

(No Model.)

T. G. KIRKPATRICK.

REGENERATOR FURNACE FOR USE OF NATURAL GAS.

No. 308,565.

Patented Nov. 25, 1884.

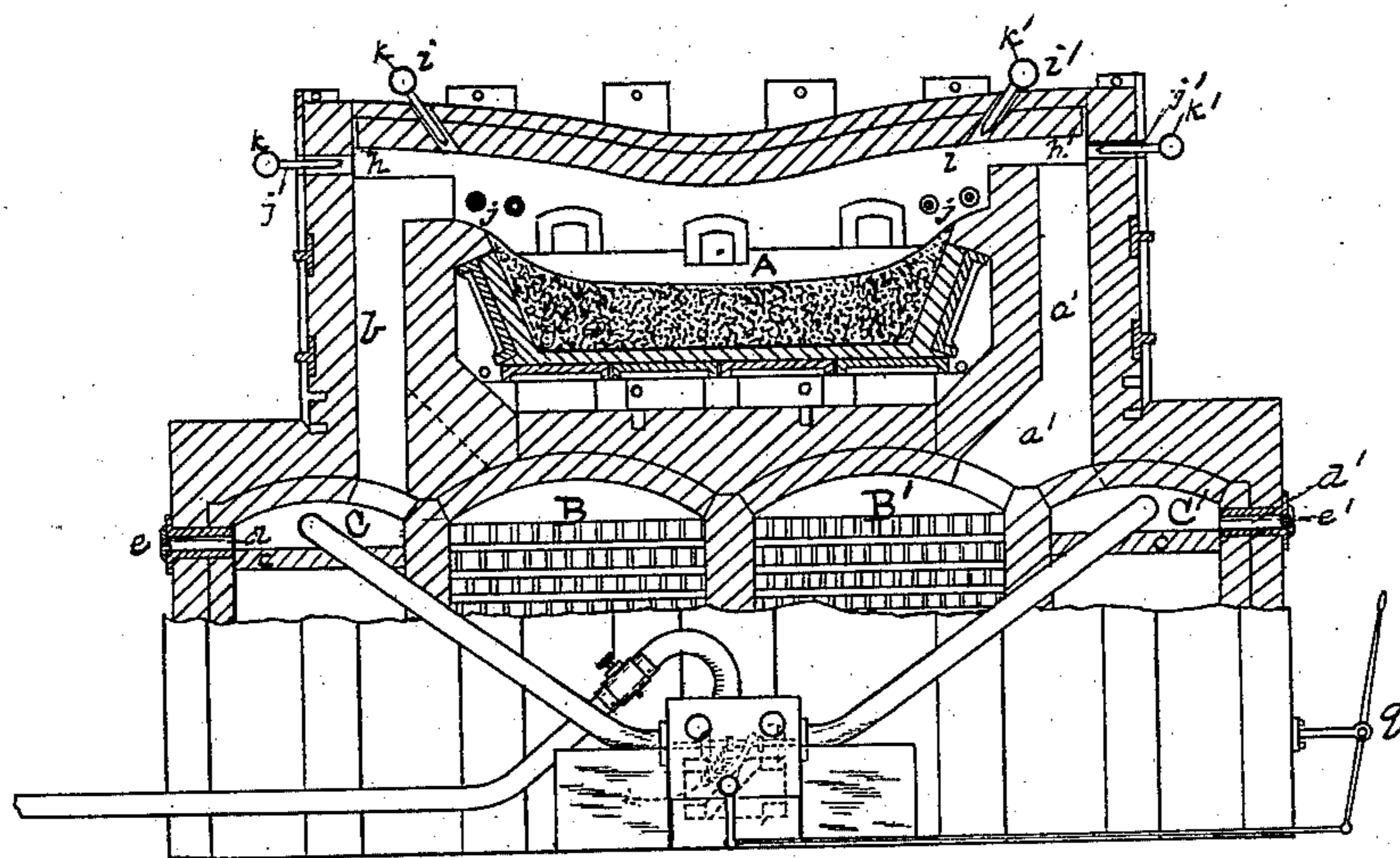


FIG 1.

