G. H. BENJAMIN.

REGENERATIVE GAS FURNACE.

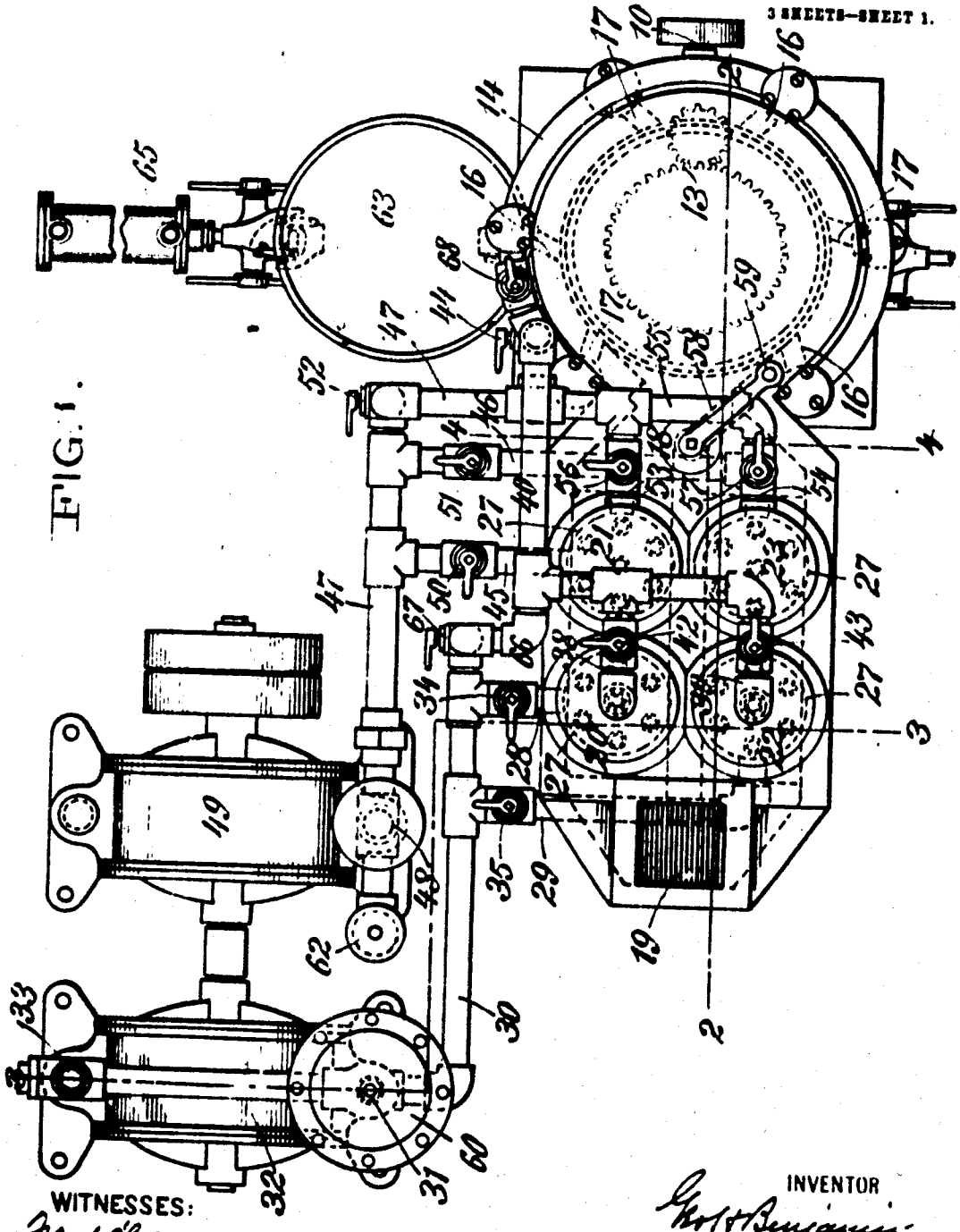
APPLICATION FILED DEC. 19, 1908. RENEWED DEC. 6, 1909.

