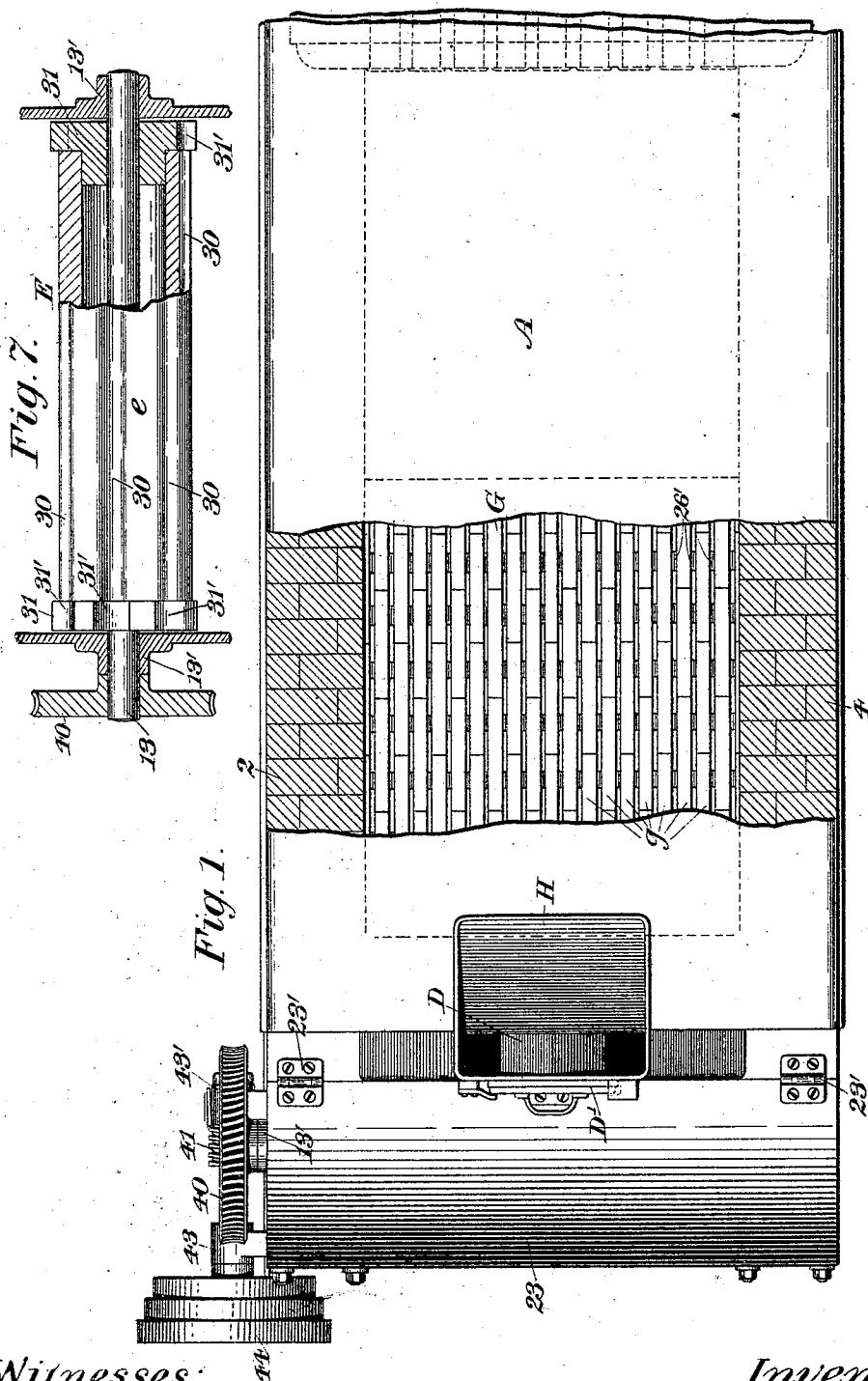


F. H. RICHARDS.
FURNACE.

No. 536,394.

Patented Mar. 26, 1895.



