a vertical sectional view taken on the line 3—3 of FIG. 2;

FIG. 4 is a horizontal section in reduced scale taken on the line 4—4 of FIGS. 2 and 3; and

FIG. 5 is a horizontal section on the same scale as FIG. 4 taken on the line 5—5 of FIGS. 2 and 3; and

FIG. 6 shows the manner in which the system may include secondary checkers which are in series between the main checkers and the rotary preheater. This figure as to the main checkers, furnace and rotary preheater is the same as the showing in FIG. 1.

Referring first to FIG. 1, the rotary preheater indicated at 2 is shown in its general relation to the other parts of the system. Incoming fresh air is delivered by a combination motor and blower 4 to the upper part of the rotary preheater. According to the valve settings, the air then passes downwardly through the near half of the preheater to enter duct 6, whence it flows through main checker or regenerator 8 into the furnace 10 where the air burns with the fuel to heat the charge in the furnace. The hot products of combustion then pass through the other main checker or regenerator 12 to heat up the brickwork therein. The gas leaving checker 12 flows through duct 14 and passes upwardly through the other side of the rotary preheater 2 into the ejector stack 16. To insure that the burned gas is properly discharged, an ejector blower motor 18 drives a blower 20 which in turn is fed into the throat 22 of stack 16 in a manner to carry upwardly the burned gas that has just left the hot side of the rotary preheater causing the gas to flow to the atmosphere at a proper velocity through the stack.

When the main checker 12 has been heated by the exhaust gas to the required high temperature, valves 24 and 26 are reversed along with valves 28 and 30 (see FIG. 4) in the air intake line to cause complete reversal of the gas flow so that entering air now flows down through the other half of the rotary preheater, thence into duct 14, main checker 12, furnace 10 and out through main checker 8, duct 6, the near side of rotary preheater 2 and valve 24 to the ejector stack 16.

The construction and operation will now be described in further detail by reference to FIGS. 2, 3, 4 and 5.

A rotary preheater 32 of conventional construction is mounted in a cylindrical housing 34 and arranged for rotation about a vertical axis. The rotary preheater, which is circular in plan view, may be caused to rotate in any convenient manner. In the form shown, a circular

rack 36 fixed to the periphery of the preheater may be driven by a pinion 38 which is rotated by a suitable motor and reduction gear 40. During operation, the rotary element 32 moves continuously in one direction at a uniform speed.

The cylindrical housing and preheater are mounted on a foundation 42 in such manner that the lefthand half of the preheater, as viewed in FIG. 3, is related to duct 6 and the righthand half is related to duct. 14.

The housing 34 extends a short distance above the top of the preheater as at 46 where it connects with a conical roof 48 having a closed flat top area 50 to form an upper chamber. As best seen in FIG. 3, this upper chamber is divided into two areas 52 and 54 by a transverse vertical wall 56. This wall is preferably made of two spaced metal sheets, or the equivalent 58 and 60.

In the top closure area 50 are two ports 62 and 64 which in plan are preferably circular, as shown in FIG. 5. Port 62 may be closed by valve 24 actuated by an air cylinder 66 and port 64 may be closed by valve 26 actuated by an air cylinder 68. When valve 24 is open, valve 26 is closed; and vice versa.

At the back side of chambers 52 and 54, as viewed in FIG. 3, and to the left, as viewed in FIG. 2, are two openings 70 and 72. These openings are connected by ducts 74 and 76 (see FIG. 4) to a common source of incoming air in the form of vertical duct 78. The air is supplied to duct 78 by a blower 80 driven by motor 82.

In duct 74 is valve 28 and in duct 76 is valve 30. Valves 28 and 30 are controlled in such manner in relation to valves 24 and 26 that when valve 28 is closed valve 24 is open, valve 30 is open and valve 26 is closed. When valves 24 and 26 are reversed, so also are valves 28 and 30 reversed.

Immediately above ports 62 and 64 is a truncated conical hood 84 terminating in a centrally located upper opening 86. Surrounding hood 84 is a cylindrical cover 88 which through a short truncated conical section 90 connects with the bottom end of ejector stack 16.

As can be seen in FIGS. 1 and 2, a duct 92 leads into the side of cover 88. The lower end of duct 92 is connected to the outlet side of blower 20 driven by motor 18. There are no valves in this system, so while motor 18 and blower 20 are in operation outside air will be forced continuously upwardly into cover 88 and thence into the stack through an annular passage 94 (see FIGS. 2 and 3). The purpose of this arrangement is to insure proper upward movement of the burned gases through stack 16 to the atmosphere.

At the top end of stack 16 is a valve 96 which will normally be open so that the burned gas will flow upwardly into the atmosphere. Just below valve 96, however, may be provided a bypass 98 which leads to gas cleaning equipment and a secondary ejector. This bypass, which is not essential to the present invention, may be put into operation by closing valve 96. Utilization of the bypass does not affect normal operation of the rotary preheater.

For convenience in the following description, that side of the rotary preheater that is in series with port 62 and duct 6 will be referred to as the left side and the other side which is in series with port 64 and duct 14 will be referred to as the right side.

The operation of the unit shown in FIGS. 1, 2 and 3 will now be described. Consider that valve 26 is closed and valve 24 open, as shown in FIGS. 3 and 5, so that gas can flow to stack 16 only through the left side of the preheater. Under these conditions, valve 30 will be open and valve 28 closed, as shown in FIG. 4. Motor 82 and fan 80 are in operation to force air upwardly through duct 78, thence through duct 76, past open valve 30, to enter the upper chamber 52 above the right side of the preheater. With valve 26 closed, the air must flow downwardly through the right side of the preheater and thence into duct 14 through the main checker 12, as illustrated in FIG. 1. On leaving main checker 12, the air is mixed with fuel and burned to produce the necessary heat. The burning gas crosses the furnace 10 and is discharged into main checker 8 which in conventional manner is heated as the gas loses a substantial part of its temperature. The burned gas then flows through duct 6 and upwardly through the left side of the preheater, transferring some of the remaining heat in the gas to the heat absorbing elements in the rotary preheater 32. The gas then continues to flow upwardly through chamber 54, through port 62 and port 86 into stack 16.

