(No Model.) 3 Sheets—Sheet 1.

E. B. COXE, Dec'd.

A. B. & H. B. Coxe, Executors.

ART OF AND APPARATUS FOR CONTROLLING OPERATION OF TRAVELING GRATE FURNACES.

No. 562,068. Patented June 16, 1896.

Fig. 2.

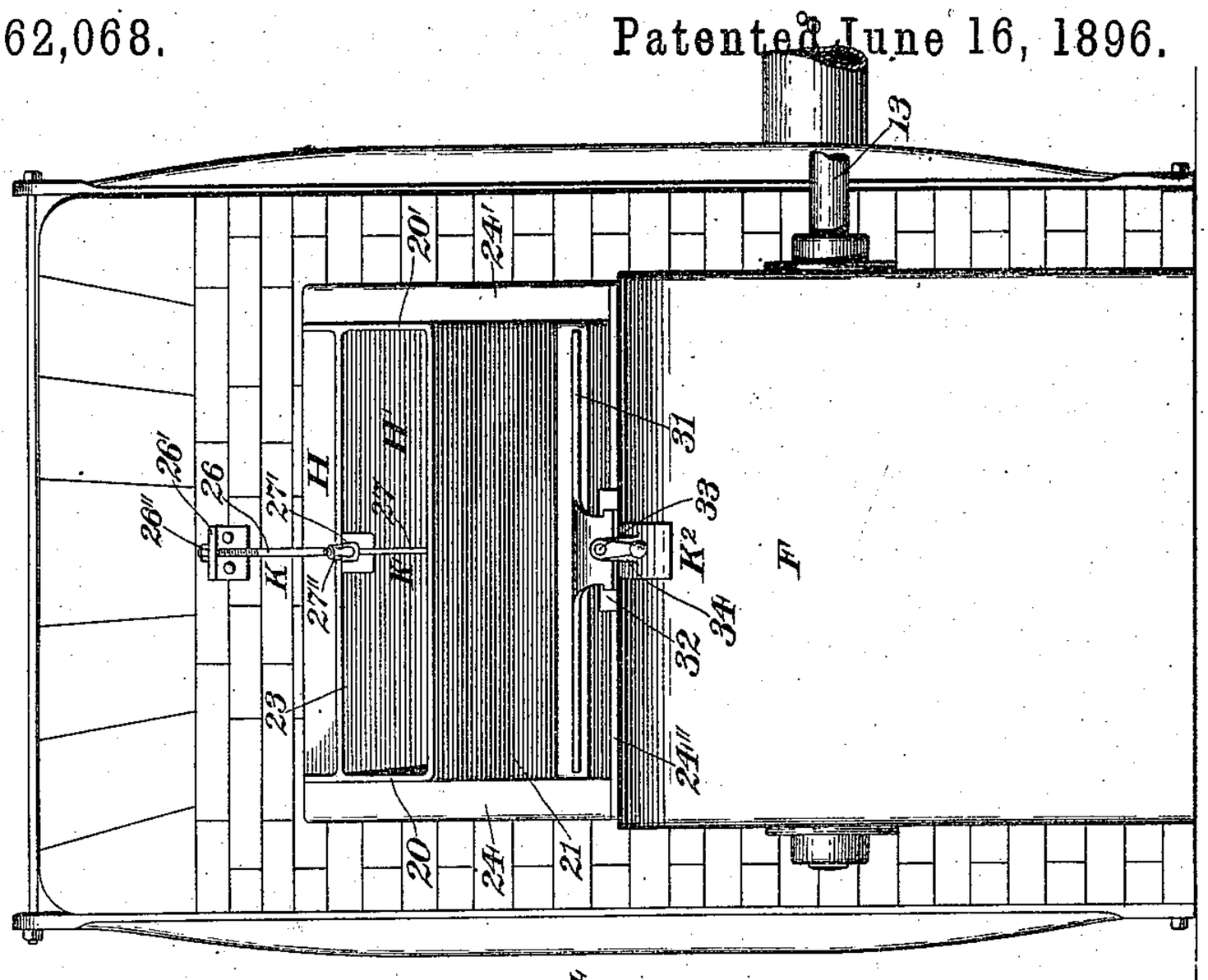
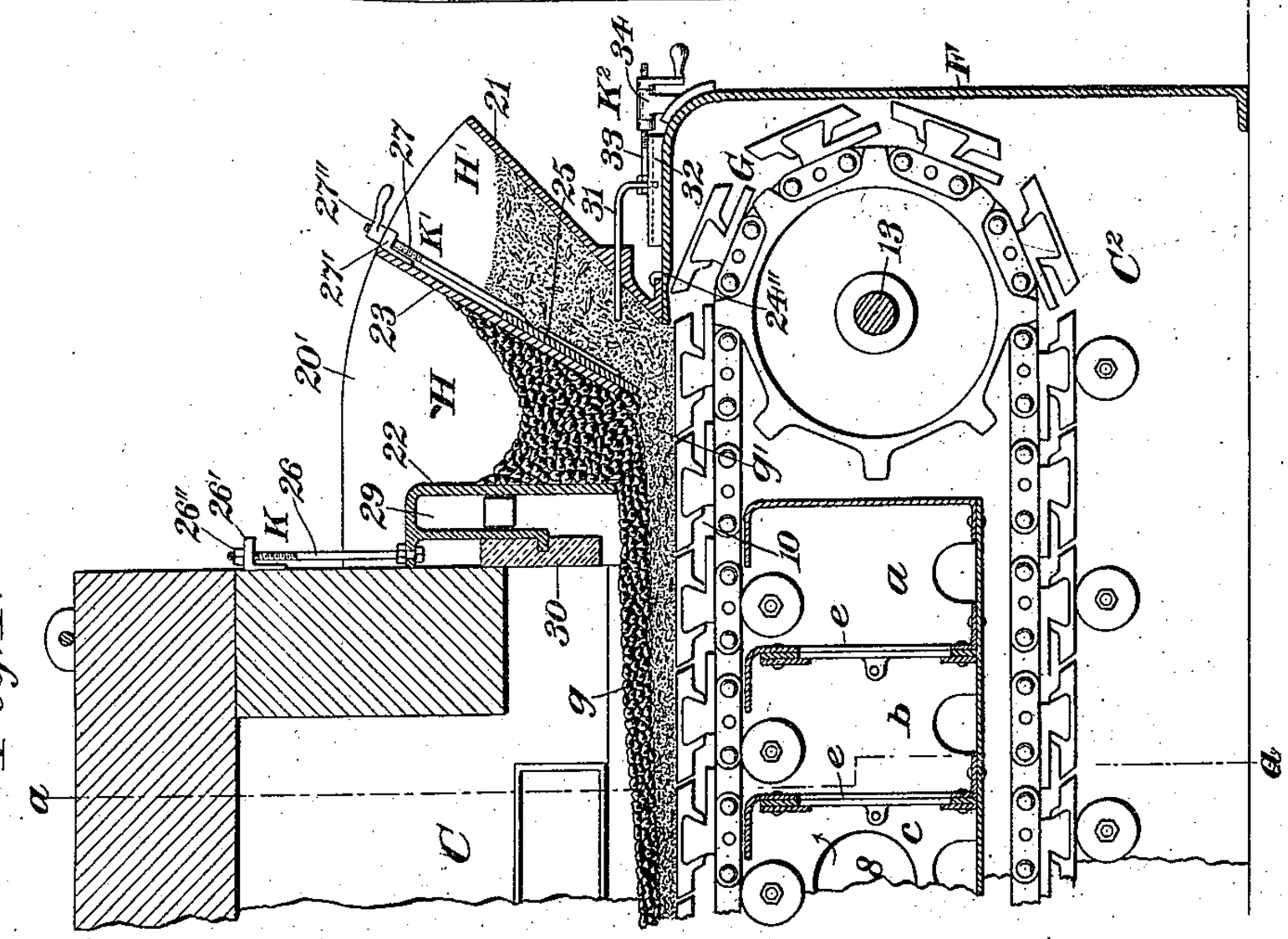


