(No Model.) 3 Sheets—Sheet 1.

L. G. LAUREAU.

REGENERATIVE FURNACE.

No. 362,018. Patented Apr. 26, 1887.

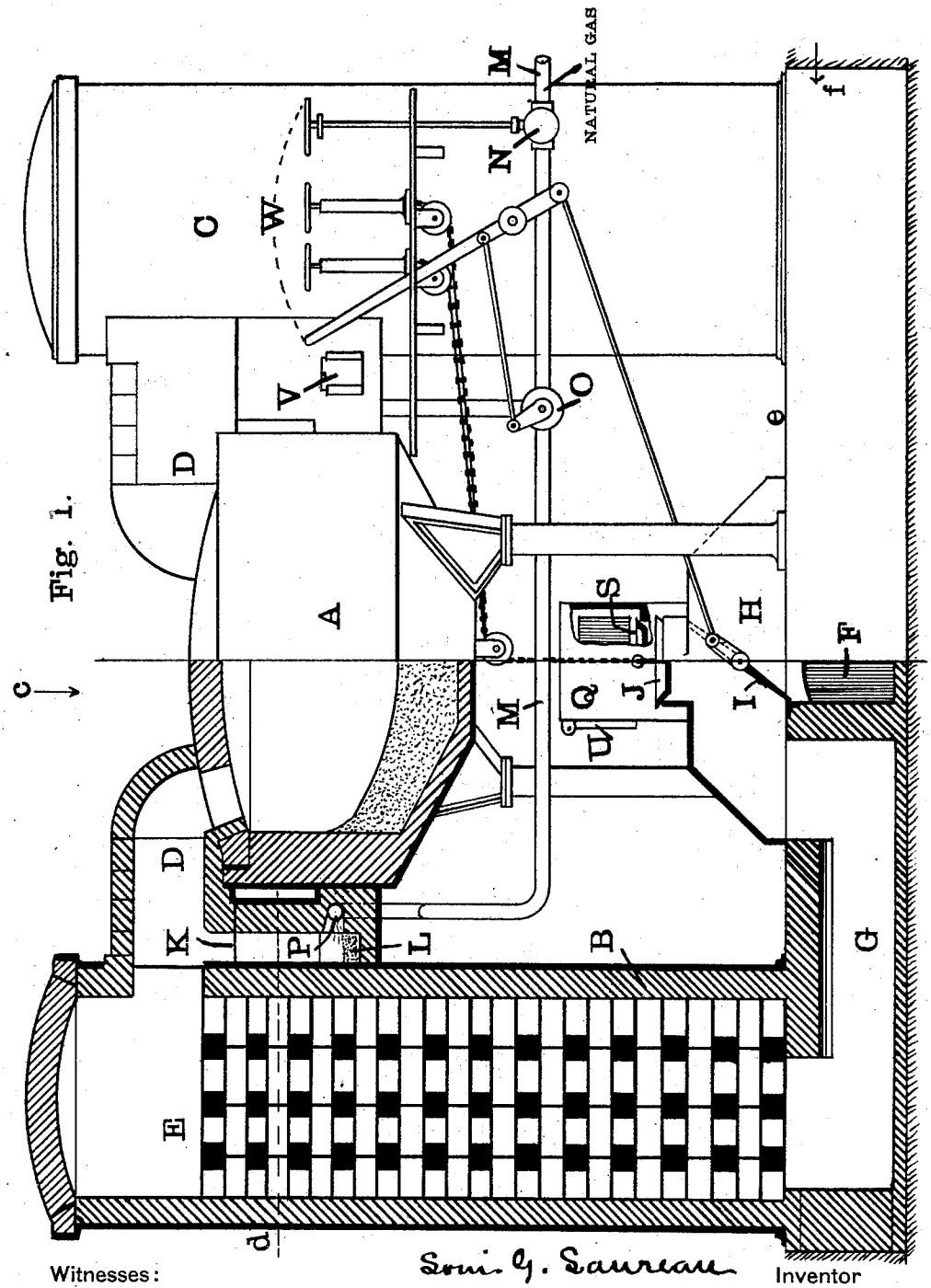

Fig. 1.