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

Inventor:
F. H. Richards

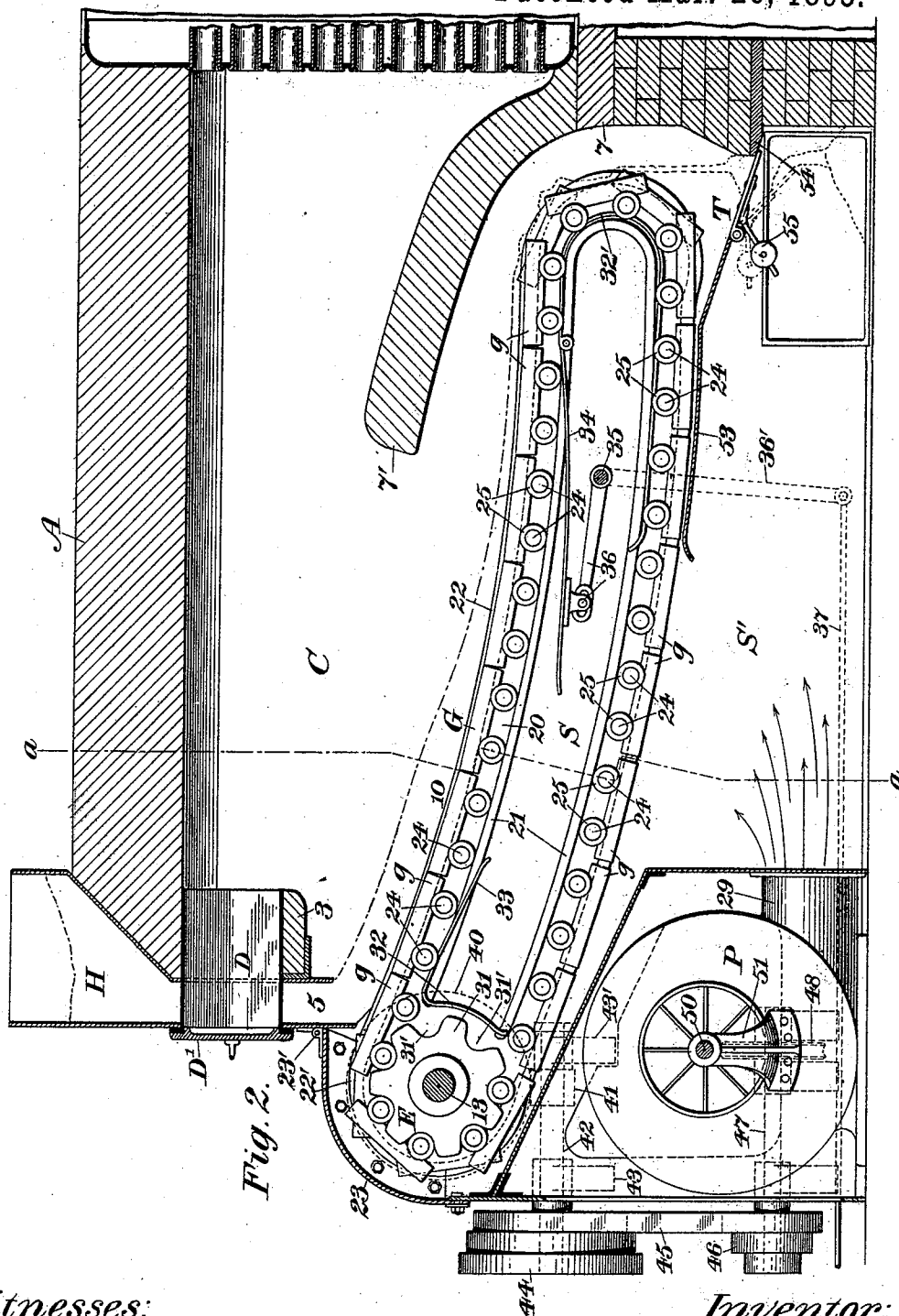
(No Model.)

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4 Sheets—Sheet 2.

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Fig. 4.

