(No Model.)

F. H. RICHARDS.

FURNACE.

No. 535,403. Patented Mar. 12, 1895.

Fig. 1.

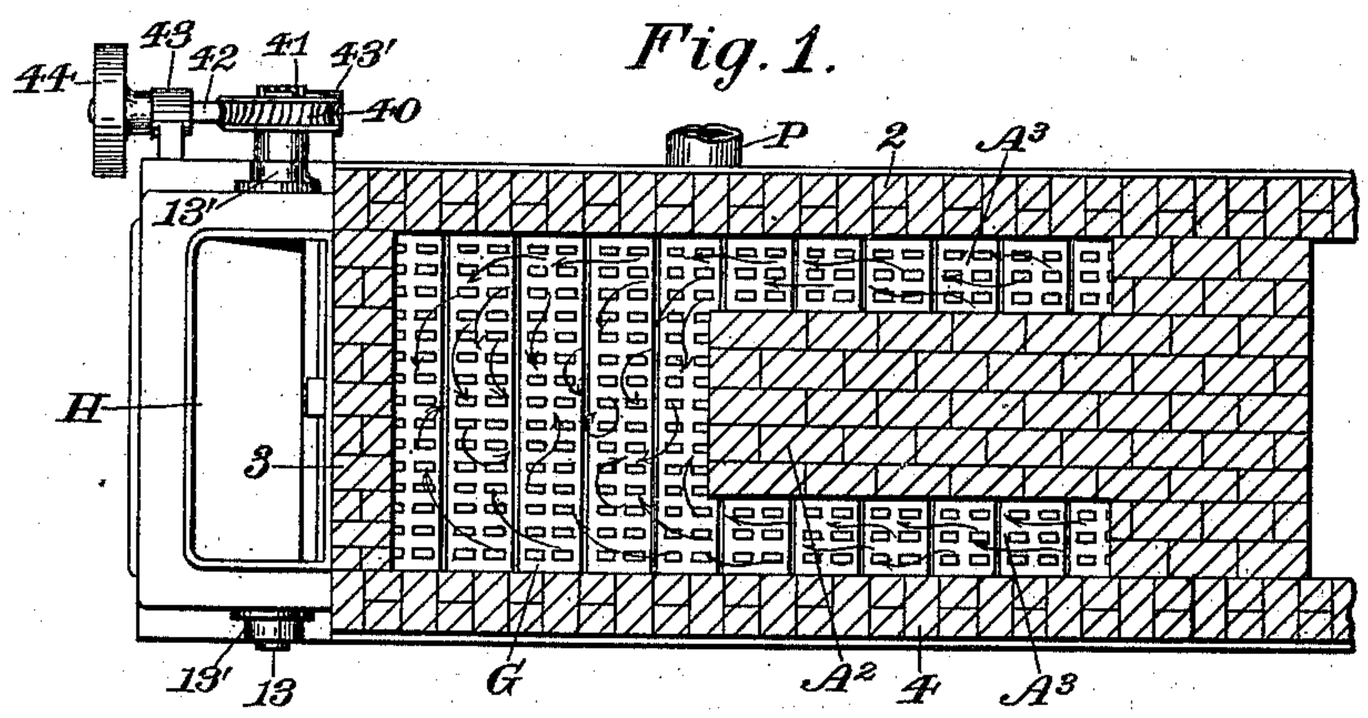


Fig. 2.

