(No Model.) 3 Sheets—Sheet 1.

F. H. RICHARDS.

PROCESS OF AND APPARATUS FOR BURNING FUEL.

No. 535,413. Patented Mar. 12, 1895.

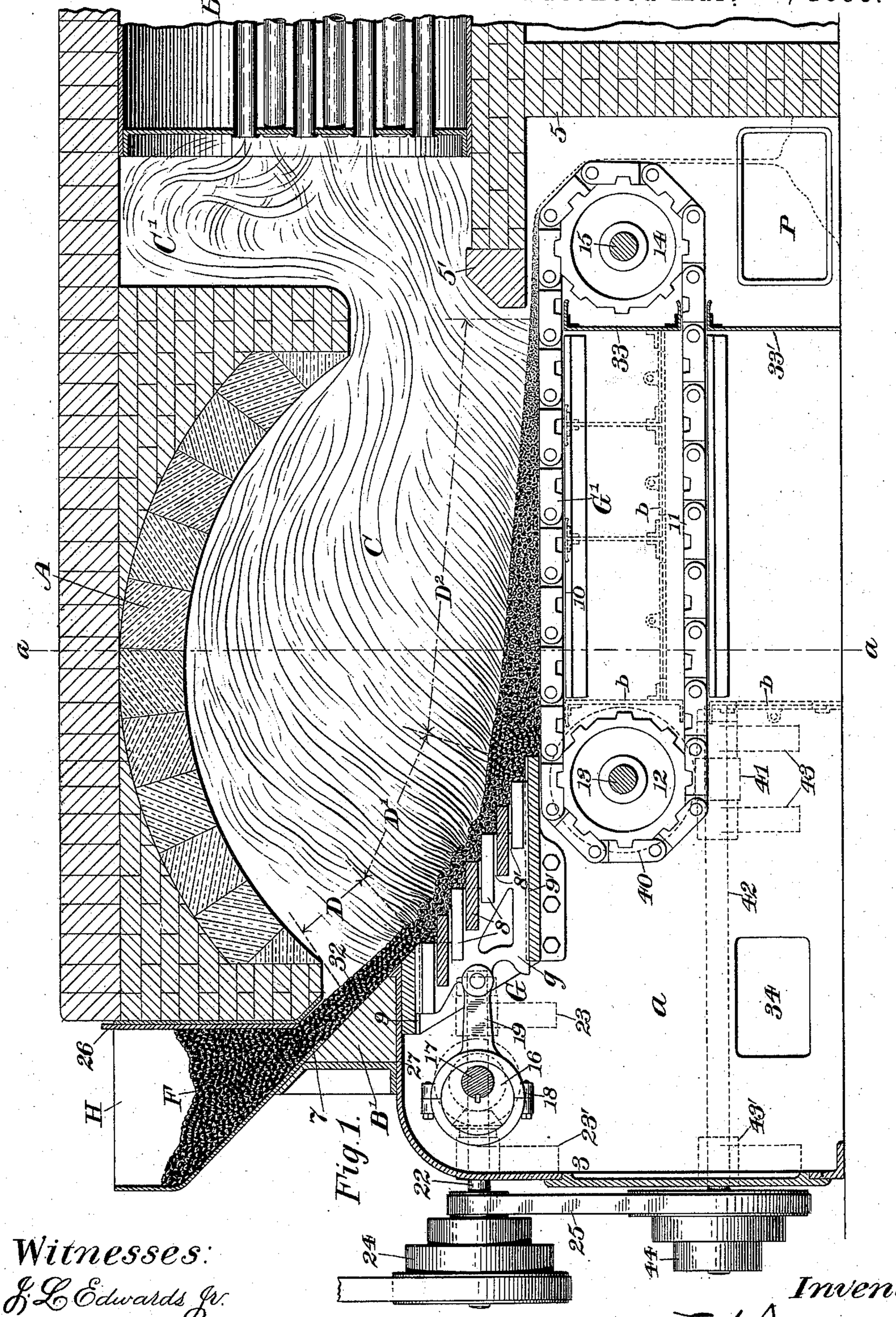

Fig. 1.

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(No Model.) 3 Sheets—Sheet 2.