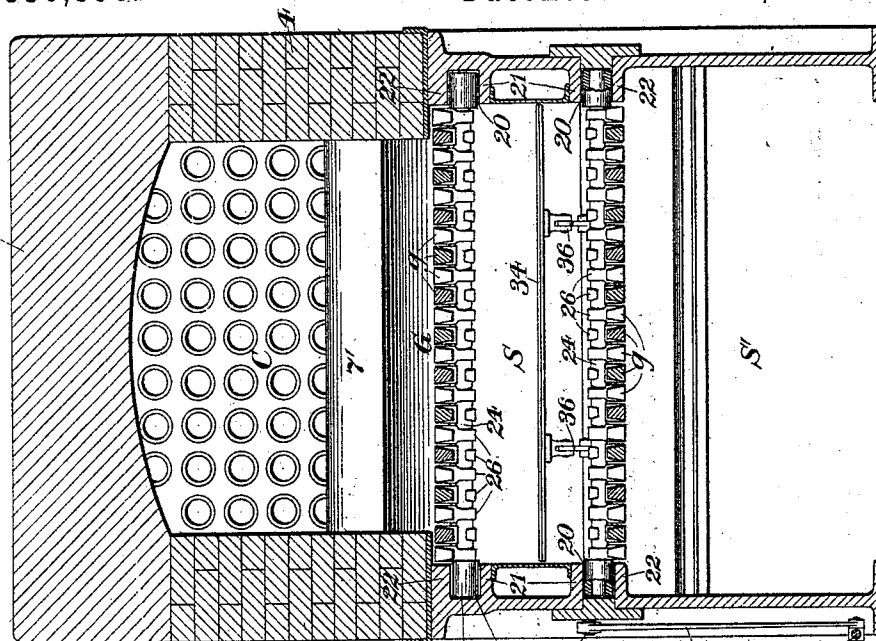
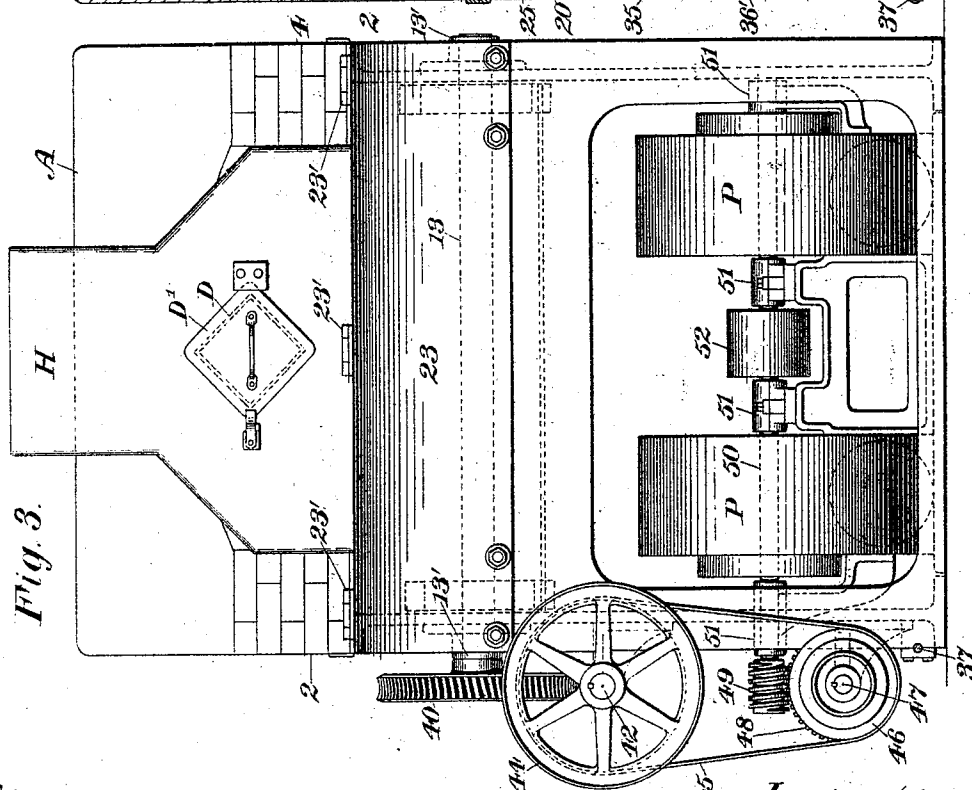


Fig. 3.



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UNITED STATES PATENT OFFICE.

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

FURNACE.

SPECIFICATION forming part of Letters Patent No. 536,394, dated March 26, 1895.

Application filed October 26, 1894. Serial No. 527,018. (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 that class of furnaces in which a fuel-traveling grate or furnace-floor is employed for carrying the fuel forward in the furnace-chamber and in which apparatus is provided for supplying air to the fuel during the traveling movement at varying pressures at successive points in the length of the grate or furnace-floor.

The object of my present invention is, primarily, to provide a furnace having apparatus of improved construction and organization, and adapted for burning the smaller sizes and lower grades of fuel, in accordance with the process described in Letters Patent of the United States No. 499,715, granted to Eckley B. Coxe June 20, 1893, and to materially improve the efficiency of said furnace and to facilitate the assembling and disassembling of certain of the parts thereof.

Another object of my invention is to provide, in connection with the fire-box or furnace-chamber of a boiler-heating furnace, a traveling-grate or furnace-floor of simplified and improved construction comprising a series of grate-bars detachably carried upon carrying-rods, and to provide in connection with said grate a revoluble carrier, which shall also constitute an assembling device for securing the grate-bars to their respective carrying-rods, and also to provide in connection with said traveling grate air-blast apparatus of improved construction and organization, adapted for supplying air to the fuel-carrying run of said grate, and improved means for regulating the supply of air to said grate to secure the requisite variation in pressure at successive points in the length of said grate.