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(No Model.) 3 Sheets—Sheet 2.

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REGENERATIVE FURNACE.

No. 362,018. Patented Apr. 26, 1887.

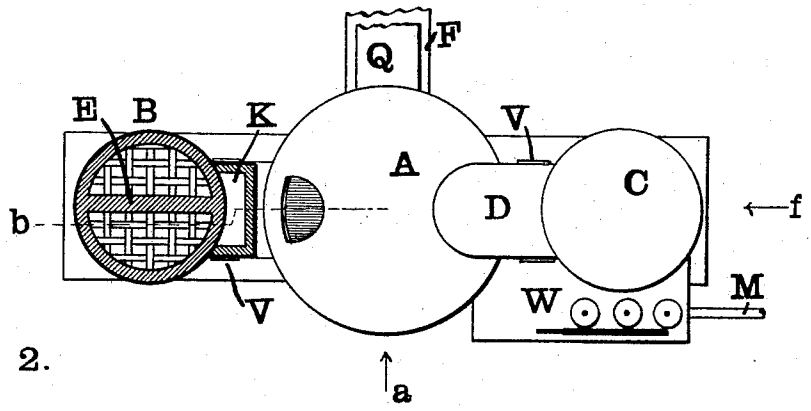

Fig. 2.

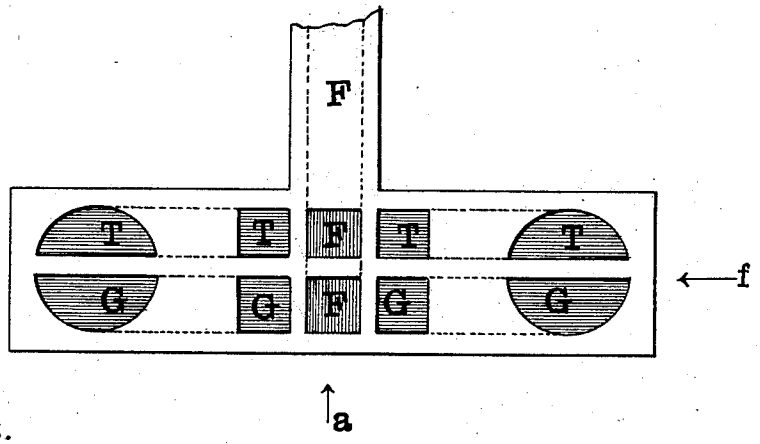

Fig. 3.

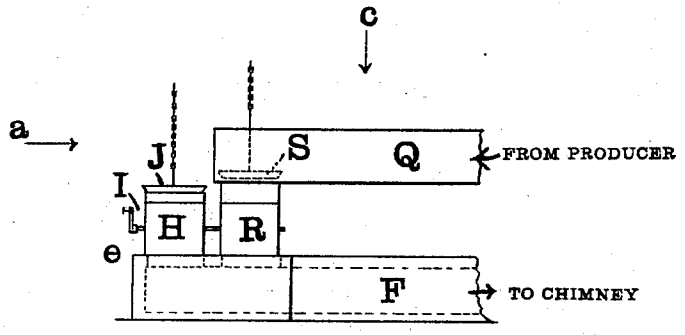

Fig. 4.

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(No Model.) 3 Sheets—Sheet 3.

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REGENERATIVE FURNACE.

No. 362,018. Patented Apr. 26, 1887.