Fig. 1.



Witnesses:
F. L. Edwards Jr.
Fred. J. Dole.

Alexander B. Coxe,
Henry B. Coxe,
} Executors of Estate of
Eckley B. Coxe, Inventor, Deceased
By their Attorney,
F. H. Richards.

(No Model.) 3 Sheets—Sheet 2.

E. B. COXE, Dec'd.

A. B. & H. B. COXE, Executors.

ART OF AND APPARATUS FOR CONTROLLING OPERATION OF TRAVELING GRATE FURNACES.

No. 562,068. Patented June 16, 1896.

Fig. 4.

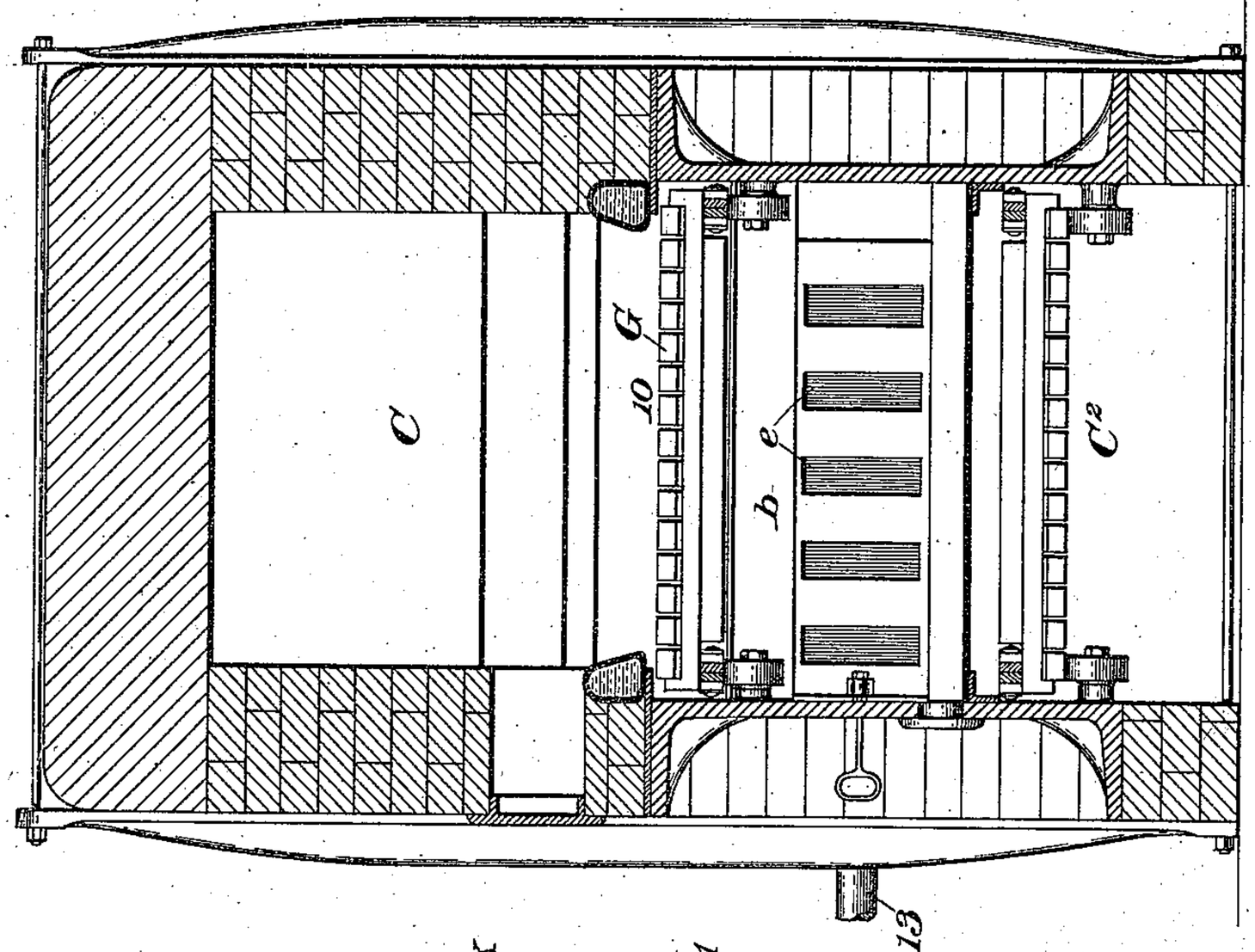
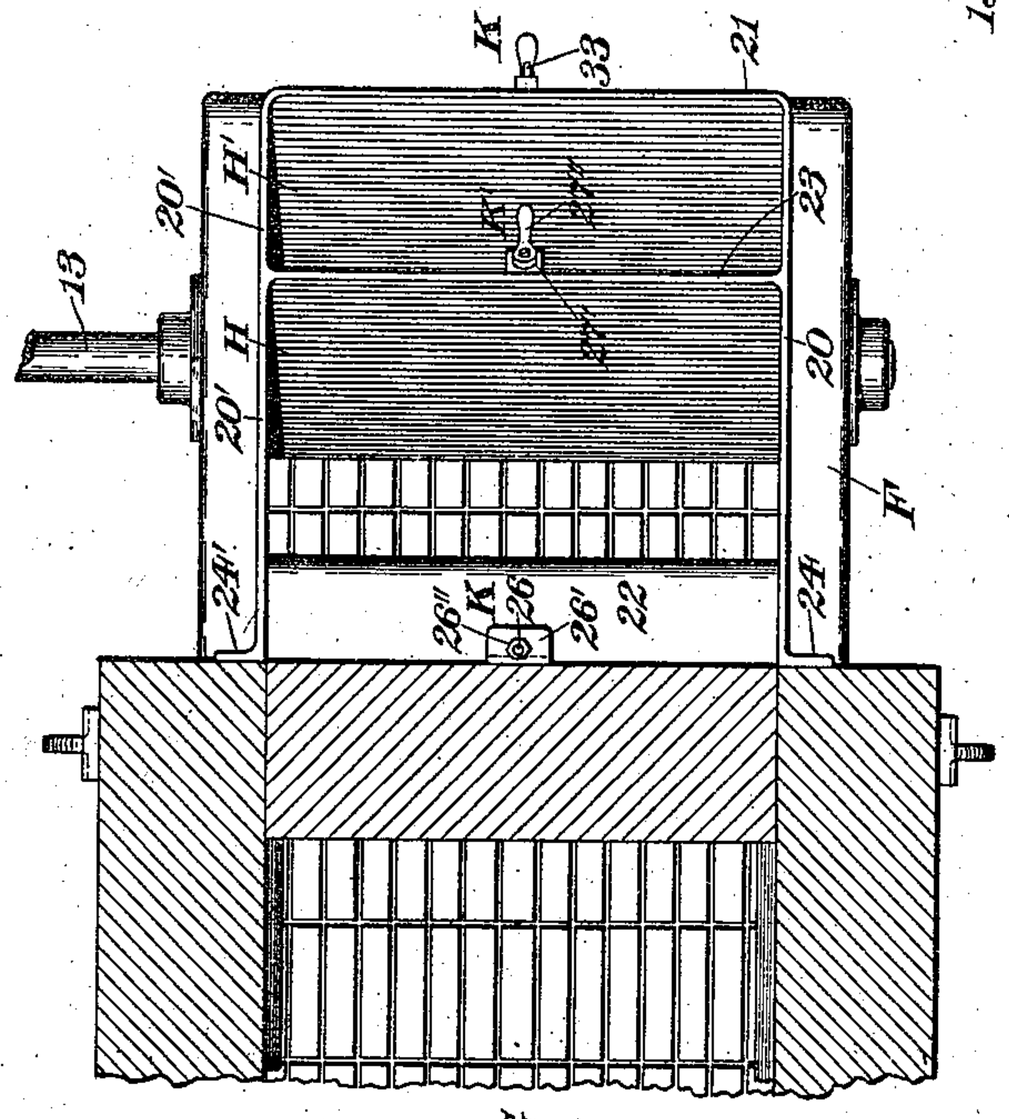


Fig. 3



Witnesses:
J. L. Edwards Jr.
Fred. J. Dole.

Alexander B. Coxe, } Executors of
Henry B. Coxe, } Estate of
Eckley B. Coxe, Inventor, Deceased.
By their Attorney,
F. A. Richards.

(No Model.) 3 Sheets—Sheet 3.

E. B. COXE, Dec'd.

A. B. & H. B. COXE, Executors.

ART OF AND APPARATUS FOR CONTROLLING OPERATION OF TRAVELING GRATE FURNACES.

No. 562,068. Patented June 16, 1896.

Fig. 5.