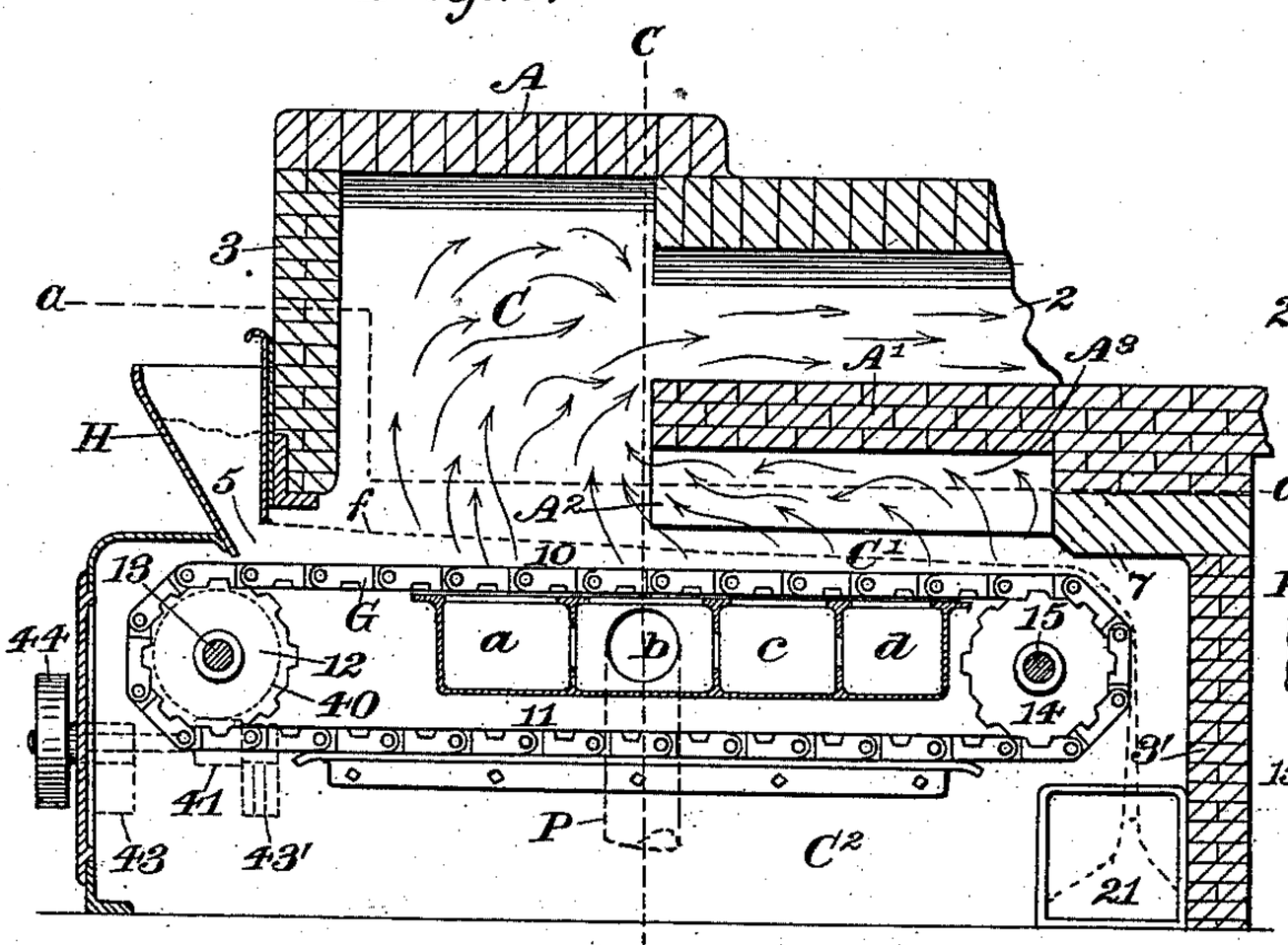


Fig. 3.