948,538.

Patented Feb. 8, 1910.

3 SHEETS—SHEET 1.

FIG. 1.



WITNESSES:

INVENTOR

G. H. BENJAMIN.

REGENERATIVE GAS FURNACE.

APPLICATION FILED DEC. 19, 1906. RENEWED DEC. 6, 1909.

948,538. Patented Feb. 8, 1910

3 SHEETS—SHEET 2

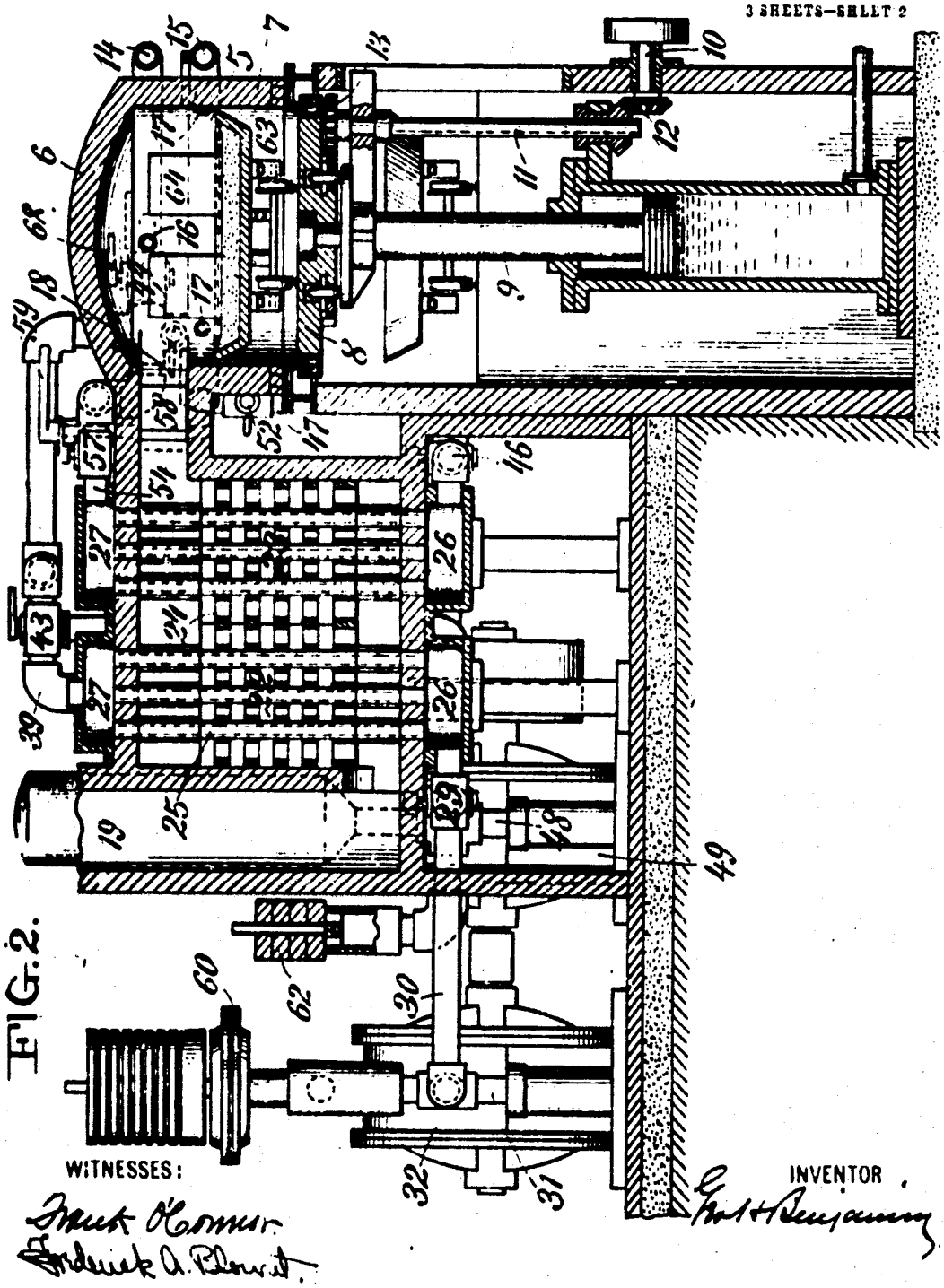


FIG. 2.

