

Sept. 21, 1965

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3,207,493

REGENERATIVE FURNACES

Filed Aug. 15, 1963

3 Sheets-Sheet 1

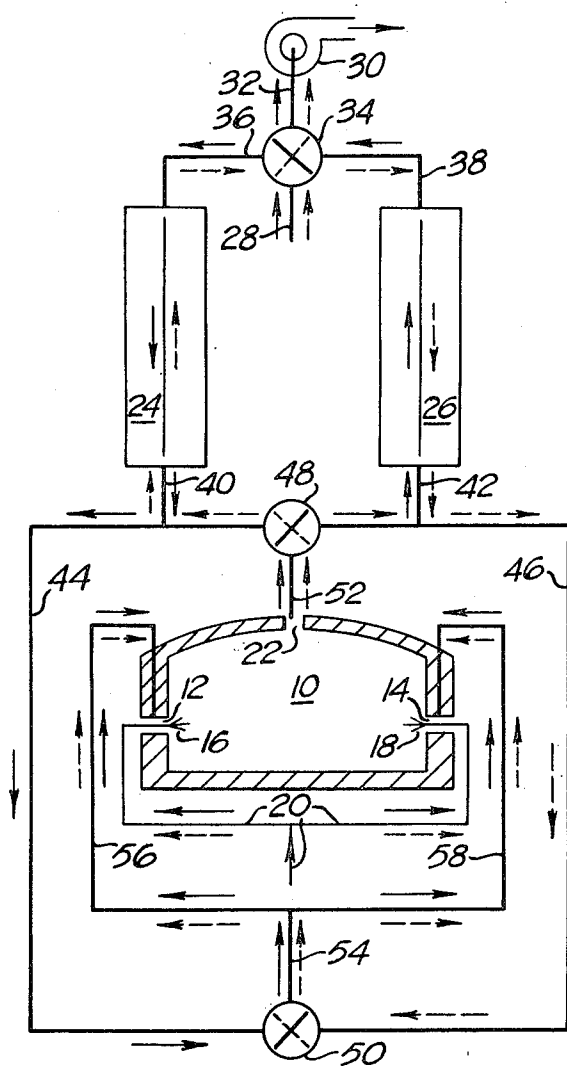


FIG. 1.

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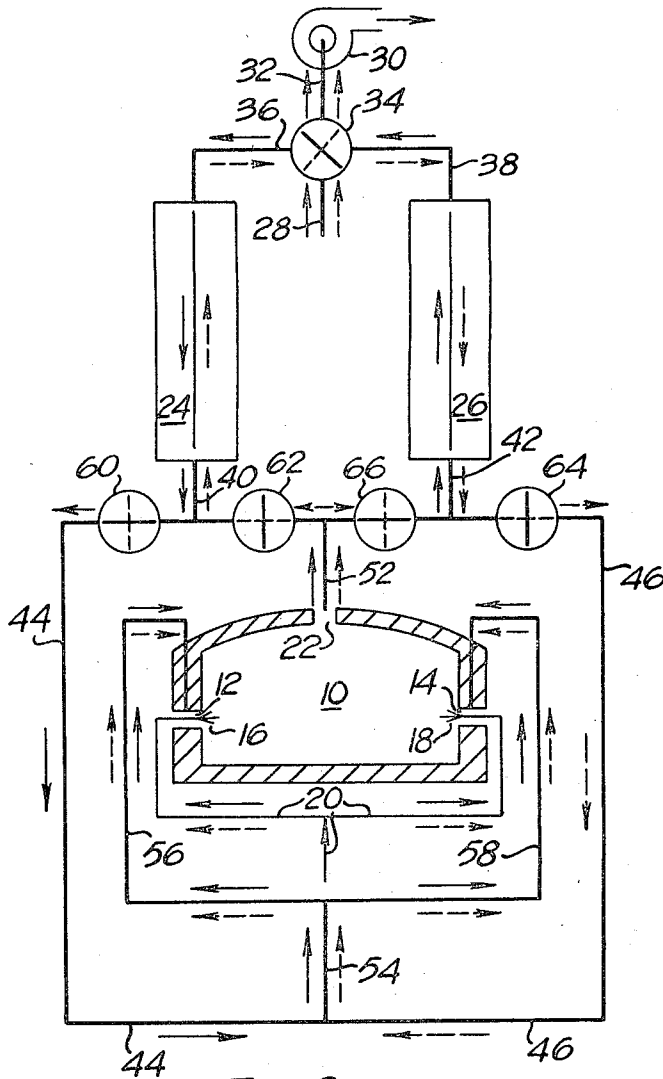


FIG. 2.