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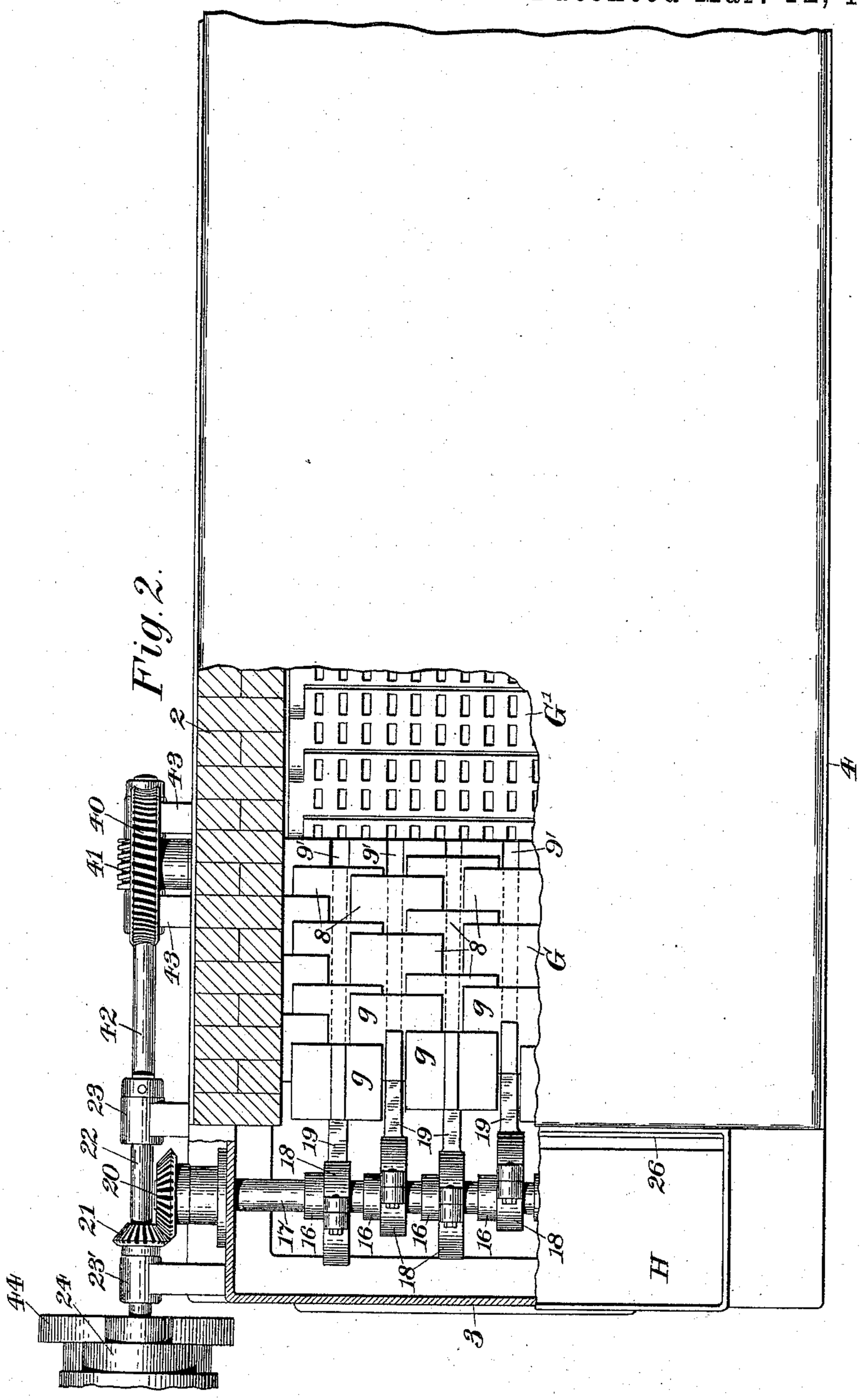
No. 535,413. Patented Mar. 12, 1895.

Fig. 2.



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(No Model.) 3 Sheets—Sheet 3.

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PROCESS OF AND APPARATUS FOR BURNING FUEL.

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Fig. 3.