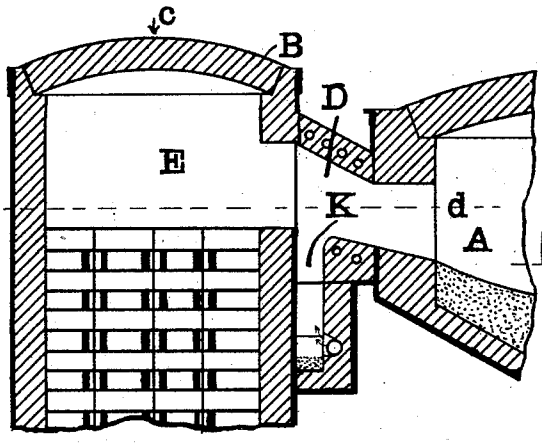

Fig. 5.

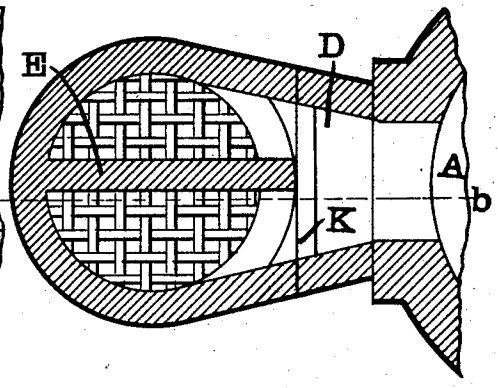

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Fig. 6.

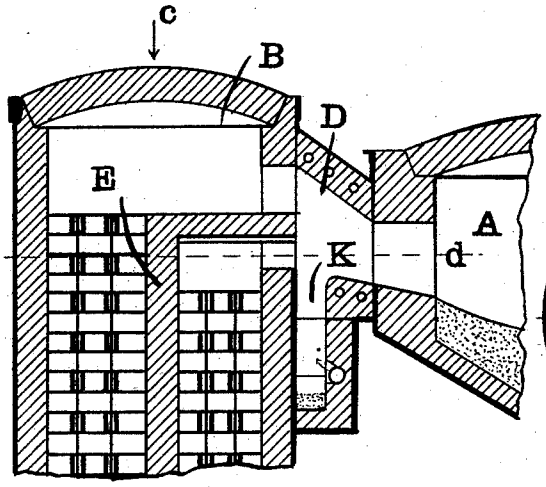

Fig. 7.

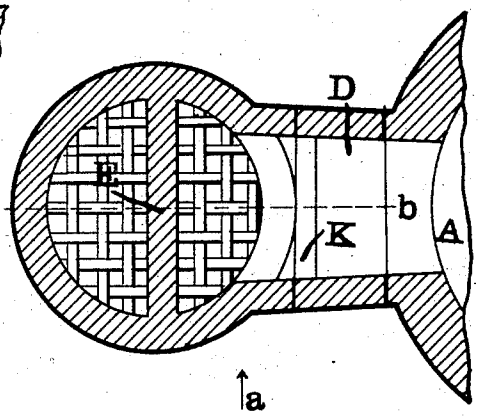

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Fig. 8.

Witnesses:

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UNITED STATES PATENT OFFICE.

LOUIS G. LAUREAU, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO GORDON, STROBEL & LAUREAU, OF SAME PLACE.

REGENERATIVE FURNACE.

SPECIFICATION forming part of Letters Patent No. 362,018, dated April 26, 1887.

Application filed February 4, 1886. Serial No. 190,768. (No model.)

To all whom it may concern:

Be it known that I, LOUIS J. LAUREAU, of Philadelphia, Philadelphia county, Pennsylvania, have invented certain new and useful Improvements in Regenerative Furnaces, of which the following is a specification.

This invention pertains to regenerative furnaces employing either natural or artificial gas for the use of steel makers, &c.; and the improvements relate to features of construction hereinafter pointed out in the claims.