WITNESSES:

Frank O'Connor

Frederick A. Blount.

INVENTOR.

Geo. H. Benjamin

G. H. BENJAMIN.

REGENERATIVE GAS FURNACE.

APPLICATION FILED DEC. 19, 1906. RENEWED DEC. 6, 1909.

948,538. Patented Feb. 8, 1910.

3 SHEETS—SHEET 1.

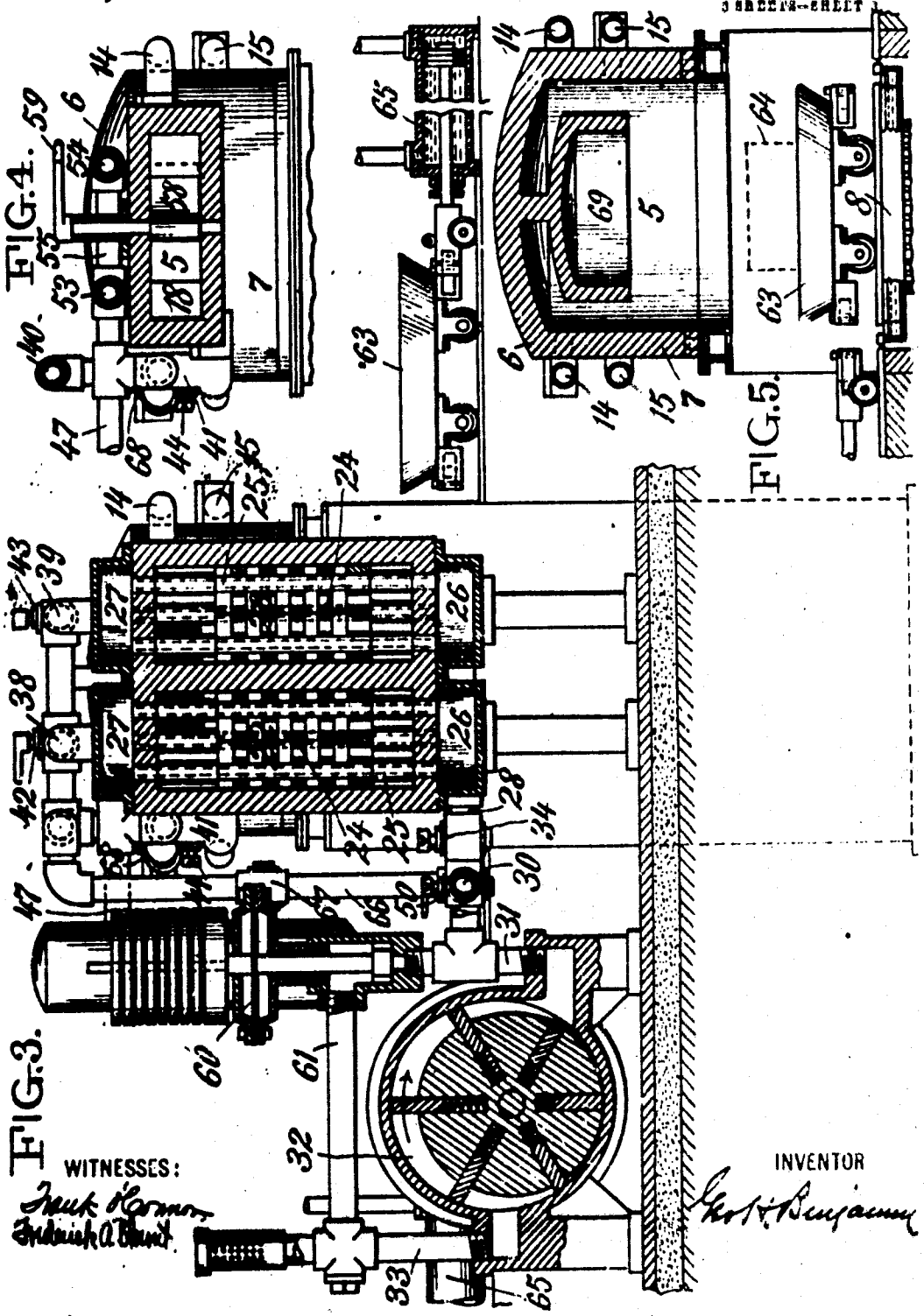


FIG. 4.

FIG. 5.

FIG. 3.

WITNESSES:

Frank L. Ormsby

Frederick A. Brandt

INVENTOR

Geo. H. Benjamin

UNITED STATES PATENT OFFICE.

GEORGE HILLARD BENJAMIN, OF NEW YORK, N. Y.

REGENERATIVE GAS-FURNACE.

948,538. Specification of Letters Patent. Patented Feb. 8, 1910.

Application filed December 19, 1906, Serial No. 348,360. Renewed December 6, 1909. Serial No. 531,666.

To all whom it may concern:

Be it known that I, GEORGE HILLARD BENJAMIN, a citizen of the United States, residing in the city, county, and State of New York, have invented certain new and useful Improvements in Regenerative Gas-Furnaces, of which the following is a specification.

My invention relates to a furnace of the type described in Letters Patent No. 827,498, granted to me on the 31st day of July, 1906, and consists in the means employed, whereby a very high temperature may be created and uniformly maintained within the furnace structure and at a much smaller expenditure of fuel than has heretofore been considered possible.

The accompanying drawings will serve to illustrate my invention, in which—

Figure 1 is a plan view of the furnace structure, with regenerative chambers, pumps, pipes, etc., Fig. 2 is an elevation and vertical section, looking from the right on line 2, 2, of Fig. 1, Fig. 3 is a vertical section on line 3, 3, of Fig. 1, looking from the bottom of the sheet, Fig. 4 is a vertical section on the line 4, 4, of Fig. 1, looking from the bottom of the sheet, and Fig. 5 is a vertical section of a modified form of furnace chamber, taken at right angles to the section shown in Fig. 2, and showing the bottom of the furnace in the lowest position, also the device for moving the carriage on and off of the furnace bottom.