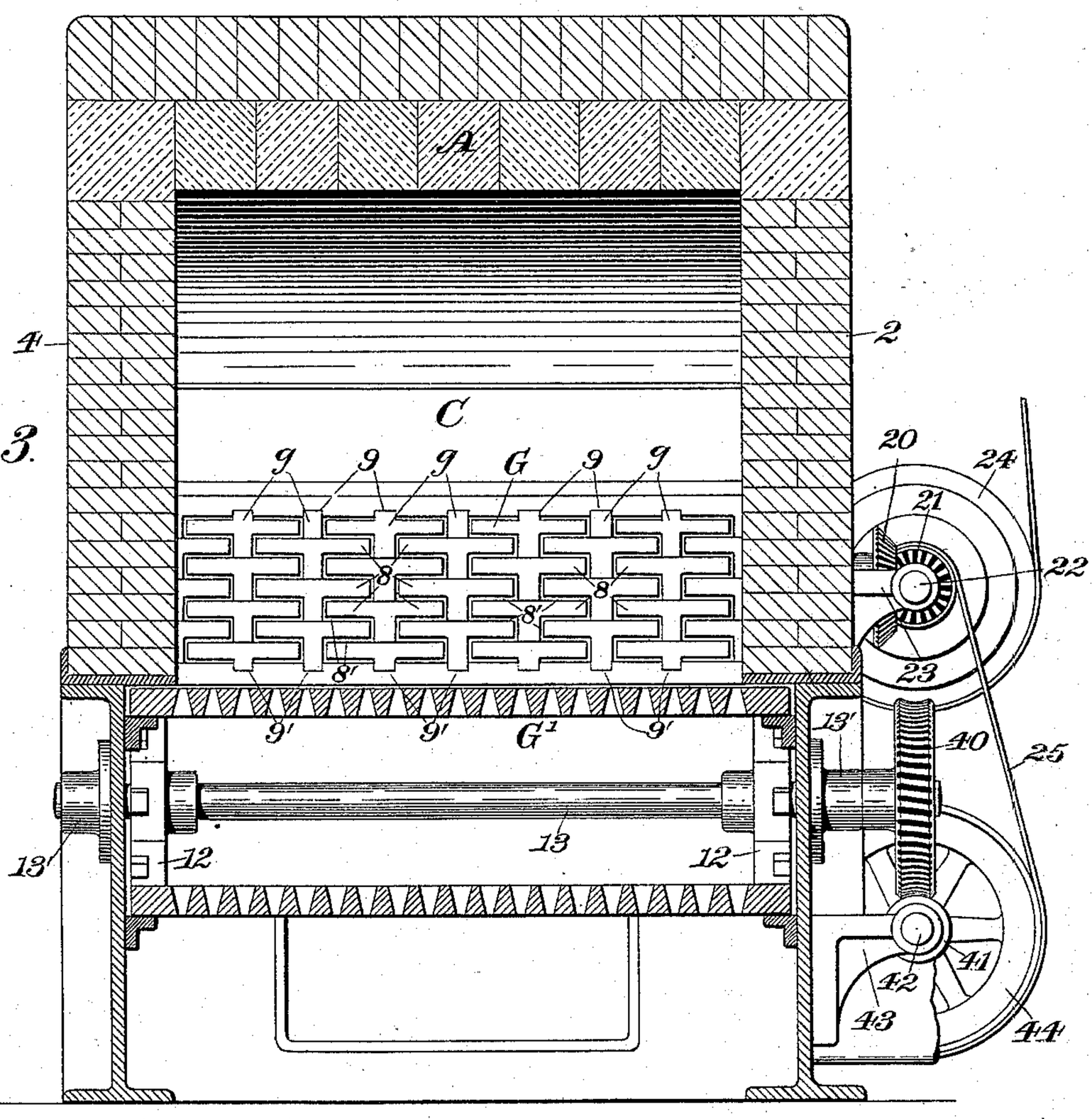

Fig. 4.

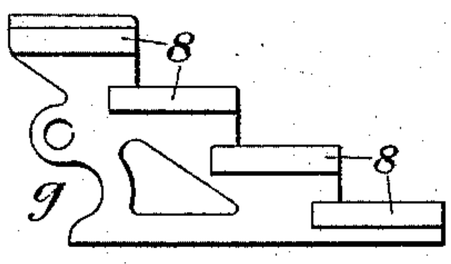

Fig. 5.

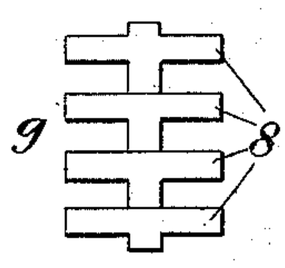

Fig. 6.

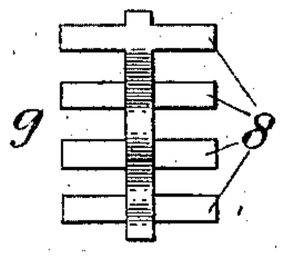

Fig. 7.

Fig. 8.

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UNITED STATES PATENT OFFICE.

FRANCIS H. RICHARDS, OF HARTFORD, CONNECTICUT, ASSIGNOR TO ECKLEY B. COXE, OF DRIFTON, PENNSYLVANIA.

PROCESS OF AND APPARATUS FOR BURNING FUEL.

SPECIFICATION forming part of Letters Patent No. 535,413, dated March 12, 1895.

Application filed October 30, 1894. Serial No. 527,424. (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 Processes of and Apparatus for Burning Fuel, of which the following is a specification.

This invention relates to processes of and apparatus for burning fuel, and resides more particularly in the process which is in the nature of an improvement on the process described and claimed in Letters Patent of the United States No. 499,715, granted to Eckley B. Coxe June 20, 1893, to which reference may be had.