In the drawings accompanying and forming part of this specification, Figure 1 is a sectional plan view of a portion of a fuel-traveling grate furnace embodying my present improvements. Fig. 2 is a sectional side eleva-

tion of the same. Fig. 3 is a front elevation of the furnace, as seen from the left hand in Fig. 1. Fig. 4 is a vertical cross-sectional view of the furnace taken in line *a-a*, Fig. 2, and looking toward the right hand in said figure. Fig. 5 is a vertical longitudinal section of a portion of the furnace, taken in line *b-b*, Fig. 1, with the grate and air-blast apparatus removed. Fig. 6 is a vertical cross-sectional view, on an enlarged scale, of one of the side-walls of the furnace showing a portion of the traveling grate in connection therewith. Fig. 7 is a sectional side elevation of the combined grate-bar-clinching die or anvil and grate-driver or actuator, said figure showing said combined revoluble die and driver, supported in bearings secured to the side-walls of the furnace, which side-walls are only partially shown. Fig. 8 is a plan view of one of the grate-bars. Fig. 9 is a cross-sectional view of a portion of the combined clinching-die and grate-driver, showing two grate-bar-carrying rods in position for attaching the grate-bars thereto, and showing the grate-bar with its fastening-prongs in position to be clinched around said carrying-rods. Fig. 10 is a view similar to Fig. 9, showing the grate-bar with its fastening-prongs clinched around the carrying-rod, and Fig. 11 is a side elevation of a modified form of grate-bar, showing the same secured to the two carrying-rods, which rods are shown in cross-section.

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

As a frame-work for carrying the operative parts of the furnace-mechanism, and also for protecting said mechanism, and for preventing the efflux of the air, excepting through the requisite channels, the furnace-chamber, C, is shown provided with the usual inclosing walls at the sides and ends thereof; the lower portions of the side-walls of which may consist, as shown in the drawings, of relatively-thin vertically-disposed plates, in a manner somewhat similar to that shown in the patent hereinbefore referred to. The side-walls are designated in a general way by 2 and 4, respectively, front end-wall by 3, and the rear end-wall by 7. The furnace-chamber, C, is also shown covered by a roof, A, and is also

shown provided, at the rearward end thereof, with a reverberatory-arch, or deflecting-wall, 7', which constitutes, practically, the bridge-wall of said furnace-chamber.

5 In the preferred form thereof herein shown and described, the floor of the furnace-chamber, C, consists of the upper or fuel-carrying run, 10, of an endless traveling grate, designated in a general way by G, which is supported at its side-edges in a channel or guide-way, 20, between the inner and outer tracks, 21 and 22, upon the side-walls of the furnace, as will be readily understood by a comparison of Figs. 2, 4, 5 and 6; the upper and lower portions of which guide-way are preferably inclined downwardly in curved parallel lines and will be somewhat similar in construction to the grate-supporting guide-ways or tracks shown and described in Letters Patent of the United States No. 510,551, granted to me December 12, 1893, to which reference may be had. The only difference between the present construction of grate-supporting tracks and the grate-supporting tracks just referred to is that the inner track, 21, is cut away at its forward end, and the outer track, 22, has a removable section, 22', at the forward end, which is carried by a plate, 23, hinged at 23' to the front wall of the furnace, which plate also constitutes a cover or closing-wall for the front of the mechanism.

Fuel is supplied to the forward or ignition end of the furnace-floor from a hopper, H, located at the forward end of the furnace-chamber, said hopper being shown with its receiving end projected somewhat above the roof of the furnace-chamber, and having its delivering end or chute, 5, terminated in close proximity to the receiving end of the grate. As a convenient means for deflecting the fuel sidewise as it passes from the receiving end to the delivering end of the hopper, so as to spread the fuel uniformly over the receiving end of the furnace-floor from side to side thereof, I have provided in connection with said hopper a fuel-deflecting box, D, which is preferably rectangular in cross-section and is extended transversely through the interior of the hopper with its side-faces set obliquely to the normal direction of travel of the fuel, or at an inclination to a vertical plane, the oppositely inclined upper sides of the deflecting-box tending to divert the course of travel of the fuel and carry it sidewise with relation to the longitudinal axis of the grate, and the lower oppositely inclined sides of said deflecting-box permitting that portion of the fuel below the transverse axis of said box to move inwardly toward the center of said grate. This deflecting-box, D, also constitutes a man-hole which communicates with the furnace-chamber, and is provided at its front-end with a hinged door, D'.

The endless grate, G, consists preferably of a multiplicity of grate-bar-carrying rods, 24, transversely disposed relatively to the furnace-chamber, and each provided, at one or

both ends thereof with rollers, 25, which are carried in the channels or guide-ways, 20, between the inner and outer tracks, 21 and 22; and a series of duplicate grate-bars, g, having depending carrier-rod-engaging prongs, 26, in detachable engagement with the grate-bar-carrying rods, 24, as will be readily understood by reference to Figs. 1, 2, 3, 4 and 6 of the drawings.