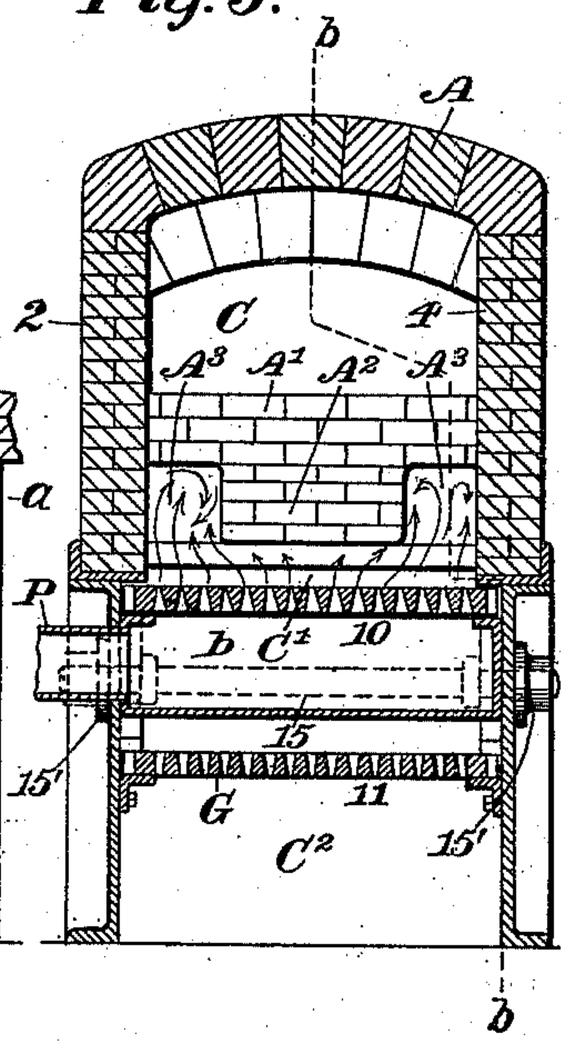
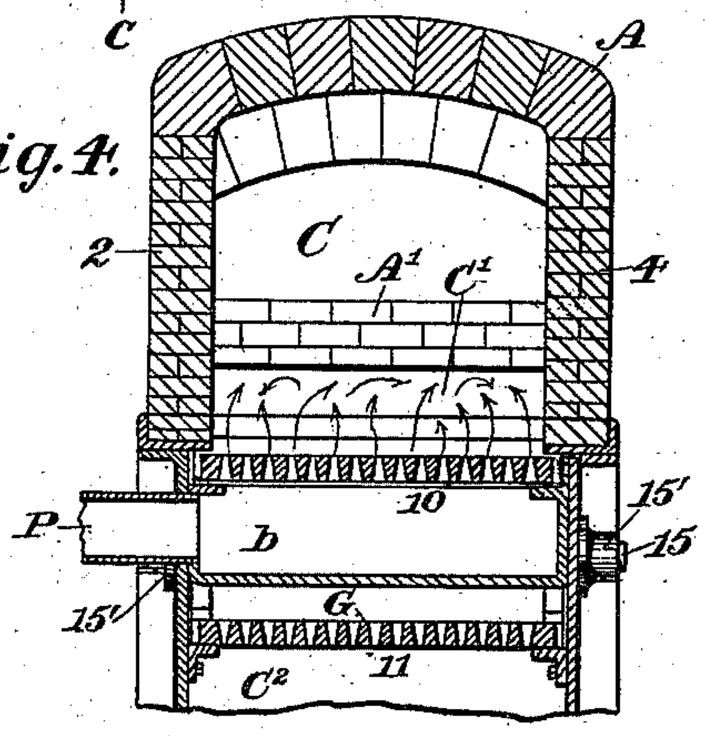


Fig. 4.



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UNITED STATES PATENT OFFICE.

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FURNACE.

SPECIFICATION forming part of Letters Patent No. 535,403, dated March 12, 1895.

Application filed September 24, 1894. Serial No. 523,865. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS H. RICHARDS, a citizen of the United States, residing at Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Furnaces, of which the following is a specification.

This invention relates to furnaces and especially to the class of furnaces described in Letters Patent of the United States, No. 499,716, granted to Eckley B. Coxe June 20, 1893, in which a fuel-traveling grate-mechanism is employed for carrying the fuel along in the furnace-chamber and in which the fuel supported upon the grate is, during the traveling movement thereof, subjected to air-blasts of varying pressures at successive points in the length of the furnace-chamber.

The object of my present invention is to provide an improved process and apparatus whereby a mass of fuel spread in a layer and maintained substantially *in statu quo* during the successive stages of the combustion period, is ignited and carried forward under a combustion-chamber located over the ignition end of the layer; whereby the layer is subjected to successive air-blasts of varying pressures, and whereby the products of the later stages of the combustion period are reverberated or caused to traverse the ignition area so as to mingle the products of the later stages of combustion with the products of the first stages of the combustion, to bring the so-called volatile elements of the fuel at once into the region of intense combustion and utilize the relatively high temperature of the later stages of the combustion period for heating and igniting the fresh fuel at the ignition area of the layer, as will be hereinafter more fully described.