The object of my present invention is to furnish an improved process and apparatus adapted, not only for burning the smaller sizes of anthracite coal, including those sizes known in the market as "pea," "buckwheat," &c., but also adapted for burning the smaller sizes, or crushed, bituminous or semi-bituminous coal with economy and efficiency, and with the best practical results for heating purposes.

In the drawings accompanying and forming part of this specification, Figure 1 is a sectional side elevation of a portion of one form of boiler-heating furnace embodying my invention and adapted for carrying out my improved process. Fig. 2 is a plan view of the same with a portion of the upper part of the furnace broken away. Fig. 3 is a transverse vertical section of the furnace, taken in line *a*—*a*, Fig. 1, looking toward the left hand in said figure. Fig. 4 is a side elevation of one of the reciprocatory members of the fuel-agitating grate. Fig. 5 is a rear elevation of said member. Fig. 6 is a front elevation of said member, and Figs. 7 and 8 are side and rear elevations, respectively, of another reciprocatory member of the fuel-agitating grate.

Similar characters designate like parts in all of the figures.

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 my improvements, and, as is necessary for illustrating the successive steps in my improved process of burning fuel.

According to the process described and claimed in the Patent No. 449,715 hereinbefore referred to, it will be remembered that a fuel-traveling furnace-floor was employed for carrying the fuel throughout the furnace-chamber and that the coal or other fuel to be burned is, according to that process, first placed in a mass or layer of proper thickness upon the furnace-floor, is then ignited and subsequently subjected to an air-blast the pressure of which is varied or gradually reduced (either continuously or intermittently) during the combustion period, so that the ignited mass is subjected to varying or successively-reduced pressure-blasts during the successive stages of the said combustion period; and furthermore it will be remembered that said layer of fuel is maintained substantially *in statu quo* during the entire series of the successive stages of the combustion period, no portion or portions thereof being subjected to agitation during combustion.

In practice, it has been found highly advantageous for the facilitation of combustion, especially when bituminous coal is used to subject the fuel, during its traveling movement, to slight agitation during the earlier stages of the combustion period, or those stages of the combustion period immediately preceding the preparatory stage or the ignition period, and to subject said agitated mass of fuel to aeration by a relatively high-pressure air-blast; in that a slight agitation of the fuel at this stage in the combustion period loosens and intermixes the fuel to such an extent as to prevent fusion, and practically obviates autogenous soldering of the congruous elements of the material into a homogeneous mass, and by aerating this agitated mass through the medium of a relatively high-pressure blast, said mass is practically freed from minute particles, such as dust, which minute particles will be consumed by the superheated atmosphere of the furnace-chamber, after which, said material may be delivered into position for further treatment in the process of combustion, in a refined or purified and separated condition.

Therefore, my present invention in part, particularly resides in an improved process of burning fuel, which consists in first feeding

the fuel in a continuous and continuously-advancing, and relatively thin, layer or stream, and simultaneously heating said layer without aeration, next igniting and moving said relatively thin layer onward and simultaneously subjecting the same to agitation and aëration to thereby bring the layer, at this point in the combustion period, to a high state of incandescence, without materially increasing the thickness of said layer, and next re-forming the advancing incandescent layer into a relatively thick layer, and moving said relatively thick layer onward, and subjecting the same to aeration without agitation, and maintaining the same substantially *in statu quo* during the latter successive stages of the combustion period, as will be hereinafter more fully described.

In the preferred form thereof herein shown and described, the furnace for carrying out my improved process may, in a general way, be similar to the furnace shown and described in the patent hereinbefore referred to, it having a furnace-chamber, C, inclosed at its sides and ends by the side-walls, 2 and 4, and end-walls, 3 and 5, and is covered by a reverberatory-roof, A, the construction and function of which will be hereinafter described. The furnace is also shown provided with a flue-boiler, B, at the rearward end thereof and is also shown having a combustion-chamber, C′, at the rearward end of the furnace-chamber, C, and immediately adjacent to the forward flue-sheet of the boiler, B.

As a means for carrying the fuel, designated by F, longitudinally of the furnace-chamber and maintaining the same substantially *in statu quo* during the latter stages of the combustion period and to agitate and intermix the same at a point coinciding with the first stages of the combustion period, I have provided a furnace-floor which, in the preferred form thereof herein shown and described, consists of two separate and independently-operable grates, designated in a general way by G and G′, respectively, the one G, which will be herein termed the "fuel-agitating grate," being shown in the nature of a reciprocatory stoking grate and being supported with its receiving end contiguous to the front end of the furnace-chamber and in oblique alignment with the delivering end of the chute, 7, of a fuel-supply hopper, H, located at the front end of the furnace; whereas the grate, G′, is in the nature of a progressively-movable endless chain grate and may be similar in construction and organization to the endless chain grate shown in the Patent No. 499,715 hereinbefore referred to, said chain grate, G′, being supported for traveling movement longitudinally of the furnace-chamber with its receiving end below the delivering end of and in position to receive the fuel as it is delivered from the fuel-agitating grate G; the delivering end of said endless grate extending under and in close proximity to a bridge-wall, 5′, in a manner similar to that shown in the patents hereinbefore referred to. This grate is carried at the opposite ends of its circuit by chain-wheels, 12 and 14, which are carried upon shafts, 13 and 15, journaled in suitable bearings, 13′ and 15′, upon the side-walls of the furnace-structure. As a means for actuating said endless grate to impart a continuous movement to the fuel supported thereon, the shaft 13 is provided at one end thereof with a worm-wheel, 40, which meshes with a worm, 41, on a driving-shaft, 42, which shaft is supported in suitable bearings, 43 and 43′, upon the frame-work, and is shown provided at one end thereof with a cone-pulley, 44, which is preferably driven in a manner hereinafter more fully described.