As a convenient means for detachably securing the grate-bars, g, to their respective carrying-rods, 24, each grate-bar is provided at its under side, at opposite ends thereof, with one or more relatively-pliable, depending, carrying-rod-grasping prongs, 26, adapted to be bent around one or both sides of the carrying-rods, as will be understood by reference to Figs. 6, 9, 10 and 11 of the drawings. In the form thereof shown in Figs. 9 and 10, each grate-bar has one laterally-disposed carrying-rod-grasping prong at each end thereof adapted to be bent inward, one relatively to the other, and around opposite faces of two carrying-rods, whereas, in the form shown in Fig. 11, the grate-bar has two depending carrying-rod-grasping prongs at each end thereof, the prongs of each set being adapted for grasping each side of each carrying-rod, as fully illustrated in said figures. These rod-grasping prongs, 26, upon the grate-bars in their unbent or normal condition, project outward substantially at right angles to the plane of the under face of the grate-bar, as shown by dotted lines in Fig. 10, the outer ends thereof being bent slightly toward each other. Each grate-bar is provided at one or both sides thereof with flanges or projections, 26', adapted for abutting against portions of the next adjacent bar, to form air-spaces between the adjacent side-faces of adjacent bars, as will be understood by reference to Figs. 1, 4 and 8.

As a means for actuating the endless traveling grate, and as a means for connecting the grate-bars to their respective carrier-rods to facilitate the assembling and disassembling of the grate, I have provided, in connection with the furnace to which the grate is applied, a combined grate-bar-clinching die or anvil and revoluble grate-driver or actuator, designated in a general way by E, and so designated on account of its having two separate and distinct functions; it constituting a "clinching-die" for clinching the prongs of the grate-bars around their respective carrying-rods, thus facilitating the assembling of the grate, without the employment of a separate device for this purpose; and it also constituting a "revoluble-driver" for the endless grate. In the preferred form thereof herein shown and described, this combined clinching-die and grate-driver, E, comprises the central or main body portion, e, which is in the nature of a drum having a series of equidistantly-disposed longitudinal die-grooves or clinching-grooves, 30, in the periphery thereof, which main body constitutes the clinch-

ing-die proper, and the two end-portions, 31, which are in the nature of sprocket-wheels and practically constitute the drivers for the endless grate, the tooth-spaces, 31', of said sprocket-wheels registering with the clinching-grooves, 30.

If desired, the combined clinching-die and grate-driver may have its main portions constructed integral, although it is preferable to form them separately and to connect them together after the manner most clearly shown in Fig. 7 of the drawings. This combined clinching-die and grate-driver, E, is shown carried at the forward end of the furnace-chamber upon a shaft, 13, which is journaled in bearings, 13', upon the side-walls of the furnace-chamber.

As a convenient means for rotating the combined clinching-die and grate-driver to impart a traveling movement to the endless grate, the shaft, 13, is provided at one end thereof with a worm-wheel, 40, which meshes with a worm, 41, upon a driving-shaft, 42, journaled in bearings, 43 and 43', upon the framework of the furnace, which shaft, 42, is provided at one end with a driving-pulley, 44, which is driven by means of a belt, 45, extending over said pulley and over a pulley, 46, upon an intermediate shaft, 47, which carries a worm-wheel, 48, which meshes with a worm, 49, upon the end of the main driving-shaft, 50, as will be hereinafter more fully described.

By the provision of the combined clinching-die and grate-driver, substantially as described, and by the provision of an endless traveling grate, of a construction substantially as described, it will be seen that the repairing of the grate in case of one or more of the grate-bars becoming defective is greatly facilitated, as it is simply necessary to rotate the grate-driver until the defective bar rests with its carrying-rods in the clinching-grooves of the combined clinching-die and driver, E, (the plate, 23, together with the removable section, 22', hinged at 23' with the front-wall of the furnace-chamber being, of course, thrown open for the purpose of repairing the grate) after which the defective grate-bar may be knocked off from its carrying-rods by means of a hammer or other suitable contrivance, and a new grate-bar placed with its unbent prongs in the position shown in Fig. 9, and driven down with its lower edge in close proximity to the periphery of the die, as shown in Fig. 8, which clinches the prongs thereof around the carrying-rod.

By reference to Figs. 5 and 7, it will be seen that while the clinching-grooves, 30, and the tooth-spaces, 31', are in alignment with one another, the inner faces thereof are in different planes. The inner faces of the tooth-spaces project slightly beyond the inner faces of the clinching-grooves, the purpose of which is to leave a space around the middle or grate-bar-receiving portion of the carrying-rods, when said carrying-rods rest with their rollers in

the tooth-spaces, 31', of the end-portions of the combined clinching-die and driver, which space shall be sufficient for the insertion and free movement of the prongs of the grate-bars.