My improvements will be readily understood from the following description, taken in connection with the accompanying drawings, in which—

Figure 1 is a front elevation of a regenerative furnace embodying my improvements, a portion of this view being in vertical section, taken upon line *b* of other figures, the direction of view being indicated by the arrow *a* in other figures; Fig. 2, a plan of the furnace, the direction of view being indicated by the arrows *c* on other figures, a portion of the view being in horizontal section on line *d* of other figures; Fig. 3, a plan of the base-work of the furnace, the melting-chamber, regenerators, and valve-work being removed, the direction of view being indicated by the arrows *c* of other figures, the exposed plane of the view corresponding with line *e* of other figures; Fig. 4, a side elevation of the base-work, the regenerators and melting-chamber being removed, the direction of view being indicated by arrows *f* of other figures; Fig. 5, a vertical section on line *b* of a portion of the apparatus, showing modified nozzle-connections; Fig. 6, a horizontal section of the same parts on line *d;* Fig. 7, a vertical section on line *b* of the same parts as seen in Fig. 5, showing modified arrangements of the separating-wall of the regenerator; and Fig. 8, a horizontal section on line *d* of the parts shown in Fig. 7.

In the drawings, A indicates a heating or melting chamber of circular plan, supported on columns and provided with a removable convex roof and with a bottom shell, whose margin is coned or beveled; B, a regenerator disposed to one side of the melting-chamber and formed of a cylindrical metal shell inclosing regenerative filling or flues, the regenerator having a removable convex roof; C, a second regenerator, similar to the one just referred to and disposed upon the opposite side of the melting-chamber; D, nozzles or combustion-chambers placing the upper portions of the regenerators in communication with the melting-chamber, these nozzles or combustion-chambers being shown in Fig. 1 as communicating with the melting-chamber through ports in the roof and in Figs. 5 and 7 through ports in the side wall thereof, the nozzles or combustion-chambers being separable from the heating or melting chamber and regenerators, so that they can be removed for repair or replaced by new ones without disturbing the heating or melting chamber or the regenerators; E, a separating-wall disposed vertically from top to bottom of the filling in each regenerator and serving to divide the regenerator throughout into two portions of somewhat different horizontal area, the smaller portion being hereinafter designated as a gas-regenerator, through which producer-gas finds its inlet to the nozzles or combustion-chambers, the larger portion as the air-regenerator; F, a flue disposed at the base of the structure and intended to communicate with a suitable chimney; G, flues at the base of the structure, leading from the base of the larger portion of the regenerator—that is, the air portion of the same—to a point contiguous to the chimney-flue; H, a valve-casing connecting the inner terminals of the flues G with each other and with the chimney-flue; I, a butterfly-valve arranged in this valve-casing and serving to place either of the flues G in communication with the chimney-flue while cutting off the chimney communication of the other one of the flues G; J, a valve in the top of the valve-casing H, serving to admit air to the valve-casing, which admitted air will reach whichever one of the flues G is cut off from communication with the chimney-flue by means of the valve I; K, gas-pockets disposed below the nozzles D and between the regenerators and the melting-chamber; L, sand in the bottom of these pockets; M, a pipe leading from a source of supply of natural gas, said pipe branching to each of the gas-pockets; N, a valve in this pipe, by means of which the

flow of natural gas may be regulated or cut off; O, an ordinary three-way valve, or equivalent valve, disposed at the point where the pipe M branches to the two gas-pockets, such three-way valve serving, in the manner common to such valves, to determine by its position of adjustment which one of the two branches shall be in communication with the pipe M and which branch shall be cut off from communication; P, pipes built into the walls of the gas-pockets near their bases, and serving to discharge the natural gas into the base of the pockets; Q, a pipe leading from an ordinary gas-producer to a point at the base of the structure contiguous to the valve-casing H; R, a valve-casing similar to the valve-casing H, and similarly provided with a butterfly-valve, the butterfly-valves of the two casings being upon the same spindle, so as to move coincidently; S, a valve disposed at the juncture of the producer-pipe Q with the valve-casing R, and serving to regulate the flow of producer-gas to said valve-casing; T, flues at the base of the structure, disposed parallel to the flues G and serving to place the smaller portions of the regenerators—that is to say, the gas portions—in communication with the valve-casing R, and thence through the butterfly-valve therein and the valve S in communication with the producer-pipe Q and the chimney-flue F; U, a valve or door in the producer-pipe Q above the producer-gas valve S, this valve or door serving to admit air to the valve S when no producer-gas is being used; V, doors in the front and rear walls of the gas-pockets, the same permitting access to the interior of the pockets, and W the working position from which the various valves are operated.