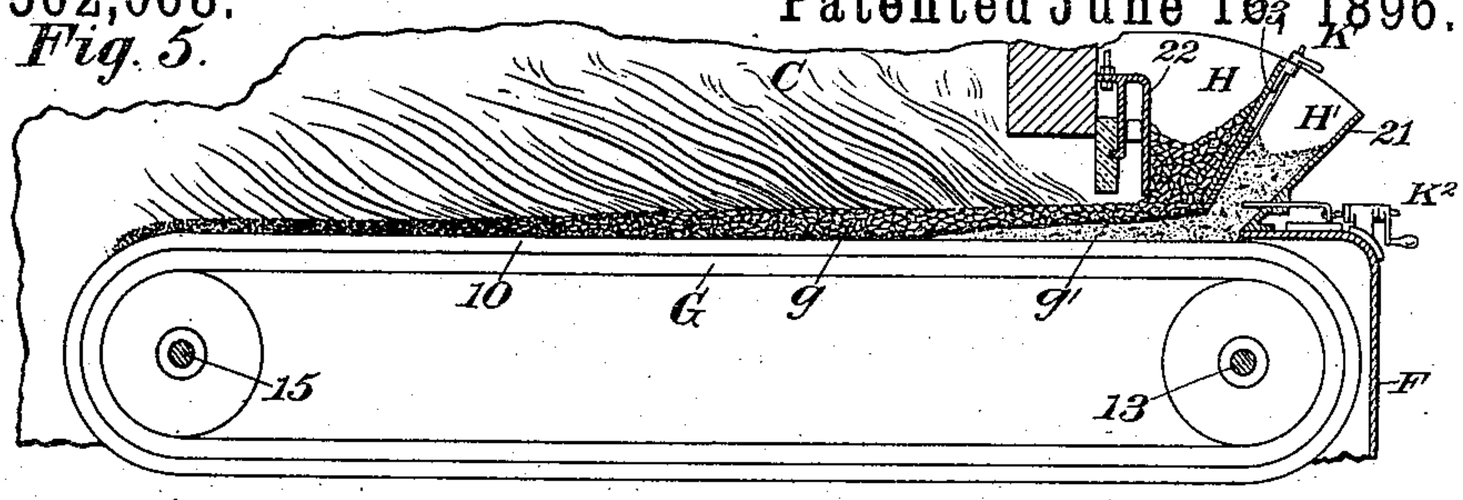


Fig. 6.

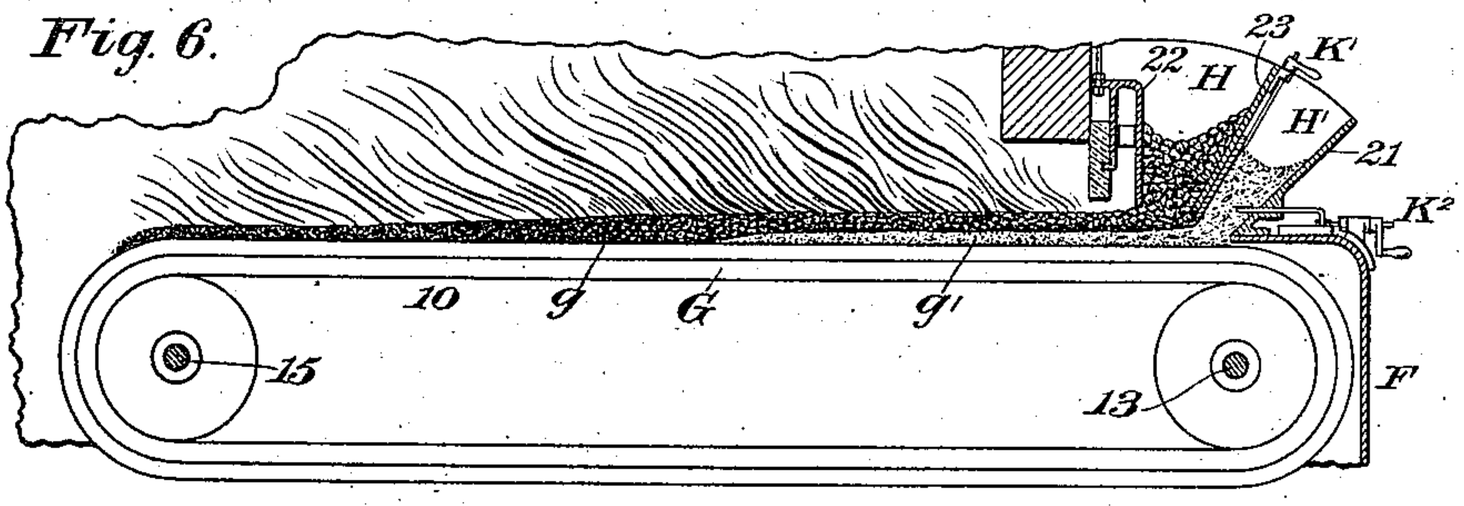