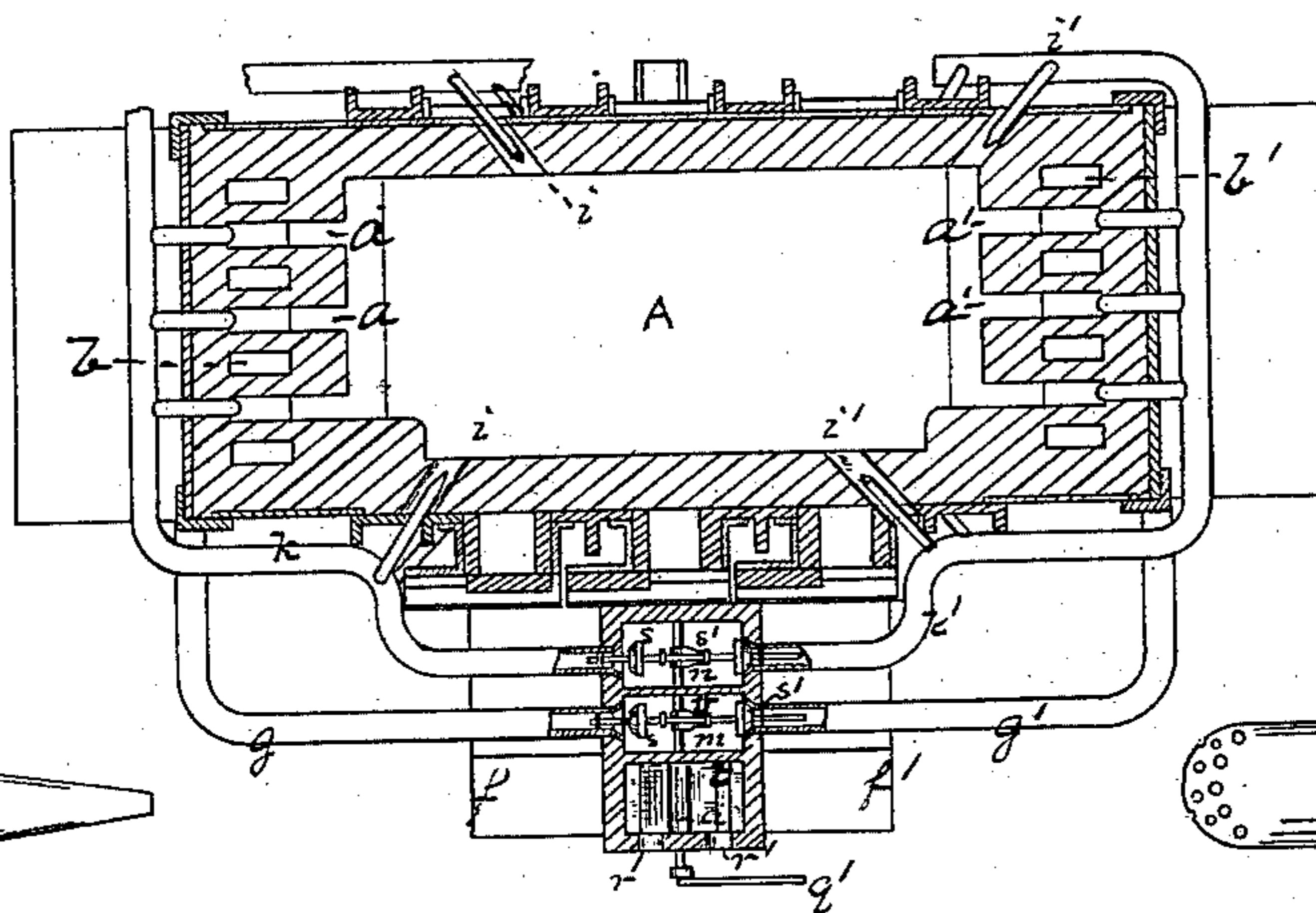


FIG 2

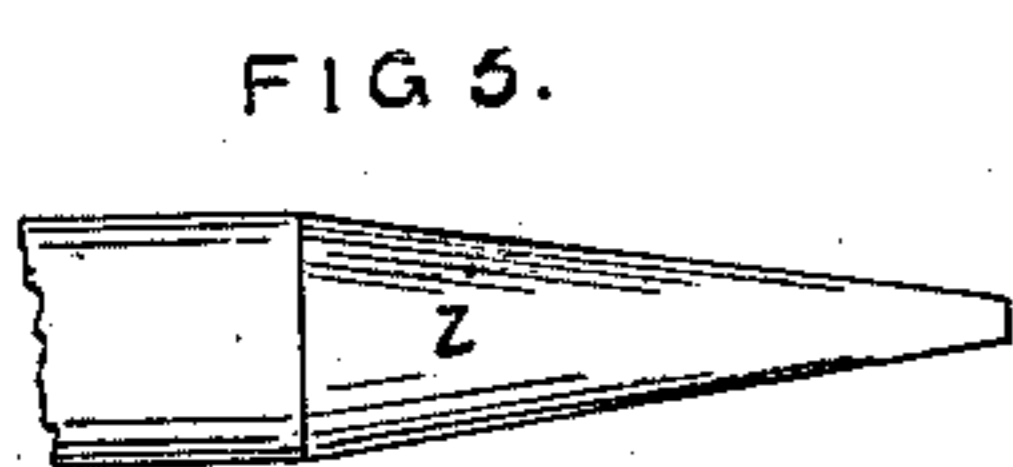


FIG 5.

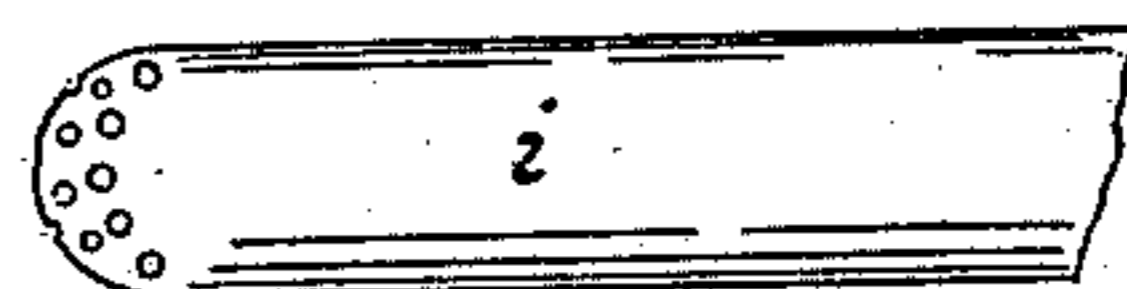


FIG 4.

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UNITED STATES PATENT OFFICE.

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REGENERATOR-FURNACE FOR USE OF NATURAL GAS.

SPECIFICATION forming part of Letters Patent No. 308,565, dated November 25, 1884.

Application filed December 24, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS G. KIRKPATRICK, of Leechburg, in the county of Armstrong and State of Pennsylvania, have invented a new and useful Improvement in Regenerator-Furnaces for Use of Natural Gas; and I do hereby declare the following to be a full, clear, and exact description thereof.

I have discovered a method whereby natural gas, by which I mean the carburated-hydrogen gas obtained from the earth, may be used with safety and with great advantage in steel-making furnaces and other furnaces employing gaseous fuel.

The great obstacle to the use of natural gas in gas-furnaces arises from the fact that a mixture of hydrogen with half its volume of oxygen is highly explosive when heated to the required temperature for their combination; but I have discovered that by mixing with the natural gas a small proportion—say about one per cent.—of atmospheric air, the mixture may be safely ignited within the furnace without producing explosion, and may then be conducted in a condition of slow combustion to the working-chamber of the furnace, where it is united with a current of highly-heated air, a vivid combustion and intense heat being produced. This discovery forms the subject of another application for Letters Patent of even date herewith, Serial No. 115,435, my present invention consisting in a modified construction of the gas-furnace known as the "Siemens Regenerator-Furnace," by which natural gas may be used with great advantage. This modification consists, mainly, in substituting a gas-chamber for the usual gas-regenerator, and providing said gas-chamber with a valved air-port, to permit a small per cent. of air to enter the gas-chamber to support low combustion in said chamber prior to the complete combustion which takes place on the hearth, where the preheated air from the air-regenerator meets the gas issuing from the gas-chamber. A secondary feature consists in combining with the air and gas reversing-valves a reversing-valve for controlling the steamways. There are also other details, which will hereinafter more fully appear.