Referring to the drawings: 5 indicates the furnace. The furnace consists substantially of a top portion 6, side portion 7, and a bottom portion 8. The top and sides are partially closed to the atmosphere, in order that the furnace chamber may be maintained full of flame. The bottom portion 8 is vertically movable by means of the hydraulic piston 9 and may also be rotated through the instrumentality of the power shafts 10 and 11 and the interposed pairs of gears 12, 13. The particular construction of the furnace considered apart from the heating apparatus forms no part of my present invention.

In Fig. 5 a modified form of the furnace is shown. The form shown in Fig. 2 is that of an open furnace, while the form shown in Fig. 5 is that of a muffle furnace.

Surrounding the exterior of the furnace are two fuel flues 14, 15. These flues are illustrated as formed of iron pipe. They may, if desired, be formed within the walls of the furnace chamber. These flues are provided with ports or burner openings 16, 17. In Fig. 1, I have shown three burner openings for each fuel flue. The number of burner openings is immaterial. I prefer to arrange them, however, equi-distant, around the furnace.

To convey away the products of combustion from the furnace, an exit flue 18 is provided. This flue communicates with pairs of the regenerators 20, 21, or 22, 23, as the case may be. The products of combustion passing through the regenerators are carried off by the stack 19.

20, 22, are gas regenerators, 21, 23, air regenerators. Each of these regenerators consists of a checker-work 24 and a series of vertical pipes 25. The pipes 25 communicate at their lower ends with chambers 26 and at their upper ends with chambers 27.