Fig. 7.

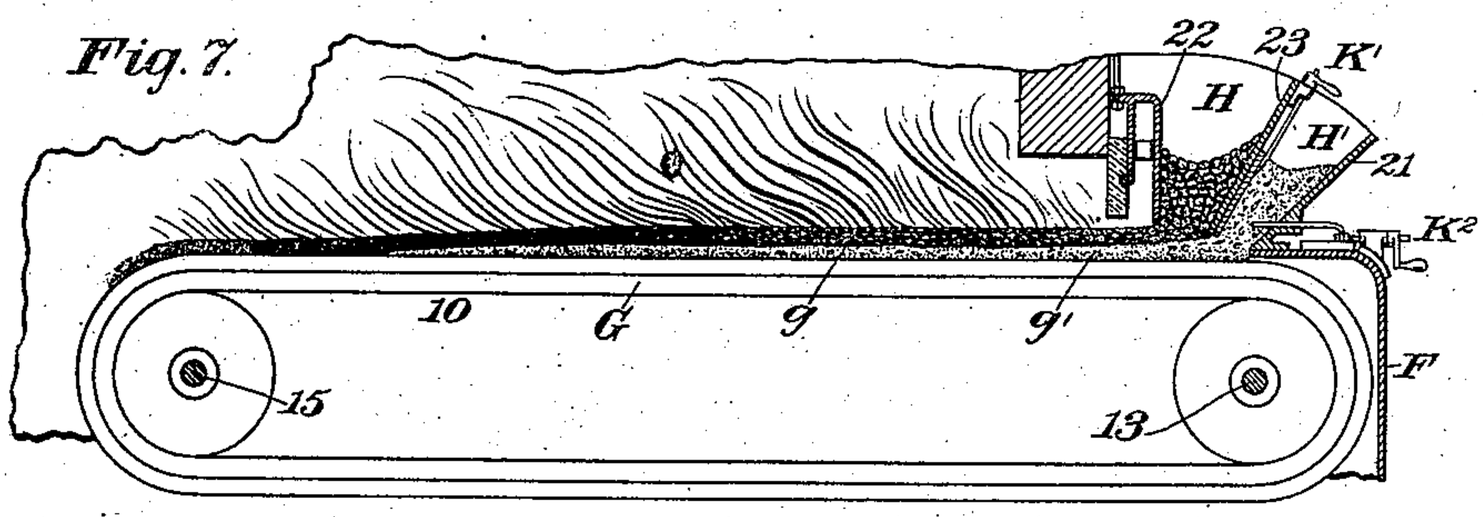
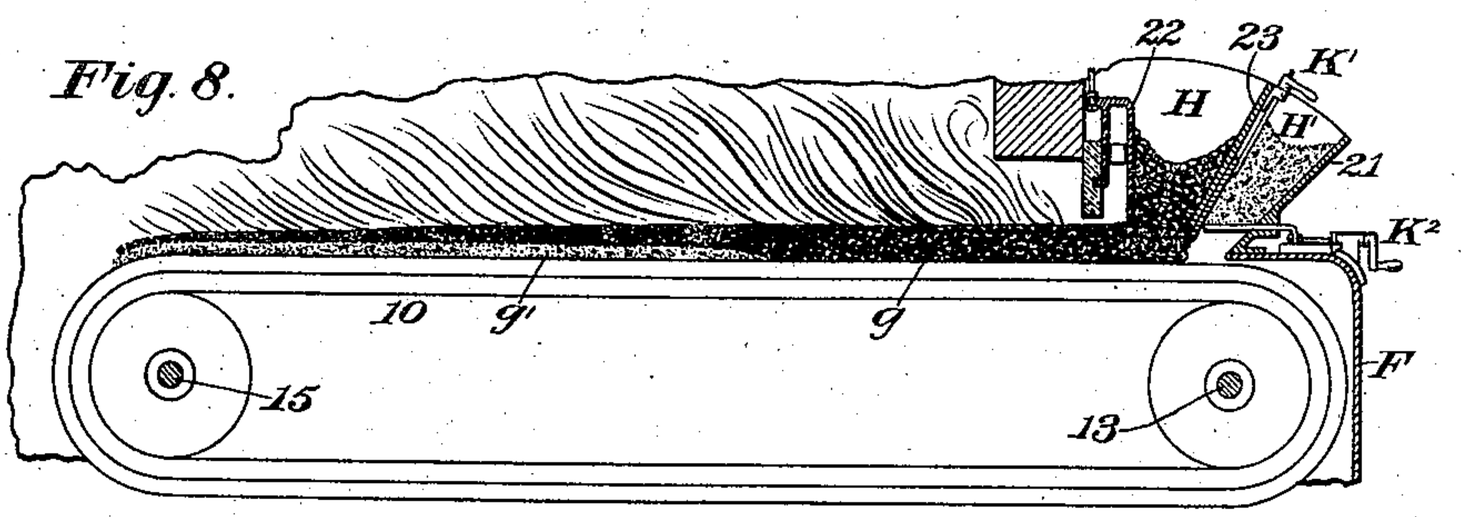