In the accompanying drawings, Figure 1 is

a transverse vertical section of a regenerator-furnace for manufacture of steel constructed with my improvements. Fig. 2 is a horizontal section through *xx* of Fig. 1. Figs. 3 and 4 are representations of nozzles for steam-tuyeres.

The drawings represent a Siemens open-hearth regenerator-furnace of ordinary construction, excepting in the particulars pointed out in this specification.

A is the hearth or working-chamber of the furnace. *a* are the hot-air passages from the regenerator to the working-chamber at one end of the furnace, and *a'* at the other end. *b* and *b'* are the gas-passages to the working-chamber at opposite ends of the furnace. B B' are a pair of air-regenerators of ordinary construction, communicating with the air-passages *a* and *a'*, respectively. The air and gas passages *a* and *b* and *a'* and *b'* are placed side by side, as shown in Fig. 2, the air-passages opening into the working-chamber preferably at a higher level than the gas-passages. There are no gas-regenerators used, and in case of altering an existing Siemens furnace to use my improvement the gas-regenerators are covered over by a slab or tile of fire-brick, *c*, so as to leave the gas-chambers C C'. Into these gas-chambers C C' openings *d d'* are made for the admission of air into the chambers C C'. These openings *d d'* are furnished with a slide or register, *e e'*, by which the amount of air admitted may be regulated with exactness. Air is admitted through the pipes *f f'* into the bottom of the regenerators B B', with the upper ends of which the air-passages *a a'* communicate. Natural gas is introduced through the pipes *g g'* into the chambers C C', which communicate directly with the gas-passages *b b'*. Tuyeres *j j'*, for admission of steam and air, are introduced through the openings in the side walls of the furnace, so that the mouth of the tuyeres opens into the passages *h h'*, through which the air enters into the working-chamber. Tuyeres *i i'* are also inserted into the crown of the working-chamber, which tuyeres point downward and inward, as shown in Fig. 1. These tuyeres are made of pipe about one and one-half inch in diameter, with a piece of steam-pipe inserted concentrically through

the first-named pipe, so as to leave an annular space for the passage of an induced current of air. The steam-pipe is drawn down at the inner extremity to an orifice of one-eighth-inch diameter, as shown in Fig. 3, or is perforated with a series of fine holes, as shown in Fig. 4. These tuyeres all communicate with the steam-pipe *k* from a steam-generator through a valve-chest, *n*. (Shown in Fig. 2.)

In like manner the gas-pipes *g g'* communicate with the valve-chest *m*, and the air-pipes *f f'* with the valve-chest *l*. Air enters the valve-chest *l* through openings *r r'*, or one end of the valve-chest may be left open. The valve-chest *m* communicates with a pipe leading the gas from the gas-well or gas-holder. The three valve-chests *l*, *m*, and *n* may be placed side by side, as shown in Fig. 2, so that all the valves may be opened on one side and closed on the other side simultaneously by means of the lever *q*, Fig. 1. The valves *s s'* in the gas and steam chests *m* and *n* are mushroom-valves seating into valve-seats at the ends of the pipes *g g'* and *k k'*, which open into the valve-chests.