The roofs of the nozzles or combustion-chambers D may be made up in removable sections consisting of fire-brick laid up in clamps, whereby this most destructible portion of the nozzle may be readily renewed when burned out. The melting or heating chamber is shown as being circular in plan; but its form may, if desired, be elliptical or otherwise. The melting or heating chamber should be provided with the usual charging-doors, working-doors, tapping-holes, &c.

In connection with the point W, from which all of the valves may be operated, I arrange a working-platform, from which may be operated the mechanism which adjusts the various valves. The two butterfly-valves are operated by a lever, which can be reached from this platform, and the movement of this lever serves to reverse the action of the butterfly-valves, so that the flues G and T of one regenerator are placed in communication with the chimney-flue, while the flues G and T of the other regenerator are placed in communication with the upper portions of the valve-casings, one of which valve-casings receives air through the valve J and the other gas through the valve S.

The same lever which operates the butterfly-valves also operates the three-way valve O, whereby natural gas is admitted to the pocket of that regenerator which is not at the time in communication with the chimney-flue. The valve N is operated by a hand-wheel upon the platform, as are also the valves J and S, through the medium of connecting-chains, though any other suitable connecting mechanism may be employed.

The furnace is adapted for operation either with producer-gas or with natural gas.

The operation with producer-gas will first be described, it being assumed that in such case no natural gas is at command, or that the valve N is closed. The furnace having been in operation for some time, we will assume that the left-hand regenerator has been highly heated and that the butterfly-valves are in the position indicated in Fig. 1, thus placing the right-hand regenerator (both portions of it) in communication with the chimney-flue. Gas from the producer goes through the pipe Q, thence in regulated quantity through valve S, thence up the smaller portion of the left-hand regenerator to the top of the regenerator. Meanwhile air for combustion, in regulated quantities, passes through valve J downward and through the flue G, and thence upward through the larger portion of the left-hand regenerator to the top of that regenerator. The producer-gas and the air for combustion, in rising through the regenerator, have become highly heated in an obvious manner, and they mingle in the nozzle or combustion-chamber of the left-hand regenerator, where combustion takes place, and the heating-gases thus in combustion pass into the melting-chamber, where they affect the material placed therein. The products of combustion, after passing over the material in the melting-chamber, pass through the right-hand nozzle and down through the entire regenerator-work of the right-hand regenerator, thence through the right-hand flues G and T, and thence to the chimney-flue. These highly-heated products of combustion, in passing downward through the right-hand regenerator, heat the regenerative work of that regenerator. When the left-hand regenerator has become so cool as no longer to properly heat the air and gas passing through it, the lever at the working-platform is shifted, thus reversing the position of the butterfly-valves. This reversal of the butterfly-valves places the left-hand regenerator in communication with the chimney-flue and places the respective portions of the right-hand regenerator in communication with the air-valve J and the producer-gas valve S. Under these circumstances the incoming gas and air for combustion will become heated in passing through the hot right-hand regenerator, and the hot products of combustion will pass to the chimney through the left-hand regenerator, which will in turn become highly heated.