Fig. 8.



Witnesses:
J. L. Edwards Jr.
Fred. J. Dole.

Alexander B. Coxe, }
Henry B. Coxe, } Executors of Estate of—
Eckley B. Coxe, Inventor,—Deceased.
By their Attorney,
F. A. Richards.

UNITED STATES PATENT OFFICE.

ALEXANDER B. COXE, OF DRIFTON, PENNSYLVANIA, AND HENRY B. COXE, OF NEW YORK, N. Y., EXECUTORS OF ECKLEY B. COXE, DECEASED.

ART OF AND APPARATUS FOR CONTROLLING OPERATION OF TRAVELING-GRATE FURNACES.

SPECIFICATION forming part of Letters Patent No. 562,068, dated June 16, 1896.

Application filed January 21, 1896. Serial No. 576,350. (No model.)

To all whom it may concern:

Be it known that ECKLEY B. COXE, deceased, late a citizen of the United States, residing in Drifton, in the county of Luzerne and State of Pennsylvania, invented certain new and useful Improvements in the Art of and Apparatus for Controlling the Operation of Traveling-Grate Furnaces, of which the following is a specification.

This invention relates in part to that class of furnaces described in Letters Patent of the United States No. 499,716, dated June 20, 1893, in which a fuel-traveling-grate mechanism is employed for imparting a normally continuously-advancing movement to the fuel longitudinally of the furnace-chamber, and in which the fuel spread in a layer upon the grate is, during the advancing movement thereof along the furnace-chamber, subjected to air-blasts of varying efficiencies or pressures at successive points, respectively, in the length of the furnace-chamber, and in which the fuel upon the grate is maintained substantially *in statu quo* during the successive stages of the combustion period.

The invention further relates to the art or method of decarbonizing and burning carbonaceous materials upon a disseminative bed or layer of relatively non-carbonaceous material, and this part of the present invention is, in some respects, in the nature of an improvement upon the method described and claimed in Letters Patent of the United States No. 499,715, dated June 20, 1893, to which reference may be had.

In large steam-plants, such as the power plants of electric-lighting stations and the plants of other industrial establishments, where large and variable amounts of power are required, it is frequently necessary to effect a reduction in the generation of steam for a longer or shorter period of time, according to requirement, and where traveling-grate furnaces, such as described in the Letters Patent hereinbefore referred to, are employed this reduction in steam generation is usually effected by stopping the traveling movement of the fuel-carrying grate and reducing or cutting off the air-blast from below, the fuel upon the grate being kept burning only for maintaining the furnace in readiness for immediate operation. This method of temporarily reducing the efficiency of the furnace without undue waste of fuel might be satisfactory if it were not for the fact that the heat naturally confined by reducing or cutting off the air-blast has a tendency to reverberate through the fuel lying dormant upon the grate, thus overheating and materially impairing the life of said grate.

One object of the present invention is to furnish an improved method and instrumentality whereby two independent layers of carbonaceous and non-carbonaceous disseminative materials may be relatively superimposed and synchronously advanced during the decarbonizing and burning of the carbonaceous layer upon the non-carbonaceous layer.

A further object of the invention is to furnish an improved method and instrumentality whereby the mass of carbonaceous material is spread in a layer, is ignited and progressively advanced, and is subjected, during the advancing movement thereof, to an air-blast from below, and whereby a protective layer of non-carbonaceous disseminative material is introduced between the carbonaceous layer and air-blast during the advancing movement of said carbonaceous layer, and is advanced in synchronism with said carbonaceous layer and during the decarbonizing and burning of said carbonaceous layer upon the non-carbonaceous layer, and whereby the advancing movement of said two layers may be arbitrarily retarded.