In the drawings accompanying and forming part of this specification, Figure 1 is a horizontal cross-section of a portion of the forward end of a fuel-traveling grate furnace, taken in line *a*—*a*, Fig. 2, as seen from the upper side in said figure. Fig. 2 is a vertical longitudinal section of the same taken in line *b*—*b*, Fig. 3, as seen from the right hand in said figure. Fig. 3 is a vertical cross-section of the same taken in line *c*—*c*, Fig. 2 showing that portion of the furnace at the right hand of said line. Fig. 4 is a similar cross-sectional view of the furnace embodying a modification of my invention.

Similar characters designate like parts in all of the figures.

The furnace in connection with which my present improvements are shown is of the traveling-grate variety and the construction thereof, is, in a general way, somewhat similar to that shown in Letters Patent of the United States, No. 499,716, hereinbefore referred to, the differences in the present furnace over the furnace described in said patent residing in the provision of certain chambers above the fuel-carrying run of the grate and in certain combinations and arrangements of certain elements relating thereto which are foreign to the furnace described in the patent referred to, and which will be hereinafter fully described.

The furnace shown in the drawings has the usual grate-mechanism chamber C^2 in which is located a grate, designated in a general way by G, which is of the endless traveling grate variety, and which may be substantially the same as the grate shown and described in the patent referred to: and has the usual inclosing walls at the sides and ends thereof and is shown provided with the ordinary roof A.

The side-walls are designated by 2 and 4, respectively, the front-end wall by 3, rear-end wall by 3′, and the bridge-wall by 7. At the forward end of the furnace this is provided with the usual fuel supply hopper H from which fuel is admitted to the fuel-carrying run of the grate through the opening, 5, which is contiguous or in close proximity to the upper surface of said grate. In the form thereof herein shown, the endless grate which comprises the upper and lower runs 10 and 11, respectively, the upper run of which constitutes the furnace-floor proper, is carried at the opposite ends of said runs by chain-wheels, 12 and 14, carried upon shafts, 13 and 15, respectively, journaled in suitable bearings, 13′ and 15′, respectively, secured to the side-walls of the grate-mechanism chamber, and as a convenient means for actuating said grate, the forward shaft 13 is shown provided with a worm-wheel, 40, which meshes with a worm, 41, on a driving-shaft, 42, journaled in bear-

ings, 43 and 43′, (shown in dotted lines in Fig. 2) which shaft is provided with a driving pulley, 44, which may be driven from any suitable source of power (not shown). The hopper, H, will, in practice, be provided with a suitable cut-off gate for regulating the supply of fuel to the furnace-floor.

As a means for supplying air to the fuel at varying pressures at successive points along the fuel-carrying run of the grate, an air-supply apparatus is provided, which air-supply apparatus may be of the same general construction as that shown in Letters Patent No. 499,716, hereinbefore referred to, it consisting of a series of successive air-supply chambers, *a*, *b*, *c*, and *d*, respectively, located below the fuel-carrying run, 10, of the grate, and having the usual outlet openings contiguous to the fuel-carrying run of the grate. As a means for supplying air to the air-supply chambers, I have shown a pipe, P, in connection with one of said chambers, as *b*, which pipe may receive its supply from any suitable blower or air-pump, (not shown,) the other air-supply chambers *a*, *c* and *d*, receiving their supply of air from the chamber *b* through communicating openings in the side-walls of said chambers.

The process of supplying air to the fuel at varying pressures, or at successively reduced pressures at successive points in the length of the fuel-carrying run of the grate, is and may be substantially the same as the process described in Letters Patent of the United States, No. 499,715, granted to Eckley B. Coxe, June 20, 1893, to which reference may be had.