As a means for supplying air to the fuel-carrying run of the grate, at varying pressures at successive points in the length thereof, the space between the upper and lower runs of the grate is closed at the front and rear ends thereof by means of transverse partitions or plates, 32 and 32', respectively. The plate, 32, at the forward end of the grate, has an angular-disposed rearward extension, 33, at the upper end thereof, contiguous, or in close proximity, to the under face of the upper run of the grate, which extension is preferably slightly inclined downward with relation to the plane of movement of said grate, and the transverse partition at the rear end of the grate has a forwardly projecting extension, 34, adapted for movement toward and from said grate, to increase or decrease the area of the space between said grate and the forward extension. This extension, 34, will be herein termed the "regulating-valve." This regulating-valve, 34, will preferably be pivotally connected at its rear end with the end plate or partition, 32', as illustrated most clearly in Fig. 2 of the drawings, and will be operated from the outside of the furnace-chamber by means of a crank-shaft, 35, journaled in suitable bearings in the side-walls of the furnace, and operatively connected with said valve by means of links, 36, in any suitable manner; said shaft being operated by means of a crank, 36', and a connecting-rod or operating-rod, 37. This partially inclosed space, designated by S, between the upper and lower runs of the traveling grate, practically constitutes an air-accumulating chamber having a variable outlet contiguous to the upper run of the grate, and is adapted for regulating the supply of air to the fuel-carrying run of the grate, the regulation of the supply of air to said fuel-carrying run to secure varying pressures at successive points in the length thereof, being accomplished by increasing or decreasing the effective area of the outlet, contiguous to said fuel-carrying run, by changing the positions of the valve, 34, relatively to the grate, as will be readily understood by reference to said Fig. 2.

The accumulating-chamber, S, is supplied with air through the lower run of the grate from a chamber, S', located beneath said run, which in turn is supplied with air from a pair of blowers, P, supported side by side below the forward end of the fuel-traveling grate, and in the rear of the lower air-supply chamber, S, said blowers having conduits, 29, in communication with said air-supply chamber. These blowers are simultaneously actuated by means of the shaft 50, which is journaled in bearings, 51, and is provided with a pulley, 52, which is driven from any suitable source of power (not shown), said shaft also constituting the main driving-shaft for the grate-act-

uating mechanism, it being connected therewith in the manner hereinbefore described.

In connection with the lower air-supply chamber, S', I have provided an automatic air-seal, designated in a general way by T, which is adapted for automatically cutting off communication between said chamber S' and the furnace-chamber C, or that area above the fuel-carrying run of the grate. This air-seal, T, is in the nature of a swinging gate, pivotally connected with the upper wall, 53, of the chamber S', below the delivering end of the grate, and having its opposite ends normally in close contact with an overhanging ledge, 54, upon the rear wall 7 of the furnace, said grate being held normally in contact with said wall by a weighted lever, 55. This gate also constitutes an automatic ash-discharger, it being located directly below the delivering end of the grate, and above the floor of the main ash-pit. Said gate is so weighted as to open after a certain quantity of ashes has been deposited thereon, as will be readily understood by reference to Fig. 2 of the drawings, and after discharging the accumulated ashes it will automatically return to its closed position.

Owing to the curvilinear construction of the tracks which support the upper and lower runs of the grate, and owing to the difference in the length of the radius of said tracks, it will be seen that the grate-bars of the traveling grate, when in their upper run position, have their adjacent ends in close contact, thereby decreasing, to a considerable extent, the aggregate area of the air-spaces or outlet openings through the upper run of said grate, and limiting to some extent the supply of air to the fuel; whereas, the said grate-bars, when in their lower position, have their adjacent ends separated somewhat, which increases the aggregate area of the air-spaces or inlet openings through the lower run of the grate. This is advantageous in the furnaces herein described, in that it insures a supply of air to the chamber S in excess of the efflux of air therefrom, irrespective of the position of the regulating-valve, 34, and also provides for the exit of any fuel which may accidentally drop through the upper run of the traveling grate.

Having thus described my invention, I claim—

1. The herein-described fuel-traveling furnace-floor for furnaces of the class specified, it consisting of a series of grate-bar-carrying rods, and a series of grate-bars having depending prongs in clinched detachable engagement with said carrying-rods, substantially as described.

2. In a furnace of the class specified, the combination with the furnace-chamber and its inclosing walls, of a fuel-traveling furnace-floor supported for movement within said furnace-chamber, and comprising a series of grate-bar-carrying rods, and a series of grate-bars having pliable depending prongs in

clinched and detachable engagement with said carrying-rods, and means in connection with and adapted for actuating said furnace-floor, substantially as described and for the purpose set forth.