If the furnace is to work upon natural gas instead of producer-gas, the valve or door U is opened, thus admitting air to the valve S

as freely as to the valve J, whereby both these valves serve in admitting air for combustion, the producer-pipe Q performing no office. At the same time the valve N is opened to admit the proper quantity of natural gas. The course of the fluids is then as follows, reference being had to Figs. 1 and 3: Air for combustion, in regulated quantities, enters past the valves J and S, and goes thence through both the left-hand flues, T and G, to the left-hand regenerator. This air passes up this regenerator and becomes highly heated. In the meantime natural gas is issuing into the left-hand gas-pocket, the communication between the right-hand gas-pocket and the pipe M being closed by the valve O. This natural gas rises in the pocket, and in the nozzle or combustion-chamber meets the incoming highly-heated air of combustion. Combustion takes place and the burning gases go to the melting-chamber, from whence the products of combustion pass through the right-hand nozzle downward through the right-hand regenerator, and thence through the right-hand base-flues to the chimney. When the lever is reversed, the natural gas is shut off from the left-hand pocket and admitted to the right-hand pocket, and simultaneously the butterfly-valves are reversed, so as to place the left-hand regenerator in communication with the chimney-flue and the right-hand regenerator in communication with the valves J and S.

The sand in the bottom of the gas-pockets serves in receiving the cinder carried from the melting-chamber by the gases, and the doors in the side walls of the pockets permit of this sand and accumulated cinder being readily removed. In most of the figures the separating-wall *e* of the regenerators is parallel to the general plane of the furnace structure; but in Figs. 7 and 8 I show these walls as being disposed at right angles to the general plane of the structure.

The nozzles D form the combustion-chambers, where the gas and air of combustion mingle and the combustion takes place. Any or all of the walls of these nozzles may be provided with channels or passages for water, as indicated in Figs. 5 and 7.

The coning or beveling of the margin of the metal shell of the heating or melting chamber permits of the inner refractory lining being constructed of a concave form or with a heavy corner fillet without materially thickening the lining at the margins. The lining being of substantially uniform thickness, and the exterior of the shell being exposed to the cooling action of the atmosphere, such cooling action will apply equally to all portions of the lining.

In some cases the damp nature of the ground may require that underground work be avoided. In such case the base-flues will be above ground, and the regenerators will be accordingly elevated and the nozzles inclined, made depending, or otherwise modified.

The regenerators may be circular or elliptical in plan, and the partitions within the nozzles may, if desired, be continued to the juncture of the nozzles with the heating or melting chamber.

In the well-known Pernot furnace the regenerators are disposed directly beneath the furnace, and from them rise vertical flues to the top of the furnace, with which they communicate by detachable horizontal conduits, one for each of the four regenerators. One opening in the furnace-top serves for two of these horizontal conduits—viz., one from an air-regenerator and one from a gas-regenerator—the air and gas mingling only at the juncture of the two conduits where they connect with the furnace-top. My construction is distinguishable from that just described, in that in my device the horizontal conduits receive air and gas in common at their outer ends, whereby the horizontal conduits serve as mingling-chambers and combustion-chambers, only the products of combustion passing from the horizontal conduits, of which only half the heretofore-required number are required. My construction relieves the melting-chamber from duty as a combustion-chamber and permits of half the usual number of horizontal conduits being dispensed with.

It has been proposed to construct a furnace with a vertical regenerator standing upon each side thereof and connected thereto by horizontal conduits and with a gas-pocket interposed between the furnace and each regenerator; but the gas and air mingled only upon entrance to the furnace, which became the combustion-chamber. Such construction is distinguishable from mine, in that in my device the gas and air in common enter the horizontal conduit and there mingle and burn, only the products of combustion going into the furnace proper, thus relieving the heating-chamber of duty as a combustion-chamber and avoiding the necessity for lattice-work gas-inlets to the heating-chamber to induce proper diffusion.