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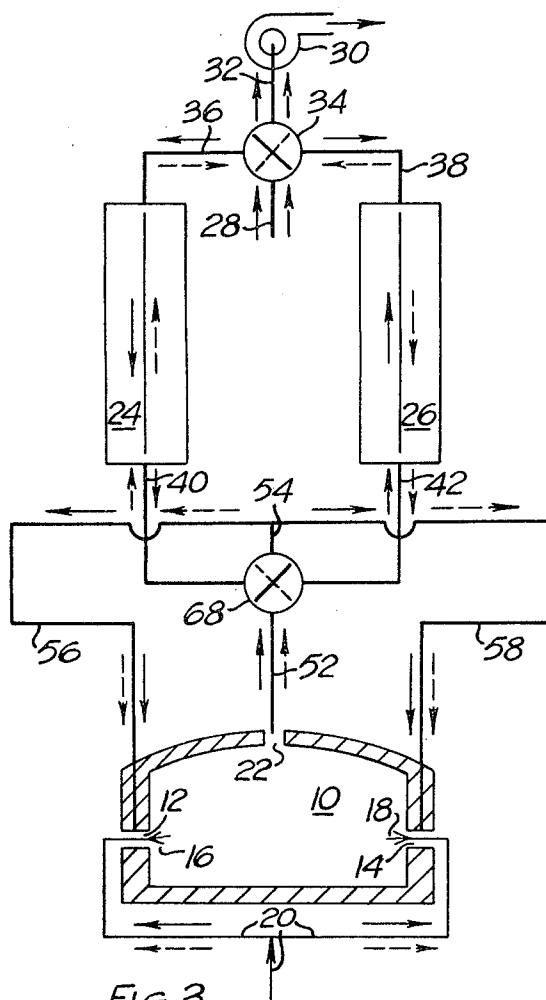


FIG. 3.

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REGENERATIVE FURNACES

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Filed Aug. 15, 1963, Ser. No. 302,337

Claims priority, application Great Britain, Aug. 17, 1962, 31,683/62

4 Claims. (Cl. 263—15)

This invention relates to regenerative furnaces, in which the combustion air (or oxygen or oxygen-enriched air), hereinafter referred to for brevity as "air," is preheated by paired regenerators which alternately receive heat from the combustion products and reject heat to the combustion air.

In hitherto conventional practice, such furnaces have had two sets of burners, usually disposed on opposite sides of the working chamber of the furnace, to which sets of burners the preheated air and fuel for combustion are alternately fed, the combustion products being taken off alternately from one and the other of two outlets, which, in practice are usually the same as the preheated air inlets containing the burners.

Such an arrangement entails cyclical reversal of the flow of combustion products from one side of the furnace to the other and consequent uneven heating of the charge in the furnace chamber. Moreover, since in each half cycle one set of burners is inactive, each set of burners (and the ducting leading thereto), must be capable of handling twice as much air and fuel as they would have to if all the burners were operative continuously.

The principal aim of the invention is to provide means enabling all the burners (on both sides of the furnace chamber) to operate continuously and to eliminate cyclical reversal of flow of combustion products within the furnace chamber.

An object of this invention is a regenerative furnace, whose chamber had two (or two sets of) combustion air inlets and a separate outlet for combustion products, and which is provided with reversing valve means, additional to and synchronised with the reversing valve for alternately connecting the cold ends of the regenerators with the cold air supply and with the exhaust flue, and operative to connect the hot end of one regenerator alternately with the combustion air inlets and the hot end of the other regenerator with the combustion product outlet of the furnace chamber.