In operation, the fuel is fed to each section of the grate at or before the time this reaches the first air-supply chamber, *a*, and is then carried along, maintained substantially *in statu quo*, over that chamber and the succeeding chambers *b*, *c*, and *d*, during which period the combustible material of the fuel is consumed, the resulting cinder or ash being afterward carried under the bridge-wall, 7, and finally delivered over the rearward end of the grate into the ash-pit, 21, which ash-pit, in this instance, constitutes a part of the grate-mechanism chamber C^2. In practice, the combustion goes on at one stage or another throughout the entire length of the furnace, or the entire length of the fuel-supporting run of the grate, the ignition taking place within a short distance of the point where the fuel falls upon the grate, or at the point near the forward end of the grate which is herein termed the "first combustion" or "ignition area," said fuel being completely reduced to cinder over the last chamber, *d*, of the series, or at that point near the rearward end of the grate which is herein termed the "last combustion area."

Heretofore it has been customary, in furnaces of this class, to carry the products of combustion from the first ignition area in the direction of travel of the upper run of the grate toward and over the succeeding combustion-chambers without material aeration or intermingling of the products of the first, last or intermediate areas, or the products of the various successive stages in the combustion period, other than that which might accrue from forced contact of the gaseous products moving in streams in one and the same direction, as will be understood by reference to the Patent No. 499,715 hereinbefore referred to, and in consequence a considerable percentage of effective energy has been lost owing to the incomplete oxidation of the combustible elements from want of proper aeration.

To facilitate the effective oxidation of the combustible elements and thereby secure the liberation of the maximum amount of energy to a given amount of burning fuel, and in the shortest possible length of time, I have found that this can be done in traveling-grate furnaces by diverting the course of travel of the products of the later stages of the combustion period and causing them to travel reversely to the fuel layer and intermingle with the products of the first stages of the combustion period—in other words—by creating two oppositely-moving currents comprising the combustible elements and intermingling said elements in the area above the fuel-carrying run of the traveling-grate. As a convenient means for securing this result, the area above the fuel-carrying run of the grate (which area ordinarily constitutes the furnace-chamber proper) is divided for a portion of its length by a horizontal transverse partition, A′, which extends from the rear wall 3′ toward and terminates remote from the front-end wall 3 of said furnace, thereby forming, practically, two independent chambers, namely, a main combustion chamber, C, which is practically closed at the forward end thereof and usually has its outlet at the rearward end of the furnace, and a reverberatory chamber, C′, which is closed, as against the egress of the combustible elements, at the rearward end of the furnace and has its outlet into the combustion-chamber, C, at the forward end thereof as clearly illustrated in the drawings.

In the preferred form thereof, most clearly shown in Figs. 2 and 3 of the drawings, the dividing-wall, A′, between the two chambers C and C′ has a depending central portion, A^2, the lower edge of which terminates in close proximity but slightly remote from the normal surface-line of the fuel supported upon the traveling-grate, which fuel-line is designated by a dotted line, *f*, in Fig. 2 of the drawings, thus forming longitudinal passage-ways, A^3, one on each side of the depending portion, A^2, which passage-ways lead back to the combustion-chamber C. In practice, during the combustion of the fuel, the air-supplies from the low-pressure air-chambers, *c* and *d*, for instance, are diverted sidewise in the reverberatory chamber C′ under the depending portion A^2 of the partition or roof A′ of said chamber into the passage-ways A^3 at each side thereof and are there mingled together

and directed along the sides of said chamber C backward over the preceding combustion areas and into the combustion-chamber C at or near the ignition-area thereof, there to be turned inwardly one toward the other and mingled with the air-supply from the main blast-chamber *b* and to be co-mingled with the gases in the final stages of the combustion period. This organization of the several features of the furnace and its chambers C and C′ insures the very thorough and effective mingling of the several air-supplies and of the several portions of the furnace gases and effectively utilizes the relatively high temperature of the later stages of the combustion period for heating and igniting the fresh fuel as it is delivered to the grate.

In Fig. 4 of the drawings the reverberatory chamber C′ is shown without the longitudinal dividing wall A^2 at the center thereof. This construction shown in Fig. 4 is adequate for the purposes of my invention, but the construction shown in Figs. 1, 2 and 3 is preferable, as by providing the chamber C′ with two side-passage-ways a more thorough intermingling of the combustible elements will be secured. Therefore I do not desire to limit myself to the exact construction of furnace shown in the drawings, as such construction might be modified without departure from this invention.