In the proposed furnace last referred to as having gas-pockets the gas entered the pocket from a jetted horizontal base-pipe disposed in the pocket between the pocket-walls. These pipes were to be protected by superposed grate-work; but no provision was proposed for preventing the clogging of the grate-work. My device is distinguishable from such an arrangement, in that the cinder cannot fall upon the gas-pipe, but passes it and reaches the sand-bed below, whence it may be removed from time to time. M. Tessie, of France, proposed a baryta-furnace with a hollow wall into which cinders could be raked from the grates, the cinder being removed as desired from the hollow wall through proper doors. My device is distinguishable from this baryta-furnace arrangement, in that my wall-pipe and sand-bed construction keeps the gas-pipe free of cinder without the necessity of raking the cinder from it.

In the gas-furnace above referred to as having gas-pockets, provision was necessarily

made for reversing the action of the regenerators, and also for shutting off and letting on the gas to either pocket; but there appeared no equivalent for my device in which the reversal of the operation of the regenerators automatically and properly and simultaneously reversed the operation of the gas-pipes.

My improved furnace is adapted for use with natural gas or with producer-gas, the intention being to provide for continuous operation of the furnace in the event of the supply of one quality of gas being temporarily deficient. If the supply-connections for natural gas be omitted from the structure, then of course only producer-gas can be used. The division-walls E in the regenerators permits two simple regenerator structures to perform the office of the four regenerator structures heretofore employed, and two combustion-chambers or horizontal top conduits serve for the entire regenerative system. Heretofore in such furnaces four independent regenerative structures have been employed, each with its top connection leading to the melting-chamber.

A structure has been proposed in which a pair of contiguous regenerators was inclosed by the outer wall-work; but in this case the two regenerators of the pair were isolated and separated by the two boundary-walls of the undivided regenerators, and independent conduit proceeded from the two regenerators of the pair. In both these cases an excessive quantity of wall material was required, an expensive and complex construction was involved, considerable space was involved between the regenerators, and separate conduits to the melting-chamber were employed, thus distinguishing them from my improved structure, in which the two regenerators of a pair are separated by a single wall only and no intervening space, whereby complexity and cost and the need of separate conduits is avoided.

I claim as my invention—

1. The combination of a melting or heating chamber, two vertical regenerators standing alongside thereof and detached therefrom, combustion-chambers having their inner ends connected with said melting or heating chamber and their outer ends connected with said regenerators, gas-pockets opening upwardly into the outer ends of said combustion-chambers, and a gas-inlet to each of said pockets, substantially as set forth.

2. The combination of a melting or heating chamber, two vertical regenerators standing alongside thereof and detached therefrom, combustion-chambers connecting the tops of the regenerators with said heating or melting chamber, an upwardly-opening gas-pocket below each of said combustion-chambers, an inwardly-discharging gas-pipe, P, in the side wall of each of said gas-pockets, disposed above the level of the floor of the pockets, and doors in the walls of said pockets, near the bottom thereof, substantially as set forth.

3. In a regenerative furnace, the melting or heating chamber A, the vertical detached regenerators B and C, disposed alongside thereof, combustion-chambers D, placing the tops of the regenerators in communication with the melting or heating chamber, gas-pockets K, below the combustion-chamber, the pipe N, for natural gas, provided with reversing-valve O, and branches therefrom to the two gas-pockets, a chimney-flue, flues from the base of the regenerators to near the chimney-flue, a valve-casing connecting said base-flues with the chimney-flue, a valve to admit air to such valve-casing, a valve serving to place the regenerators alternately in connection with the chimney-flue and with the air-valve, and a lever adapted for the simultaneous operation of the valves controlling the inlet of gas to the pockets and the outlet of gases to the chimney, combined substantially as and for the purpose set forth.

4. In a regenerative furnace, a melting or heating chamber, two vertical regenerators disposed alongside thereof, two combustion-chambers connecting the tops of the regenerators with the melting or heating chamber, a chimney-flue, a conduit for producer-gas, a separating-wall in each regenerator dividing each regenerator into a gas portion and an air portion, joined directly by their common combustion-chamber, and valves serving to control the flow of gas and air to and from the bases of the regenerators, combined substantially as and for the purpose set forth.

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Witnesses:
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