In one preferred form of construction the combustion product outlet of the furnace chamber is connected by a branched duct with corresponding ends of both regenerators and a three-port reversing valve is situated at the junction of the branches, while preheated air inlets on each side of the furnace are connected to one port of a second three-port reversing valve whose other two ports communicate respectively with one and the other of the regenerators, at the same end as is connected to the aforesaid branched duct, the two reversing valves being appropriately synchronised.

Alternatively, each of the three-port reversing valves may be replaced by a pair of two-port reversing valves, all four two-port valves being appropriately synchronised with the required phase relationships.

It is possible to replace the two three-port reversing valves by a single four-port reversing valve.

In each form of construction described above, the preheated air inlets are provided with burners to which a suitable fuel, e.g. a gas, is continuously supplied by suitable ducting.

The objects and nature of the invention will be better understood from the following description, with reference to the accompanying drawings of three embodiments of

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the invention, given by way of example only and without limitation of the scope of the invention, which is defined in the hereto appended claims, of these drawings:

FIGURE 1 is a diagrammatic representation of the first embodiment, the furnace chamber being shown in schematic vertical section; and

FIGURES 2 and 3 are similar representations of the second and third embodiments respectively.

In these drawings:

Fuel supply lines are represented in thin line, and ducting carrying air and combustion products in heavy line; in one phase of the reversing cycle, the positions of the reversing valves, which are of the butterfly type, and the arrows indicating direction of flow, are in full line, and in the other phase of the cycle in dotted line; and the several reversing valves are operatively interconnected (mechanically or otherwise) for synchronisation, by means (not illustrated) giving the appropriate phase relationships.

In these drawings, elements common to more than one of the embodiments illustrated, are identified by the same reference characters.

Referring to FIGURE 1, the furnace chamber 10 has combustion air inlets 12, 14 on each side, in which are disposed burners 16, 18, continuously supplied with fuel (oil or gas) by pipes 20. In the roof of the furnace is an outlet 22 through which the hot combustion products are extracted.

The combustion air is heated by regenerators 24, 26 which operate alternately. Cold air enters through a pipe 28 and exhaust gases are extracted by a blower 30 from a pipe 32. A four-port reversing valve 34 is connected to pipes 28, 32 and also by pipes 36, 38 respectively to the "cold" ends of the regenerators 24, 26. As shown in the drawing in one (the first) phase of the regenerative cycle the valve 34 connects pipe 28 to pipe 36 and pipe 32 to pipe 38, these connections being reversed in the succeeding phase.

The "hot" ends of the regenerators 24, 26 are respectively connected by branch pipes 40, 42 with pipes 44 and 46 which are alternately connected by a three-port reversing valve 48 with a pipe 52 leading from the exhaust outlet 22 of the furnace.

Pipes 44, 46 are likewise alternately connected by a three-port reversing valve 50 with a pipe 54 having two branches 56, 58 connected to the combustion air inlets 12, 14 of the furnace.

The reversing valves 34, 48, 50 are mechanically or otherwise (e.g. pneumatically, hydraulically or electrically) synchronized in such a way that in the first phase of the regenerative cycle, regenerator 24 is connected by pipes 40, 44 and the valve 50 with pipes 54, 56, 58 and regenerator 26 is connected by pipes 42, 46 and the valve 48, with the pipe 52. In the succeeding (or second) phase these connections are reversed.

The embodiment illustrated in FIGURE 2 differs from that of FIGURE 1 only in the following respect:

The three-port reversing valves 48, 50 of FIGURE 1 are replaced by two pairs of two-port reversing valves 60, 62 and 66, 64. Valves 60, 62 are placed in the run of pipe 44 on opposite sides of its junction with pipe 40 and are antiphased as shown; and valves 64, 66 are similarly placed in the run of pipe 46 with respect to its junction with pipe 42 and are likewise antiphased.

Between valves 62 and 66, pipes 44, 46 are both joined directly to pipe 52, and the portions of pipes 44, 46, extending beyond valves 60 and 64 respectively are both joined directly to pipe 54.