Having thus described my invention, I claim—

1. The herein described process of burning coal and other fuel, which consists in, first, igniting a mass of fuel spread in a layer; second, carrying the ignited layer progressively forward and maintaining the same substantially *in statu quo* during the successive stages of the combustion period; third, subjecting the layer to successive air-blasts of varying pressures at successive points in the length of the traveling movement thereof; fourth, reverberating, or carrying the products of the later stages of the combustion period backward in a direction in opposition to the direction of the traveling movement of the fuel toward and intermingling these latter products with the gaseous products of the first stages of the combustion period whereby the so-called volatile elements of the fuel are at once brought into the region of intense combustion, and whereby the products of the later stages of the combustion period are made to supply partially combined heated air for consuming said volatile products, substantially as described and for the purpose set forth.

2. The herein described process of burning coal and other fuels, which consists, first—in igniting a mass of the fuel spread in a layer; second,—carrying the ignited layer maintained substantially *in statu quo* during the successive stages of the combustion period, progressively forward with a uniform traveling movement; third,—subjecting the ignited layer at successive points in the length thereof to air-blasts of successively reduced pressure, respectively, to thereby form successive combustion areas of relatively varying ratios, and fourth,—causing the products of combustion at the areas coinciding with the lower-pressure air-blasts to reverberate and traverse the areas coinciding with the preceding higher-pressure air-blasts, whereby the products of the last stages of the combustion period are thoroughly intermingled with the products of the first stages of the combustion period, substantially as described and for the purpose set forth.

3. In a furnace of the class specified, a furnace-chamber divided midway of its height at the rear end thereof by a transverse partition or wall, and comprising two separate or practically independent chambers, one of which extends around the open end of and above the other, and both of which are adapted for carrying portions of the combustible elements simultaneously in opposite directions, an endless grate supported for traveling movement longitudinally of and below said chambers, means for imparting a traveling movement to said grate, and means supported below the fuel carrying run of said grate and adapted for supplying air through said grate to said chambers at varying pressures at successive points in the length of said grate, substantially as described and for the purpose set forth.

4. In a furnace of the class specified in combination a fuel-traveling grate, means for actuating said grate to impart a traveling-movement to the fuel supported thereon, an air-blast apparatus comprising a series of air-chambers located below the fuel-carrying run of said grate and adapted for supplying air to the fuel, upon said grate, at varying pressures at successive points in the length thereof, a relatively high combustion-chamber located above the forward end of the grate, and a relatively low combustion-chamber located above the rearward end of said grate and having its outlet forwardly into the first-mentioned combustion-chamber adjacent to the middle portion of the grate, and adapted for directing or reverberating the products of the last stages of the combustion period and carrying them backward to and intermingling them with the products of the first stages of the combustion period, substantially as described and for the purpose set forth.

5. In a furnace of the class specified, the combination with a grate supported for traveling movement of the furnace-chamber above said traveling grate divided longitudinally at the rearward end thereof by a depending transverse partition or wall terminating at its forward end remote from the front wall of the furnace-chamber to thereby form a relatively low reverberatory chamber having its outlet into the furnace-chamber near the forward end thereof, means for imparting a traveling movement to the grate, an air-blast apparatus located below the fuel-carrying run of the grate, and comprising a series of successively

reduced pressure-blast chambers located below the reverberatory chamber, and one or more relatively high and relatively low-pressure blast-chambers located below the furnace-chamber in advance of said reverberatory chamber, substantially as described and for the purpose set forth.

6. In a furnace of the class specified, the combination with the fuel-traveling grate and means for actuating the same, of an air-blast apparatus comprising a series of air-supply chambers located below the fuel-carrying run of said grate and adapted for supplying air to the fuel upon said grate at varying pressures at successive points in the length thereof, and the furnace-chamber divided longitudinally and transversely at the rearward lower end thereof by a T-shaped partition to form a vertically-and-longitudinally divided reverberatory chamber having separated air-passages one at each side the center thereof and with outlets into the principal furnace-chamber near the forward end thereof, substantially as described and for the purpose set forth.

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