The chamber 26 of the regenerator 20 is connected through a pipe 28, and the chamber 27 of the regenerator 22, through a pipe 29 with a pipe 30 connected to the eduction orifice 31 of a gas pump 32, which pump is connected through its induction orifice to a gas producer, not shown, which gas producer should be of a type capable of generating a gas high in hydrogen and carbon. In the pipes 28, 29 are the controlling valves 34, 35.

The chamber 27 at the top of the gas regenerator 20 is connected through a pipe 38, and the chamber 27 at the top of the gas regenerator 22 through a pipe 39 to a pipe 40, leading to the upper fuel flue 14 surrounding the furnace, and also through a branch pipe 41 to the lower fuel flue 15 surrounding the furnace. In the pipes 38, 39, and 41 are the controlling valves 42, 43, 44.

The chamber 23 at the bottom of the air regenerator 21 is connected through a pipe 45, and the chamber 26 at the bottom of the air regenerator 23, through a pipe 46 to a pipe 47, leading from the eduction orifice 48 of an air pump 49. The pipe 47 is connected to the fuel flues 14, 15. In the pipes 45, 46, 47 are the controlling valves 50, 51, 52.

The chamber 27 at the top of the air regenerator 21 is connected through a pipe 53, and the chamber 26 at the top of the air regenerator 23, through a pipe 54 to a pipe 55, leading to the fuel flues 14, 15. In the pipes 53, 54 are the controlling valves 56, 57.

It will be readily understood that by manipulating the various controlling valves the fuel flues 14, 15, may be fed with heated air, or with heated gas and air, or with cold air, or with cold gas and air, as may be desired; and further, one or both of the fuel flues may be operated as required.

Situated in the exit flue 18 is a butterfly valve 58, and on the outside of the furnace is a handle 59, by means of which the position of this valve may be changed so as to throw the products of combustion either through the regenerators 21, 20, or 23, 22, as desired, and as is usual in regenerative furnace operations.

In order to control the gas and air, regulating valves are provided for the pumps. The regulating valve for the gas pump consists of a diaphragm 60, which controls a by-pass 61. The regulating valve of the air pump consists of a weighted valve 62. These pumps being old, no further description is necessary.

In practice I prefer that the gas be delivered at a pressure of 1½ pounds to the square inch and air at 1 pound to the square inch, as in practice it has been demonstrated that if water gas and air are delivered and mixed at the pressures indicated and then ignited, the resulting temperature will be very high.

Situated on the movable bottom of the furnace 8 is a carriage 63, through which the article to be heated, 64, may be moved into and out of the furnace by means of the hydraulic device 65, Figs. 1 and 3. In the modification shown in Fig. 5, the article 64 to be heated will be inclosed by a muffle 69.

The operation of the furnace will be readily understood. The gas delivered by pump 32 passes through pipe 30, thence by pipe 29 to the bottom of the gas regenerator 22, then up through tubes 25 of this regenerator to the pipe 39 and by pipe 39 to pipe 40 to fuel flues 14, 15. The air delivered by pump 49 passes through pipe 47 to pipe 46, then up through tubes 25 of this regenerator to pipe 54 by pipe 55 to fuel flues 14, 15, that is, supposing the various valves are so arranged to permit the flow of the gas and air in the direction indicated. This direction is indicated by the position of the valves in the drawing, while the position of the butterfly valve 58 indicates that the regenerators 20, 21, are at the time being heated by the outgoing products of combustion. After a given time, as is usual in regenerative furnaces, the position of the butterfly valve is changed to divert the outgoing products of combustion around the regenerators 22, 23. Similarly, the position of various valves will be changed to turn the gas and air through regenerators 20, 21. Pipes 30 and 40 are connected by means of a pipe 66 in which is a valve 67.

As before stated, by manipulating the valves, including the valve 44, in the branch pipe 41, or valve 68 in fuel flue 14, the incoming streams of gas and air may be delivered hot or cold to one or the other or both of the fuel flues 14, 15.