A further object of the invention is to provide an improved furnace of the class specified and an improved method whereby the ignited fuel, spread in a layer upon the traveling grate, will have a normally-continuous advancing movement along the furnace-chamber, will be subjected to an air-blast from below, and be maintained substantially *in statu quo* during the successive stages of decarbonization or during the successive stages of the combustion period, and whereby the decarbonized fuel residuum may be arbitrarily introduced in a layer of predetermined thickness between the grate and the fuel upon the grate during the traveling movement thereof

to separate the fuel from and prevent the overheating of the grate, as will be hereinafter more fully described.

In the drawings accompanying and forming part of this specification, Figure 1 is a sectional side elevation of a portion of the forward end of a traveling-grate furnace embodying the present improvements, said figure showing a protective layer of material interposed between the layer of fuel and the traveling grate. Fig. 2 is a front end elevation of the furnace, parts of the grate-actuating mechanism being broken off. Fig. 3 is a sectional plan view of that end of the furnace shown in Fig. 1, the grate-protecting layer and fuel not being shown. Fig. 4 is a vertical cross-sectional view of the furnace, taken in dotted line *a a*, Fig. 1, and looking toward the right hand in said figure, the grate-protecting layer of material and the fuel not being shown. Figs. 5, 6, 7, and 8 are sectional side views illustrating four successive steps in the operation of introducing a layer of protective material between the grate (which, in these figures, is only represented in outline) and the fuel, Fig. 5 showing the protective layers extended but a short distance under the forward end of the fuel, Fig. 6 showing the protective layers extended about midway of the left of the layer of fuel, Fig. 7 showing the protective layer extended nearly to the end of the layer of fuel, and Fig. 8 showing the protective layer as having been cut off and a portion of the forward end of the fuel layer as resting upon the grate.

Similar characters of reference designate like parts in all the figures of the drawings.

In the drawings only so much of a boiler-heating furnace is shown as is necessary for illustrating the construction and mode of operation of the improvements and as is necessary for illustrating the method or art of controlling the operation of furnaces in accordance with this present invention.

According to the process described and claimed in the Patent No. 499,715, hereinbefore referred to, it will be remembered that a fuel-traveling furnace-floor or endless grate was employed for carrying the fuel with a normally-continuous advancing movement throughout the furnace-chamber, and that the carbonaceous material or fuel to be burned was, according to that process, first deposited in a mass or layer at proper distance upon the furnace-floor, then ignited, and during the advancing movement thereof subjected to air-blasts from below of successively-reduced pressures, either continuously or intermittently, at successive points in the length of the traveling movement thereof, and, furthermore, that the layer of fuel was maintained substantially *in statu quo* throughout the successive stages of its traveling movement, and to avoid prolixity in the description of the present invention it is here desired to state that this method of the operation of the furnace may consistently apply, part, to the operation of the furnace shown in the drawings and hereinafter more fully described, it being practically a preparatory or an associate method to the method constituting a part of the subject-matter of this present invention.

In the preferred form thereof herein shown and described the furnace which comprehends the mechanical instrumentalities of the present invention may, in a general way, be similar to the furnace shown and described in the Patent No. 499,716, hereinbefore referred to, it being understood, however, that the mechanical instrumentalities are applicable to other forms of traveling-grate furnaces within the scope and limits of the present invention.

The furnace herein shown has the usual furnace-chamber C, which will be inclosed in the usual manner by suitable side and end walls, and will be provided with a suitable roof. At the forward end of the furnace this is shown provided with two supply-hoppers II and II′, whose discharge ends are in close proximity to and in direct communication with the upper run of the traveling grate, one of said hoppers, as II, constituting the fuel-supply hopper and being located between the other hopper and the front end wall of the furnace-chamber, and the other hopper, as II′, constituting a protective-layer-supply hopper for introducing a layer of non-combustible material between the upper run of the grate and the fuel, as will be hereinafter more fully described.

The floor of the furnace consists of the upper run 10 of an endless traveling grate, (designated in a general way by G,) which is carried upon suitable grate-carrying wheels or chain-wheels that are supported upon shafts 13 and 15, journaled in suitable bearings on the framework or side walls of the structure. This endless grate may be of the same general construction as the traveling grate described in Letters Patent No. 515,656, dated January 27, 1894.

As in the Patents Nos. 499,715 and 499,716, hereinbefore referred to, the furnace is shown in the present instance (see Figs. 1 and 4) having a series of air-blast chambers located below and having the outlets contiguous to the fuel-carrying run or upper run 10 of the endless grate, only a portion of three of said air-blast chambers being herein shown, which are designated by *a*, *b*, and *c*, respectively. These chambers preferably have communication with one another through valve-regulated openings *e* in their separating-partitions and will usually be supplied with air from a suitable blower, (not shown,) having an air-conduit 8 in communication with one of said chambers, as will be understood by a reference to Figs. 1, 2, and 4 of the drawings.

The method of supplying air at varying pressures or at successively-reduced pressures at successive points in the length of the fuel-carrying run of the grate may be

substantially the same as the method hereinbefore described in connection with Patent No. 499,715.

When a furnace is operating to its fullest capacity, the fuel is fed directly upon each section of the grate or before this reaches the fuel-supply chamber *a* and is thus carried along, maintained substantially *in statu quo* over this chamber *a* and the succeeding chambers, during which period the combustible material is consumed and the resultant ash or decarbonized residuum is delivered over to the rearward end of the grate into a suitable ash-pit, (not shown,) which may constitute 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-chamber or throughout the entire length of the fuel-supporting run of the grate, the ignition of the fuel taking place within a short distance of the point where said fuel falls upon the grate and said fuel being completely reduced to ash by the time it reaches the rearward end of the grate or the last combustion area of the furnace-chamber.

For the purposes of the present invention and as one instrumentality for carrying out the method herein described the furnace is shown provided at the forward end thereof with two adjacent supply-hoppers H and H′, whose discharge ends are set contiguous to each other and which are constructed and organized to deliver their respective materials directly upon the grate alternately or in superimposed layers arbitrarily, as will be hereinafter more fully described.