In the form thereof herein shown and described, the reciprocatory stoker or fuel-agitating grate, G, comprises a series of inclined members or sections, *g*, each having a series of horizontally- and remotely-disposed fuel-supporting steps, 8, and supported at their upper and lower ends for horizontal reciprocation in guide-ways, 9, and 9′, preferably formed by transverse plates secured to the side-walls of the furnace-structure. These members, *g*, are so disposed relatively to each other that the fuel-supporting shelves or steps, 8, of one member will overlap the shelves or steps of the next adjacent member in such manner as to leave air-spaces, 8′, between the overlapping fuel-supporting steps.

As a means for actuating the reciprocatory or fuel-agitating grate so that certain of the members thereof shall have an advancing movement during the retracting movement of others of said members, I have provided a grate-actuating mechanism which in the preferred form thereof herein shown, consists of a series of eccentrics, 16, carried upon a transverse shaft, 17, journaled in suitable bearings in the side-walls of the furnace-structure, and connected, each of said eccentrics, with a grate-member, *g*, by means of an eccentric-strap, 18, and connecting-rod or link, 19, as will be readily understood by reference to Figs. 1 and 2 of the drawings.

As a means for actuating the shaft, 17, to impart a reciprocatory movement to the several grate-members, *g*, said shaft is shown provided at one end thereof with a bevel-gear, 20, which meshes with a bevel-gear, 21, of relatively small size, upon a shaft, 22, journaled in bearings, 23 and 23′, upon the side-walls of the furnace-structure, which shaft, 22, is provided at one end thereof with a cone-pulley, 24, which may be driven from any suitable source of power (not shown).

As a means for operating the fuel-agitating grate, G, and the non-agitating grate, G′, at comparative velocities of varying ratios, the driving-shafts of these two grates are preferably operatively connected together, as most clearly shown in Figs. 1, and 3, by a belt, 25, extending over the two pulleys, 24 and 44, upon the shafts, 22 and 42, respectively, the relative difference in the velocities of the two

grates, G and G′, being governed by variable speed-gearing, as shown in, and as will be understood by reference to, Figs. 1, 2 and 3 of the drawings.

In practice, that portion, G, of the furnace-floor (herein termed the fuel-agitating grate) immediately adjacent to the ignition end of the furnace-chamber will have a relatively rapid fuel-traveling movement, and that portion, G′, of the furnace-floor (designated the endless grate) immediately adjacent to the portion G of the furnace-floor, will have a relatively slow fuel-traveling movement, so that, in operation, the layer of fuel, F, as it passes from the front portion, G, to the rear portion, G′, of the furnace-floor will be re-formed into a relatively thick layer, as will be hereinafter more fully described.

As a convenient means for regulating the supply of fuel to the furnace-floor, to secure the requisite thickness of layer at the ignition end of the furnace-chamber, the fuel-supply hopper, H, will usually be provided with a suitable gate, 26, for increasing or decreasing the effective area of the outlet opening of said hopper.

Between the hopper, H, and the receiving end of the furnace-floor, I place a block, B′, designated as the ignition-block, over which the fuel passes in its descent from the hopper, H, to the furnace-floor. This ignition-block, B′, has its inclined surface or "slope" set facing the furnace-chamber and is preferably constructed of refractory material of low conductivity, such as fire-brick or other furnace-building material of similar character. Said block or hot-slope is supported upon a suitable plate or beam, 27, of the furnace-structure. The ignition-block is set in close proximity to the receiving end of the furnace-floor with its inclined face in substantial alignment with the normal "angle of repose" of the fresh fuel, so that the stream or layer falling down over said block will be subjected, in a continuous and continuously moving layer, to heating, simultaneously, from above and below without aeration, thus preparing the fuel for sudden subsequent ignition. The ignition-block is designated as "non-aerating" for the reason that it is so made as to protect the fuel, during the preparatory heating, from the admission of air from below, which admission of air would tend to prematurely liberate and ignite the gases of the fuel, and would also cool said block and thereby prevent the proper underheating of said fuel.