Each pair of valves is placed on one stem, so that when one valve of the pair is open the other valve is closed. The valve in the air-chest *l* is a butterfly reversing-valve, *t*, such as is ordinarily used in connection with regenerators, so that turned in one direction it opens the communication between the outside air and the regenerator B, and at the same time opens the communication between the other regenerator, B', and the flue leading to the chimney. The butterfly-valve *t* is pivoted to a horizontal shaft, *u*, which shaft is operated to reverse the valve *t* by means of the levers *q q'*; and the horizontal shaft *u* is also connected by short links *v* to the stem of each of the mushroom-valves *s s'*, &c., so that they are opened or closed as and when the butterfly-valve *t* is shifted. By this arrangement, when the butterfly-valve *t* is shifted so as to connect the regenerator B with the air-flue, and open the communication between the regenerator B' and the chimney, valves *s s* open communication between the gas-chest *m* and the chamber C, and between the steam-chest *n* and the steam-pipe leading to the tuyeres *j* and *i*, and shut the corresponding valves, *s'* and *s'*, thereby closing the connection between the gas-chamber C' and the gas-chest, and between the steam-pipes which supply steam to the tuyeres *j'* and *i'* and the steam-chest.

The operation of this furnace is as follows: When the valves are in the position just stated, air enters the regenerator B, and, being highly heated in traversing it, passes up the air-passage *a*, (which is alongside of the passage *b*,) and to a point near the roof of the furnace, at *a*, where it meets a stream of air and steam, (or superheated steam, if preferred,) and enters the working-chamber therewith. At the same time the natural gas flowing through the pipe *g* enters the gas-chamber C, where it is mixed with small currents of air entering through the openings *d*, and, being there ignited, (by

means of a taper introduced into the chamber C, or by means of a small gas-jet inside the chamber C, which is always supplied with gas and kept burning,) the burning gas ascends the gas-passage *b* and enters the working-chamber below the inflowing currents of hot air, causing a vivid combustion and intense heat. Streams of mingled steam and air also enter through the tuyeres *i*, (placed on opposite sides of the furnace, as shown in Fig. 2,) and aid the combustion and produce a swirling motion of the flame within the working-chamber.

When it is desired to charge the furnace, the regenerator B having been cooled by the inflowing air and the other regenerator heated by the outflowing products of combustion from the working-chamber, the lever *q* is shifted, which shifts the butterfly-valve *t* and closes the valves *s s*, opening the valves *s' s'*, and thus causes the air to pass through regenerator B', and the gas through chamber C', and the products of combustion through regenerator B, thus reversing the direction of all the currents.

I do not desire to confine my invention to the use of the particular kind of reversing-valves for gas and steam in combination with the pair of regenerators and of gas-chambers, as the ordinary kind of reversing-valves may be employed.

Having thus described my improvement, what I claim as my invention, and desire to secure by Letters Patent, is—

1. In a furnace for burning gaseous fuel, the combination, with a working-chamber, of two gas-chambers, each having an air-port for admitting air thereto, and a port or passage delivering into the working-chamber, two air-regenerators, each having a port or passage delivering into the working-chamber adjacent to the gas-discharge of the corresponding gas-chamber, and reversing-valves, substantially as and for the purposes specified.

2. In a furnace for burning gaseous fuel, the combination, with a working-chamber, of two gas-chambers, each having an air-port for admitting air thereto, and a port or passage delivering into the working-chamber, two air-regenerators, each having a port or passage delivering into the working-chamber adjacent to the gas-discharge of the corresponding gas-chamber, steam-jet pipes arranged to deliver into the hot-air passages leading from the air-regenerators, and three sets of reversing-valves, arranged to control the air, gas, and steam supplies, substantially as and for the purposes specified.

3. In a furnace for burning gaseous fuel, the combination, with a working-chamber having air-ports, and steam-jets arranged in said air-ports, of two gas-chambers, each having an air-port for admitting air to the gas-chamber, and a port or passage delivering into the working-chamber, two air-regenerators, each having ports or passages delivering into the working-chamber adjacent to the gas-discharge of

the corresponding gas-chamber, and reversing-valves for controlling the air, gas, and steam supplies, substantially as and for the purposes specified.

- 5 4. In a reversing-valve for regenerators, the combination of a butterfly-valve for controlling the air-passages, and two mushroom-valves arranged on opposite ends of a single stem, said stem actuated from the butterfly-

valve, substantially as and for the purposes so specified.

In testimony whereof I have hereunto set my hand this 17th day of December, A. D. 1883.

THOMAS G. KIRKPATRICK.

Witnesses:

W. BAKEWELL,

W. B. CORWIN.