Regardless of the gas temperature as it leaves the preheater, discharge of the gas through the stack is insured by the jet action of the air coming from blower 20 driven by motor 18 through duct 92 into cover 88 and thence into stack 16 through the annular opening 94. This air is moving at a relatively high velocity and carries along with it the burned gases that are coming up through port 86.

It will be understood that the preheater 32 is rotating continuously so that the areas being heated by the discharging still hot gas are being continuously rotated from the left side of the preheater to the right side. Thus the incoming cold air entering through duct 76 and flowing down through the preheater to duct 14 is being initially heated. This helps the main checker 12 to raise the temperature of the incoming fresh air to the high degree required for most efficient combustion.

In due course the temperature of the main checker 12 will fall to a degree where it will be unable to heat the incoming fresh air to the required high temperature. By that time, however, the main checker 8 will have absorbed enough heat from the burned gases leaving furnace 10 to be at a temperature considerably in excess of that of main checker 12. At this point the valves are reversed; that is, valve 26 is opened, valve 24 is closed, valve 30 is closed and valve 28 is opened. Thus the incoming fresh air from blower 80 now enters chamber 54 above the preheater and flows downwardly through the left side of the preheater into duct 6 and into main checker 8 where it is heated and then mixed with fuel to burn in the furnace. The burned gases pass through main checker 12 to commence the reheating of this element, thence into duct 14 and upwardly through the right side of the preheater to discharge through port 64 and out the stack 16 in the manner heretofore explained.

Again, when main checker 8 has cooled and main checker 12 has been reheated, the valves are once more reversed. This procedure is repeated over and over.

In FIG. 6, the rotary preheater has been placed in series with the main and secondary checkers. The secondary checkers 100 and 102, which may be mounted in a common housing 104, may be placed directly on the foundation 42 in the same manner that the preheater 32 is mounted on the foundation in FIGS. 2 and 3. That is, secondary checker 100 is placed in series with duct 6 and secondary checker 102 is placed in series with duct 14. The preheater 32 of the same construction as shown in FIGS. 2 and 3 is then mounted directly on the top of the two adjacent checkers 100 and 102.

The operation of FIG. 6 is exactly the same as that of FIGS. 1, 2 and 3 except that the air and burned gases pass additionally through the intermediate checkers 100 and 102 by which more heat is removed from the discharging burned gas and additional heat is applied to the incoming combustion air.

From the foregoing description, it will be seen that the rotary preheater with a single stack may be arranged in combination with the main checkers of the furnace, or it may be placed in combination with the main and secondary checkers. In either case, two stacks are replaced by a single stack. The valving arrangements are such that the flow of incoming fresh air shifts from one side of the preheater to the other, and conversely the still hot burned gas flows upwardly through the stack through first one side and then the other side of the preheater. By this

reversal of flow, the life of the preheater casing structure will be increased because of the averaging of temperatures.

It will be appreciated, of course, that in certain systems the rotary preheater as herein disclosed could be used as the sole source of preheating of the combustion air without the inclusion of any checkers. In such case, the preheater would run at a higher temperature and the advantages of alternation of combustion air and exhaust burned gas would still be present.

The means for inducing a draft in the stack is not limited to the ejector mechanism shown. The draft could be created by what is known as an induced draft hot fan or and other type of conventional exhaust inducing means. In some cases, natural draft could be relied upon.

It is my intention to cover all changes and modifications of the examples of the invention herein chosen for purposes of disclosure which do not constitute departures from the spirit and scope of the invention.

I claim:

The combination of a rotary preheater and a furnace comprising a pair of ducts leading from said furnace to said preheater, at least one checker interposed in each of said ducts between said preheater and said furnace, said ducts terminating under said preheater at one end and separated by a common wall whereby one duct is accessible to one half of said preheater and the other duct is accessible to the other half of said preheater, a casing surrounding said preheater, said casing having a cover and providing a closed space above said preheater, a wall dividing said space into two chambers, said wall having its lower edge in close proximity to the top of said preheater,

said wall arranged parallel to the common wall of said ducts, independent discharge ports from each of said chambers leading into a common enclosed space thereabove, said enclosed space having a single upper exhaust opening, a stack connected to said single exhaust opening, said single exhaust opening surrounded by an annular ejector passage, means for supplying air under pressure to flow through said annular passage into said stack to draw exhaust gas upwardly through said single exhaust opening into said stack, first valve means carried by said casing for opening and closing said independent discharge ports, blower means in communication with said chambers for supplying combustion air thereto, second valve means carried by said casing and connected intermediate said blower means and said chambers for selectively controlling the flow of combustion air into one or the other of said chambers, said first and second valve means operable in such a manner that when combustion air is fed to one of said chambers, the discharge port in said one chamber will be closed and the discharge port in the other said chamber will be open.

References Cited by the Examiner

UNITED STATES PATENTS

2,702,605	2/1955	Kneass	165—7 X
2,715,893	8/1955	Hingst	122—7 X
2,951,457	9/1960	Kneass	110—160

JAMES W. WESTHAVER, *Primary Examiner.*

MEYER PERLIN, *Examiner.*