The hopper H, which is intended for supplying the carbonaceous material or fuel to the grate, may for convenience be herein termed the "main" hopper or the "fuel-supply" hopper, and the hopper H′, which is intended for supplying the decarbonaceous or non-combustible protective material to the grate, may for convenience be herein termed the "auxiliary" hopper or "protective-material-supply" hopper.

In the preferred form thereof herein shown and described the two hoppers H and H′, which, as a unitary structure, may be herein referred to as the "duplex-hopper" apparatus, comprises the two side walls 20 and 20′, the vertically-disposed transverse front end wall 21, the transverse rear end wall 22, and the transverse dividing partition or wall 23, located approximately midway between the two end walls 21 and 22, and dividing the space between the two said end walls into two compartments which constitute the two hoppers H and H′ proper.

The side walls 20 and 20′, the front end wall 21, and the intermediate wall 23 are shown structurally integral, and furnished with side flanges 24, 24′, and 24″, which form a means for attaching the duplex hopper to the end wall of the furnace and to the framework F of the grate-mechanism chamber.

The two hoppers H and H′ are open at their lower ends, and the two walls 22 and 23 thereof terminate above the horizontal plane of the lower edges of the side walls of said hopper, as will be understood by reference to Fig. 1 of the drawings, which lower edge of the side walls of the hopper terminate in planes coinciding substantially with the horizontal plane of the fuel-supporting face of the upper run of the traveling grate.

Each hopper H and H′ is furnished with a vertically-adjustable part adapted for coacting with the upper run of the traveling grate, which upper run, in this instance, constitutes a traveling floor for the two hoppers to control the space between the upper run of the traveling grate and said adjustable part and to regulate the thicknesses of the respective layers of material during the advancing movement of said upper run. These adjustable parts are shown independently adjustable toward and away from the upper run of the traveling grate and have a slight adjustment toward and away from one another, owing to the inclination of one of them relatively to the other.

In the form thereof herein shown and described the adjustable parts of the supplemental hopper H′ are in the nature of a sliding gate 25, supported between ways in juxtaposition to the front face of the intermediate partition 23, which constitutes the rear wall of said hopper H′, as well as the front wall of the hopper H, and the adjustable parts of the hopper H are shown as the rear wall 22 of said hopper, which rear wall will be guided in its adjustments preferably by a fixture upon the side walls of the hopper.

As a means for independently adjusting the adjustable parts 22 and 25 of the two hoppers H and H′, respectively, said parts are provided with adjusting devices, which are designated by K and K′, respectively, the one K being shown as a bolt 26, fixed to the part 22, and having the upper screw-threaded end thereof extended through a bearing 26′, secured to the front end wall of the furnace-chamber C, a screw-threaded end of the bolt being furnished with an adjusting-nut 26″, by means of which the part 22 may be adjusted toward and away from the upper run of the traveling grate, and the adjusting device K′ is shown as a rod 27, fixed to the adjustable part 25, and having the upper screw-threaded end thereof extended through a bearing 27′, fixed to the upper end of the partition 23, the upper screw-threaded end of said rod being shown furnished with a handle-nut 27″ for adjusting the part 25 toward and away from the upper run 10 of the grate.

In the present instance the ignition block or wall usually employed in furnaces of this class and located between the discharge end of the fuel-supply hopper and the upper run of the fuel-traveling grate is dispensed with and the rear fuel-supporting wall 22 of the hopper H is located considerably in advance

of the front face of the front end wall of the furnace.

The adjustable hopper-wall 22 is shown in the nature of an oblong relatively narrow box closed at the upper end and open at the lower end thereof to form a protecting air-space 29 between the front fuel-supporting wall thereof and the front wall of the furnace-chamber C, and, as an additional protection against overheating, the box-like wall 22 of the hopper H is furnished with a reverberatory wall or partition 30, of relatively non-heat-conducting material, which is located between the box-like wall 21 and the forward end of the furnace-chamber, and which is constructed and organized relatively to the wall 22 for adjustment toward and away from the fuel-supporting run of the grate in connection with said wall 22, and is adapted for deflecting the products of combustion at the ignition end of the furnace-chamber C and for preventing in a great measure the overheating of the air contained in the protective air-space 29, and consequently prevents the overheating of the fuel contained in the hopper.

As a means for cutting off the supply from the supplemental hopper H′ said hopper is furnished with a sliding cut-off gate 31, which extends horizontally through an opening formed in the front wall 21 of said hopper and has the outer end thereof shiftably supported in the slideway 32, secured to the upper side of the grate-mechanism frame F, and, as a convenient means for moving the cut-off gate inwardly and outwardly relatively to the hopper H′, an adjusting device K^2 is provided, which, in the form thereof herein shown, consists of an adjusting-screw 33, fixed to the outer end of said gate and having its screw-threaded outer end seated in a bearing 34, secured to said framework F, the outer screw-threaded end of said adjusting-screw being furnished with a handle-nut, by means of which the screw 33, together with the cut-off gate, may be moved inwardly and outwardly relatively to the hopper H′.

It is desired to state in the above connection that the specific construction and organization of the parts of the duplex hopper and associated parts may be variously modified within the scope and limits of the present invention.

When the furnace is in operation, the main hopper H is kept constantly supplied with the carbonaceous material, such as coal or other fuel, and the supplemental hopper H′ is kept constantly supplied with non-carbonaceous or non-combustible material, such as ash or the decarbonized residuum of the fuel contained in the main hopper H after the same has passed through the successive stages of the combustion period.

In the ordinary operation of the furnace the cut-off gate 31 will be in its closed position, cutting off the supply of non-carbonaceous material from the grate, and the fuel from the main hopper H′ will be fed directly upon the grate, as illustrated in Fig. 8 of the drawings.