In accordance with my present process, the fuel, F, is delivered to the forward end of the furnace-floor in a relatively thin stream without aeration or agitation; is then ignited and advanced and, during the earliest stages of the combustion period, is simultaneously subjected to agitation and aeration, without materially increasing the thickness of said layer, after which this thin incandescent or partially consumed layer is re-formed into a relatively thick layer and further advanced without agitation, throughout the entire length of the furnace-chamber, and is maintained substantially *in statu quo* during the latter stages of the combustion period.

The arched roof, A, of the furnace-chamber is set to reflect a portion of the heated rays of the furnace backward and downward upon the ignition-block, B′. This arrangement has the effect of increasing the efficiency of the apparatus for the heating of the incandescent stream of fuel upon the said ignition-block. In passing downward over said block the inclined column, 32, of granular fuel that naturally partakes of the usual movements of the stream has within itself variable rates of movement; so that during the descent of the fuel over the inclined surface of the block, B′, the particles of the fuel are shifted or turned over more or less and are thereby more fully exposed to the action of the heated gases within the furnace-chamber.

For a full illustration of the principle of the invention, reference should now be had to Fig. 1 of the drawings, where the layer of fuel is shown divided longitudinally into three spaces or divisions, designated by D, D′ and D^2, respectively, which correspond in position to three successive stages in the combustion period of the fuel. The division D, represents the preparatory heating area of the fuel, at which point the fuel is subjected to heating from above and below without aeration, and conditioned for subsequent sudden ignition. The division D′ represents the ignition and relatively high combustion area, at which area the advancing layer of fuel is ignited, agitated and intermixed, and aerated by a relatively high-pressure air-blast from below, to bring this portion of the layer of the fuel to a high state of incandescence, separate the minute particles, such as coal-dust, from said layer and force them outward into the combustion-chamber, and at the same time practically obviate autogenous soldering of the congruous elements of the material into a homogeneous mass, and condition them for a further treatment in a purified and separated condition, and the division D^2 represents the last or completing stages of the combustion area, or that portion of the fuel-area immediately in advance of the agitated portion of the layer and where the fuel is re-formed into a relatively thick layer and maintained substantially *in statu quo* during its traveling movement, throughout this area or throughout the latter stages of the combustion period.

In practice, it is desirable to subject the successive fuel-areas, D′ and D^2, to forced air-blasts of varying pressures to facilitate and promote combustion, the best results being obtained by subjecting the fuel-area, D′, to a relatively high-pressure air-blast and to subject the fuel-area represented by D^2 to an air-blast, which is of gradually reduced pressure, from the forward to the rearward end of said area so as to burn the fuel somewhat after the

method described in Patent No. 499,715, hereinbefore referred to. The action of the air-blasts upon the layer of fuel, in the present instance, being substantially the same as in the patent referred to, but, owing to the changes in condition of the fuel during its traveling movement and at different points in the length of the combustion period, the effect of the air-blast differs materially from the effect described in said patent, as do also the results attained thereby.

As a means for supplyiug air to the fuel, I have provided an air-blast apparatus which, in the preferred form thereof shown in full lines in Fig. 1 of the drawings, is in the nature of an air-supply chamber, *a*, which is located below the furnace-floor and extends approximately from end to end thereof, it being closed adjacent to the delivering end of the furnace-floor and being cut off from the area above the furnace-floor by means of transverse partitions, 33 and 33′, one partition 33, of which is located between the upper and lower runs, 10 and 11, respectively, of the endless grate, G, and the one, 33′, of which is located below the lower run, 11, of said grate. This air-supply chamber, *a*, may be supplied with air through the inlet opening, 34, by means of a blower (not shown) or in any suitable manner. This constitutes a very simple and effective air-supply apparatus for the fuel, and, owing to the relatively varying thicknesses and owing to the variation in the density of the fuel at successive points in the length of the layer, it will be seen that the volume of air supplied from the chamber, *a*, through the fuel will be of varying efficiencies at successive points in the length of the fuel-layer and, by regulating the supply of fuel to the furnace-floor, to increase or decrease the thickness of the layer at the successive areas, D, D′ and D². The varying proportions of air-supplies at these successive areas may be nicely adjusted to increase or decrease the effective supply of air to these successive areas and consequently secure the best possible results in the combustion of the fuel and obviating the necessity of employing separate valve-regulated air-supply chambers below and at successive points in the length of the furnace-floor, as described in the patent hereinbefore referred to.