3. In a furnace of the class specified, the combination with the furnace-chamber and its inclosing walls, of an endless grate supported for traveling movement within said furnace-chamber and comprising a series of grate-bar-carrying rods and a series of grate-bars having pliable depending prongs in clinched and detachable engagement with said carrying-rods, and a revoluble driver extending from side to side of said endless grate at one end thereof, and having a series of parallel grooves adapted to register with and to receive the carrying-rods of said grate, substantially as described and for the purpose set forth.

4. In a furnace of the class specified, the combination with the furnace-chamber and its inclosing walls, of an endless traveling grate comprising a series of grate-bar-carrying rods, and a series of grate-bars having a series of pliable depending prongs in detachable engagement with said carrying-rods, and a combined clinching-die and grate-driver supported for rotation between the upper and lower runs of said grate, and having clinching-grooves in position for registering with, and for receiving the prongs of, the grate-bars, and adapted for imparting a circuitous movement to said grate, substantially as described and for the purpose set forth.

5. In a furnace of the class specified, the combination with the furnace-chamber and with the fuel-traveling furnace-floor, of a combined grate-assembling die and actuator supported for rotation at one end of and adapted for operatively engaging the grate, substantially as described and for the purpose set forth.

6. In a furnace of the class specified, the combination with the furnace-chamber and with the endless traveling grate supported for movement therein, and comprising a series of transversely-disposed grate-bar-carrying rods, and a series of grate-bars having prongs in clinched engagement with said rods, of a combined clinching-die and grate-driver located at the forward end of, and in engagement with, said endless grate, and consisting of a main-body portion extending substantially from side to side of said grate, and having a series of longitudinal and equidistantly-disposed clinching-grooves in the periphery thereof, adapted for engaging the prongs of the grate-bars, and the two end-portions having peripheral teeth adapted for engaging the grate-bar-carrying rods and for imparting a traveling movement to said grate, substantially as described and for the purpose set forth.

7. In a furnace of the class specified, the combination with the furnace-chamber and its inclosing walls, of two circuitous, or substantially circuitous, grate-supporting guide-

ways, located one at each side of the furnace-chamber, an endless traveling grate comprising a series of grate-bar-carrying rods, having rollers at opposite ends thereof supported for traveling movement in said guide-ways, and a series of grate-bars having pliable depending prongs in clinched and detachable engagement with said carrying-rods, and means in connection with and adapted for imparting a traveling movement to said grate, substantially as described and for the purpose set forth.

8. In a furnace of the class specified, the combination with the furnace-chamber and its inclosing walls, of upper and lower downwardly inclined grate-supporting tracks at each side of the furnace-chamber, an endless traveling grate, the upper and lower runs of which are supported for traveling movement in opposite directions by the upper and lower grate-supporting tracks, respectively, and comprising a series of grate-bar-carrying rods transversely disposed relatively to the furnace-chamber and having rollers at opposite ends thereof supported upon said tracks, and a series of grate-bars having depending pliable prongs in clinched and detachable engagement with said grate-bar-carrying rods, and means in connection with and adapted for imparting a traveling movement to said grate, substantially as described and for the purpose set forth.

9. In a furnace of the class specified, the combination with the furnace-chamber and its inclosing walls, of a combined clinching-die and grate-actuator, substantially such as described, supported for rotation at the forward end of the furnace-chamber and adapted for connecting the parts of and for actuating the endless grate or furnace-floor, substantially as described.

10. In a furnace of the class specified, the combination with the furnace-chamber and its inclosing walls, and with the furnace-floor supported in said furnace-chamber, of the combined clinching-die and grate-actuator supported for rotation within, and extending from side to side of, the furnace-chamber, and consisting of a drum-like body-portion having a series of longitudinally- and equidistantly-disposed clinching-grooves in the periphery thereof adapted for engaging and clinching the holding-prongs of the grate-bars of the furnace-floor around their carrying-rods, and the sprocket-wheel-like end-ports, adapted for engaging and imparting a traveling movement to said furnace-floor, substantially as described.

11. The herein-described grate-bar for grates of furnaces of the class specified, it consisting of the cross-sectionally-angular body-portion having one or more depending pliable prongs at each end thereof adapted for being bent around, and for movably clinching, a carrying-rod, substantially as described.

12. The herein-described grate-bar for grates of furnaces of the class specified, it

consisting of a cross-sectionally-angular oblong bar having spacing-flanges or projections at opposite sides thereof, and having one or more depending pliable prongs at each end of the under side thereof adapted for detachably engaging a carrying-rod or rods, substantially as described.

13. In a grate for furnaces of the class specified, two remotely-disposed parallel grate-bar-carrying rods, in combination with a series of grate-bars, each of which bars has one or more depending pliable prongs at each end thereof, which prongs are in detachable engagement with said grate-bar-carrying rods, substantially as described.