When it is desired to reduce the heating efficiency of the furnace or slow down the grate, the cut-off gate 31 will open to the position shown in Fig. 5, allowing the non-carbonaceous protective material contained in the hopper H′ to fall upon the grate and be carried, by the advancing movement of the grate, under the stream of fuel from the main hopper H, which fuel during this operation will be deposited upon the advancing layer of non-carbonaceous material interposed between the fuel and the grate. A further advancing movement of the traveling grate carries the superimposed layers of carbonaceous and non-carbonaceous materials successively to the positions shown in Figs. 6 and 7, respectively, and after the entire layer *g* of fuel upon the grate is separated from said grate by the non-carbonaceous protective layer *g′* the movement of the grate may be slowed down or stopped without fear of the heat from the fuel layer *g* overheating and injuring the upper run of said grate.

Although it is preferable to employ ashes as a protective medium, it will be obvious that any suitable non-combustible or non-heat-conducting material might be employed in lieu thereof.

By the construction and organization of apparatus herein shown and described for carrying out the present improved method the carbonaceous material or fuel may be deposited directly upon the grate independently of the non-carbonaceous material, and the thickness of the layer so deposited may be increased or decreased at will, and a protective layer of non-carbonaceous material of any requisite thickness may be arbitrarily introduced between the layer of fuel and the grate to protect the grate from undue heat arising from the burning fuel.

Having thus described the invention of ECKLEY B. COXE, what we claim as new, and desire to secure by Letters Patent, is—

1. That improvement in the art of treating matter, which consists in superimposing layers of carbonaceous and non-carbonaceous materials; subjecting said superimposed layers to an air-blast at successively different points; and burning and decarbonizing the carbonaceous layer.

2. That improvement in the art of treating matter, which consists in first igniting a mass of carbonaceous material spread in a layer; successively subjecting portions of said layer to the action of an air-blast; introducing a protective layer of non-carbonaceous material between the ignited carbonaceous material and the air-blast; feeding the two layers in synchronism; retarding the movement of said layers; and subsequently readvancing them while under the action of the air-blast; and, finally, stopping the supply of non-carbonaceous material.

3. That improvement in the art of decar-

bonizing and burning carbonaceous material, which consists in igniting a mass of carbonaceous material spread in a layer of predetermined thickness; advancing said layer, and subjecting successive portions in the length thereof to an air-blast; reducing the normal thickness of the carbonaceous layer; and reducing the effective action of the air-blast upon said carbonaceous layer by the introduction of a layer of non-carbonaceous, disseminative material of predetermined thickness between the carbonaceous layer and the air-blast, and simultaneously advancing both layers.

4. That improvement in the art of decarbonizing and burning carbonaceous materials, which consists in spreading a mass of carbonaceous material in a layer of predetermined thickness, and igniting the same; subjecting successive portions of said layer to an air-blast, successively, while advancing said layer with relation to said air-blast; maintaining said burning layer substantially *in statu quo* during the successive stages of the combustion period; reducing the normal thickness of the burning, carbonaceous layer, and separating the same from the air-blast by the introduction of a layer of non-carbonaceous material between the carbonaceous layer and air-blast during the advancing movement of said carbonaceous layer.

5. That improvement in the art of decarbonizing and burning carbonaceous materials, which consists in spreading a mass of carbonaceous material in a layer of predetermined thickness, and igniting the same; subjecting the carbonaceous layer to air-blasts of successively-reduced pressures at successive points in the length thereof while advancing said layer with respect to the successive air-blasts; maintaining the layer substantially *in statu quo* during the successive stages of the combustion period; and subsequently reducing the normal thickness of the carbonaceous layer, and reducing the normal, effective action of the air-blasts by the introduction of a layer of non-carbonaceous material of predetermined thickness between the carbonaceous layer and the air-blasts during the advancing movement of the two layers.

6. In a furnace of the class specified, the combination with the furnace-chamber and with the traveling grate; of two supply-hoppers set with their discharge ends in juxtaposition to the traveling grate, and each having an adjustable part; and means for adjusting said parts toward and away from the traveling grate.

7. In a furnace of the class specified, the combination with a furnace-chamber and a traveling grate; of two supply-hoppers located in advance of the front wall of the furnace-chamber and in advance of one another, and with their discharge ends in juxtaposition to the traveling grate, and each having an adjustable part, and one of which parts directly adjoins the front wall of the furnace-chamber; and means for independently adjusting said parts.

8. In a furnace of the class specified, the combination with the furnace-chamber and the fuel-traveling grate; of two supply-hoppers supported, one in advance of the other, at the forward end of the furnace-chamber, and having an air-space between the front end wall of the furnace-chamber and the next adjacent supply-hopper.

9. In a furnace of the class specified, the combination with a furnace-chamber having a fuel-supply opening through the front wall thereof, and with a traveling grate; of two supply-hoppers set one in advance of the other and in advance of the furnace-chamber with their discharge ends in juxtaposition to the traveling grate; two adjustably-supported parts, one of which is hollow and is located to constitute a cut-off for the supply-opening in the front wall of the furnace-chamber, and the other of which is located to constitute a cut-off for the discharge-opening of the foremost supply-hopper; and independent means for adjusting said parts.

10. In a furnace of the class specified, the combination with the furnace-chamber, and with the fuel-traveling grate; of two supply-hoppers located, one in advance of the other, with their discharge ends in juxtaposition to the grate; and one of said hoppers having a box-like adjustable rear wall adjoining the front wall of the furnace-chamber, and the other of said hoppers having a cut-off gate, which is adjustable in a plane substantially parallel to the plane of the fuel-carrying run of the grate; and means for adjusting the box-like wall and the cut-off gate in places substantially at right angles to one another.

11. In a furnace of the class specified, the combination with the furnace-chamber and with the fuel-traveling grate; of a duplex hopper comprehending two side walls secured to the framework of the furnace; a front end wall; a rear end wall adjustably supported adjacent to the front end wall of the furnace-chamber; a rigid, intermediate wall having a gate adjustably connected therewith; a horizontally-disposed cut-off gate extending through the front end walls; and means for moving said horizontally-disposed gate inwardly and outwardly relatively to the hopper.

ALEXR. B. COXE,
HENRY B. COXE,
Executors of the estate of Eckley B. Coxe, deceased.

Witnesses:
FRANCIS H. RICHARDS,
W. ALEX. ROBINSON.