It will be understood, however, that I do not desire to limit myself to the air-supply apparatus just described as, with certain kinds of fuel, it may be desirable to employ, in connection with the furnace-floor, a series of successive air-supply chambers having outlets contiguous to successive fuel-areas as illustrated in lines, *b*, in Fig. 1 of the drawings, which chambers will be adapted for supplying air to the fuel at varying pressures at successive points in the length thereof, as described, for instance, in the patent hereinbefore referred to.

In operation, the fuel-agitating grate, G, which receives the fuel as it descends from the ignition-block B′, will be actuated to impart a relatively rapid advancing movement to the layer, and, at the same time, agitate and intermix the constituents of said layer, delivering the same to the endless grate, G′, which grate, for the purposes of the present invention, has a relatively rapid velocity as compared with the velocity of the grate, G, to thereby carry the fuel to the latter stages of the combustion period, with a relatively slow movement; this difference in the velocities of the two grates G and G′, respectively, causing the fuel to be re-formed, at the adjacent ends of the two grates, into a relatively thick layer which is not subjected to agitation after it leaves the grate, G, but is maintained substantially *in statu quo* through the remaining stages of the combustion period; said layer, of course, being gradually reduced in thickness by consumption as it approaches the last stage of the combustion period, after which the resultant cinder and ash will be carried over the delivering end of the endless grate and discharged into the usual ash-pit, P.

By my improved process and apparatus, I not only secure an acceleration in the combustion of the fuel, but I also secure a more complete consumption of the fuel than is possible with methods and apparatus in which no provision is made for subjecting the fuel to agitation for the purpose of freeing the same from dust, and for obviating autogenous soldering of the congruous elements thereof, and especially is this so in the combustion of bituminous and semi-bituminous coal.

Having thus described my invention, I claim—

1. The herein-described process of burning coal and other fuel, which consists in igniting the mass spread in a layer, subjecting the same to agitation and aeration during the first stages of the combustion-period, maintaining the same substantially *in statu quo* during the latter stages of the combustion-period, and subjecting the same to the action of a forced air-blast during said latter stages, substantially as described.

2. The herein-described process of burning coal and other fuel, which consists in igniting the mass spread in a layer, subjecting the same to agitation during the first stages of the combustion-period, maintaining the same substantially *in statu quo* during the latter stages of the combustion-period, and subjecting the same to the action of a forced air-blast throughout the whole of the combustion-period, substantially as described.

3. The herein-described process of burning coal and other fuel, which consists in igniting the mass spread in a layer, imparting a continuously-advancing movement to said layer, subjecting said layer to agitation during the first stages of the combustion-period, maintaining said layer substantially *in statu quo* during the latter stages of the combustion-

period, and subjecting said layer to the action of a forced air-blast throughout the whole of the combustion period, substantially as described.

4. The herein-described process of burning coal and other fuel, which consists in igniting the mass spread in a layer, subjecting the same to agitation during the first stages of the combustion period, maintaining the same substantially *in statu quo* during the latter stages of the combustion period, and subjecting said layer to an air-blast having varying efficiencies at successive points in the length of the layer, substantially as described.

5. The herein-described process of burning coal and other fuel, which consists in igniting the mass spread in a layer, imparting a continuously advancing movement to said layer, subjecting said layer to agitation during the first stages of the combustion period, maintaining said layer substantially *in statu quo* during the latter stages of the combustion period, and subjecting said layer to an air-blast having varying efficiencies at successive points in the length of the layer, substantially as described.

6. The herein-described process of burning coal and other fuel, which consists in feeding the fuel in a continuous and continuously advancing layer, first in a relatively thin layer downwardly in inclination, and heating the same from above and below, simultaneously, without aeration, next continuing the advancing movement of said layer without materially changing the thickness thereof, and agitating and mixing said advancing layer and simultaneously subjecting the same to aeration, and next re-forming said layer into a relatively thick layer and continuing the advancing movement thereof, maintaining the same substantially *in statu quo* during the latter stages of the combustion period, and subjecting said layer to aeration without agitation during the latter stages of the combustion period, substantially as described.

7. The herein-described process of burning coal and other fuel, which consists in igniting a mass spread in a layer, imparting a continuously-advancing movement to said layer of varying velocities at successive points in the length of its traveling movement to automatically secure varying thicknesses of said layer at different points in the length thereof, and subjecting said layer from below to the action of a forced air-blast, substantially as described.

8. The herein-described process of burning coal and other fuel, which consists in igniting a mass spread in a relatively-thin layer, imparting a relatively rapid advancing movement to said ignited layer and subjecting the same to agitation and aeration, reforming said relatively-thin layer into a relatively-thick layer and imparting a relatively-slow advancing movement to said relatively-thick layer without agitation, and simultaneously subjecting said relatively-thick layer from below to the action of a forced air-blast, substantially as described.