14. In a grate for furnaces of the class specified, two remotely-disposed parallel grate-bar-carrying rods, in combination with a series of grate-bars transversely-disposed relatively to the carrying-rods and having air-spaces intermediate thereto, and having depending pliable prongs in detachable engagement with said carrying-rods, substantially as described.

15. In a furnace of the class specified, the combination with the furnace-chamber and its inclosing walls, of a fuel-traveling furnace-floor supported for movement within and longitudinally of said furnace-chamber, an air-supply chamber located below the fuel-supporting portion of the furnace-floor and having a regulating-valve contiguous to said furnace-floor, and normally inclined with relation thereto; means for supplying air to said chamber and means, substantially as described, for opening and closing said valve to regulate the supply of air to the fuel and to secure varying pressures at successive points in the length of the furnace-floor, substantially as described and for the purpose set forth.

16. In a furnace of the class specified, the combination with the furnace chamber and its inclosing walls, and with the endless traveling grate supported for movement within said furnace-chamber, of an air-supply apparatus, consisting of an accumulating-chamber located between the upper and lower runs of the grate and having a valve-regulated opening contiguous to the upper run of said grate, and having an inlet opening contiguous to the lower run of said grate, an air-supply chamber located below and in communication with the accumulating-chamber, one or more blowers supported in advance of and having air-conduits in communication with the lower air-supply chamber and driving-mechanism in connection with and adapted for simultaneously actuating the blower and endless grate, substantially as described and for the purpose set forth.

17. In a furnace of the class specified, the combination with the furnace-chamber and with the fuel-traveling furnace-floor supported for movement therein, of one or more vertically disposed air-supply chambers located underneath the furnace-floor and having an outlet contiguous to said furnace-floor,

a valve supported for swinging movement below the furnace-floor and adapted for varying the effective area of the outlet opening of the air-supply chamber or chambers, means
 5 in connection with and adapted for moving said valve toward and from the furnace-floor to regulate the supply of air to said furnace-floor and secure varying pressures at successive points in the length of said furnace-floor,
 10 and means in connection with and adapted for supplying air to said chamber or chambers, substantially as described and for the purpose set forth.

18. In a furnace of the class specified, the
 15 combination with the furnace-chamber and its inclosing walls and with the fuel-traveling grate supported within the furnace-chamber, of an air-blast apparatus located below and adapted for supplying air to the fuel-carrying
 20 run of said grate at varying pressures at successive points in the length thereof, and a self-closing or automatically-operable air-seal in connection with said grate and adapted for cutting off communication between the areas
 25 above and below said grate and in position and adapted for receiving and for automatically discharging the ashes as they are delivered from the rearward end of said grate, and means for actuating said grate, substantially
 30 as described.

19. In a furnace of the class specified, the combination with the furnace-chamber and with the fuel-traveling grate supported therein, of a fuel-supply hopper located at one end
 35 of said furnace-chamber with its delivering end in close proximity to said grate and having angularly-disposed deflecting plates or partitions extending through said hopper in position and adapted for deflecting the fuel
 40 sidewise as it passes from the receiving to the delivering end of said hopper to thereby spread the fuel uniformly upon the grate from side to side thereof, substantially as described.

20. In a furnace of the class specified, the
 45 combination with the furnace-chamber and with the grate supported therein, of a fuel-

supply hopper having a hollow fuel-deflecting box, of relatively small diameter, extending transversely therethrough, which box is open
 50 at the inner end thereof, and is provided with a door at the outer end thereof, and adapted for deflecting the fuel sidewise in its passage from the receiving to the delivering end of said hopper to thereby spread the fuel uniformly over the grate from side to side thereof,
 55 substantially as described and for the purpose set forth.

21. In a furnace of the class specified, the combination with the furnace-chamber and its inclosing walls; of an endless grate having
 60 a plurality of fuel carrying members movable longitudinally relatively to one another, and normally axially aligned in longitudinal direction, and also having their ends opposed
 65 to one another and normally non-contiguous in longitudinal direction, and thereby adapted to form transverse air-spaces in said grate, said grate having its fuel-carrying run supported for traveling movement within said
 70 furnace at an inclination to a horizontal plane, and having the opposed ends of the fuel-carrying members of its lower run normally more remote from one another than the opposed
 75 ends of the fuel-carrying members of the upper run, whereby the aggregate area of the air-spaces in the fuel-carrying run of the grate is maintained constantly less than the aggregate area of the air-spaces in the lower run
 80 of the grate, and whereby also the efflux of the air-supply through the fuel-carrying run is less than the supply of air through the lower run of the grate; and an air-supply-apparatus located below and having its air-outlet closed by the lower run of the grate, and
 85 in position and adapted for supplying air through the air-spaces of said lower run to the air-spaces of the fuel-carrying run of the grate, substantially as described.

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