By reason of the structure described, an extremely high temperature may be obtained. I am not able at the present moment to state the reasons for the high temperature obtained. The practical fact, however, remains that notwithstanding that the gas employed, which is known as "Dowson's gas," contains very few heat units, estimated at 35 B. T. U., the temperature obtained within the furnace is considerably higher than can be obtained with the richest carbon producer gas. A temperature of from 3,000 to 4,000 degrees Fahrenheit can be generated within the furnace described in less than one minute. Nickel, which requires 3,000 degrees temperature, has been melted in less than ten minutes; wrought iron, which requires 2,800 degrees, in less than three minutes, and copper, which requires 800 degrees in less than one minute. So far as applicant can discover the high temperature appears to be due to the fact that a very small quantity of air, less than is usually employed, is required to promote combustion.

I wish it understood that I do not in any wise consider it necessary that I should explain the reasons why the high temperature is produced, and, therefore, do not wish to be limited to any explanation. Every endeavor has been made by carefully conducted tests, analyses of the gases prior to and after combustion, registry of temperature with pyrometers, spectroscopic examinations, and the like, for the purpose of determining the theoretical considerations, but so far without result.

The gas employed, as before stated, is a cheap carbon hydrogen semi-water gas, which can be produced at a cost not to exceed two cents per thousand feet. A characteristic resulting from the employment of this gas under the conditions stated, is that the flame has a green tinge and the temperature is not obtained as in ordinary furnaces by accumulation or storage of heat, but attains its maximum value practically instantaneously. This latter fact is of much practical value in the construction of furnaces, in that the operations within the furnace are conducted so rapidly that no destruction of the walls by the high temperature produced takes place.

I wish it understood that the drawings accompanying this application are largely diagrammatic and intended to illustrate the general relation of parts employed, thus I may use any pipe or pump, any type of regenerator, any form of connections between the regenerator and the furnace. I may

increase or decrease the size of the pipes. The exit flue for the products of combustion is shown in the drawings as much larger than would be required in practice, as the amount of carbon dioxid delivered from the furnace is much smaller than the combined volume of carbon dioxid and nitrogen usually conveyed from such furnaces through the regenerators.

Having thus described my invention, I claim:

1. In a furnace structure and in combination with the combustion chamber thereof, means for delivering gas and air into said chamber under pressure and for effecting instantaneous combustion therein.

2. In a furnace structure and in combination with the combustion chamber thereof, reversible gas and air regenerators, means for forcing gas and air separately through said regenerators, and means for uniting the gas and air at the combustion chamber and effecting its instantaneous combustion therein.

3. In a furnace structure and in combination with the combustion chamber thereof, a pair of gas regenerators, a pair of air regenerators, means for causing the products of combustion to alternately heat one air regenerator and one gas regenerator, means for forcing gaseous fuel through a heated gas regenerator and air through a heated air regenerator, and means for combining the heated gas and air at the combustion chamber and effecting its instantaneous combustion therein.

4. In a furnace structure and in combination with the furnace chamber, two sets of fuel burners located at different levels therein, reversible gas and air regenerators, means for forcing gas and air through said regenerators to said burners, and means for controlling the action of the burners.

5. In a furnace structure and in combination with the furnace chamber, burners in said chamber, means for feeding said burners with hot gas and hot air under pressure, or hot air and cold gas under pressure, or cold air and hot gas under pressure, or cold gas and cold air under pressure, as desired.

6. In a furnace structure and in combination with the furnace chamber, reversible gas and air regenerators, a gas pump, an air pump, means for regulating the pressures of the gas and air delivered from said pumps, burners in said furnace chambers, together with valves for controlling the temperature of the gas and air delivered, and the direction of the products of combustion through the regenerators.

In testimony whereof, I affix my signature, in the presence of two witnesses.

GEORGE HILLARD BENJAMIN.

Witnesses:
FRANK O'CONNOR,
FREDERICK A. BLOUNT.