9. The herein-described process of burning coal and other fuel, which consists in igniting a mass spread in a layer, agitating said mass and imparting a relatively-rapid advancing movement thereto during the earlier stages of the combustion-period, imparting a relatively-slow advancing movement to the ignited layer and maintaining the same substantially *in statu quo* during the latter stages of the combustion-period, and subjecting said layer to the action of a forced air-blast throughout the traveling movement thereof, substantially as described.

10. In an apparatus for burning coal and other fuel, the combination with a furnace-chamber, of a fuel-traveling furnace-floor comprising a longitudinally-movable fuel-traveling grate, and a second and independently-operable and progressively- and longitudinally-movable fuel-traveling grate supported in advance of said first-mentioned grate; and means for actuating said grates at relatively varying velocities, substantially as described and for the purpose set forth.

11. In an apparatus for burning coal and other fuel, the combination with a furnace-chamber; of a fuel-traveling furnace-floor comprising a longitudinally-movable fuel-traveling grate, and a second and independently-operable and progressively- and longitudinally-movable fuel-traveling grate supported in advance of said first-mentioned grate; and means in connection with and adapted for simultaneously imparting fuel-traveling movements of relatively varying velocities to said respective grates, substantially as described and for the purpose set forth.

12. In an apparatus of the class specified, the combination with the furnace-chamber and its inclosing walls, of a fuel-traveling furnace-floor comprising two independent fuel-traveling grates supported, one above the other, and adapted for movement longitudinally of the furnace-chamber, means for supplying air to said fuel-traveling furnace-floor from below, and means in connection with and adapted for simultaneously actuating said grates at relatively varying velocities, substantially as described and for the purpose set forth.

13. In an apparatus for burning coal and other fuel, a furnace-chamber, in combination with an endless fuel-traveling grate, supported for movement within and longitudinally of the furnace-chamber, a reciprocatory fuel-agitating grate supported with its delivering end above and adjacent to the receiving end of the endless traveling grate, means in position and adapted for supplying fuel to the receiving end of the fuel-agitating grate and means in connection with and adapted for imparting a circuitous movement to the endless grate and a reciprocatory movement to

the fuel-agitating grate, substantially as described and for the purpose set forth.

14. The herein-described apparatus for burning coal and other fuel, it comprising a furnace-chamber, a fuel-traveling furnace-floor located within said furnace-chamber, and comprising two independent fuel-supporting and fuel-traveling portions supported in different planes and adapted for movement longitudinally of each other, at varying velocities, means for supplying fuel to one of said fuel-supporting portions, means in connection with and adapted for actuating said independent fuel-supporting portions, simultaneously at relatively varying velocities, and means in connection with and adapted for supplying air to said fuel-supporting portions of the furnace-floor, substantially as described and for the purpose set forth.

15. In an apparatus for burning fuel, the combination with a furnace-chamber, of a non-agitating fuel-traveling grate supported for traveling movement at the rearward end of said furnace-chamber, a fuel-supply hopper supported at the forward end of the furnace-chamber, a fuel-agitating grate supported above and intermediate to the non-agitating grate and the fuel-supply hopper, means for supplying air to the fuel supported upon said grates, means for automatically regulating the effective supply of air to the fuel to secure varying efficiencies at successive points in the length thereof, and means in connection with and adapted for actuating the agitating and non-agitating fuel-traveling grates, at relatively varying velocities, substantially as described and for the purpose set forth.

16. In an apparatus for burning coal and other fuel, the combination with the furnace-chamber having a reverberatory arch, of fuel-supplying and fuel-traveling apparatus comprising a fuel-supply hopper supported with its delivering end in communication with the furnace-chamber, a fuel-heating block or ignition-block having an inclined surface facing the interior of the furnace-chamber and contiguous to and forming an inclined chute for the supply hopper, a fuel-agitating grate supported for reciprocation with its receiving end contiguous to the delivering end of the ignition-block and comprising a series of reciprocatory members, a fuel-traveling grate supported with its receiving end below the fuel-agitating grate and adapted for receiving the fuel as it is delivered from said fuel-agitating grate and adapted for carrying the fuel onward throughout the furnace-chamber, means in connection with and adapted for actuating the two grates at relatively varying velocities, and an air-blast apparatus in connection with and adapted for supplying air to the fuel upon said grates, substantially as described and for the purpose set forth.

17. In an apparatus for burning fuel, the combination with the furnace-chamber and with the endless grate and its actuating-mechanism, of a fuel-agitating grate, supported with its delivering end above said endless grate in position to deliver fuel thereto and comprising a series of reciprocatory members, set side by side, and having horizontally- and remotely-disposed fuel-supporting shelves or steps in overlapping disposition, the shelves of one member relatively to the shelves of the adjacent member, and means in connection with and adapted for reciprocating said members simultaneously or successively, substantially as described.

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