In the embodiment of FIGURE 3, the two three-port reversing valves 48, 50 of FIGURE 1 are replaced by a single four-port reversing valve 68, of which two opposite ports are directly connected to pipes 40 and 42 respectively and the two other opposite ports are respectively

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connected to pipe 52 and pipe 54, the latter being directly joined as in FIGURE 1 to pipes 56 and 58 and the pipes 44, 46 are eliminated. In the first phase of the cycle, valve 68 connects regenerator 24 via pipes 54, 56 and 58 with both the furnace inlets 12, 14 and connects regenerator 26, via pipe 52 with the furnace outlet 22, these connections being reversed in the second phase of the cycle.

It will be evident that, in each of the three embodiments illustrated, the arrangement of reversing valves and pipes, while effecting the normal regenerative cycle, by which the regenerators alternately receive and reject heat, ensures that regeneratively preheated air is continuously supplied to the burners on both sides of the furnace, at the same time eliminating the need for a reversing valve in the fuel supply system of the burners.

It is to be understood that within the scope of the invention as defined in the hereto appended claims, any or all such modifications, variations or additions of or to what has been hereinbefore described as are within the competence of those skilled in the art may be made. For example, the constructional details of the furnace, the regenerators, the ducting, the burners, the reversing valves and their synchronising means, and the like may be of any suitable conventional design, and for this reason these details have not been illustrated or described. Again, means, including additional valving, may be provided for re-circulating an adjustable proportion of cooled exhaust gases from the outlet to the inlet of the heat-receiving regenerator, with or without the addition of an adjustable proportion of cold or regeneratively preheated air (or gaseous oxidant) for completing the combustion or unburnt or partially burnt combustibles in the gases issuing from the furnace outlet. Moreover, the invention is applicable to furnaces, such as rotary hearth furnaces or those through which the charge is continuously or intermittently propelled in a straight line, by pusher means or/and by gravity, having more than one pair of regenerators associated with different zones of the furnace.

What is claimed is:

1. A regenerative furnace comprising: a furnace chamber having opposed side walls, end walls and a roof, said opposed side walls having inlets therein for the introduction of regeneratively preheated gaseous oxydant into said chamber, said chamber having a single outlet for combustion products separate from said inlets; an exhaust blower having an inlet and an outlet; fluid fuel burner means disposed in each of said oxydant inlets; means for continuously supplying fluid fuel to all of said burner means; a source of cold gaseous oxydant; first and second regenerators for alternately absorbing heat from hot combustion products and giving up heat to cold gaseous oxydant, each of said regenerators having a hot end for receiving combustion gases from said single outlet and

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a cold end for receiving cold gaseous oxydant from said source; first reversing valve means associated with the cold ends of said regenerators operative in a first position to simultaneously connect the cold end of the first regenerator to said source of cold oxydant and the cold end of the second regenerator to the inlet of said exhaust blower and operative in a second position to simultaneously connect the cold end of the second regenerator to said source and the cold end of said first regenerator to the inlet of said exhaust blower; second reversing valve means downstream of said single outlet associated with the hot ends of said regenerators operative in a first position to simultaneously connect the hot end of the first regenerator to both said oxydant inlets and the hot end of the second regenerator to said single outlet and operative in a second position to simultaneously connect the hot end of the second regenerator to both said oxydant inlets and the hot end of the first regenerator to said single outlet.

2. A regenerative furnace as in claim 1 wherein said second reversing valve means comprises two synchronized three-port valves, each valve having two ports connected respectively with the hot end of one and the other of the regenerators, and the third ports of the three-port valves being connected respectively with both said oxydant inlets and with said single outlet.

3. A regenerative furnace as in claim 1 wherein said second reversing valve means comprises a pair of synchronized two-port valves associated with each regenerator, both of the valves of each pair having one port connected with the hot end of the associated regenerator, and the second port of one valve of each pair being connected with both of said oxydant inlets, the second port of the other valve of each pair being connected with said single outlet.

4. A regenerative furnace as in claim 1 wherein said second reversing valve means comprises a single four-port valve having one port connected with said single outlet, one port connected with both of said oxydant inlets, and two ports connected respectively with the hot end of said first and second regenerators.

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