Jan. 30, 1934. O. KELLY 1,945,224

FURNACE

Filed Nov. 8, 1928 5 Sheets-Sheet 1

Fig. 1

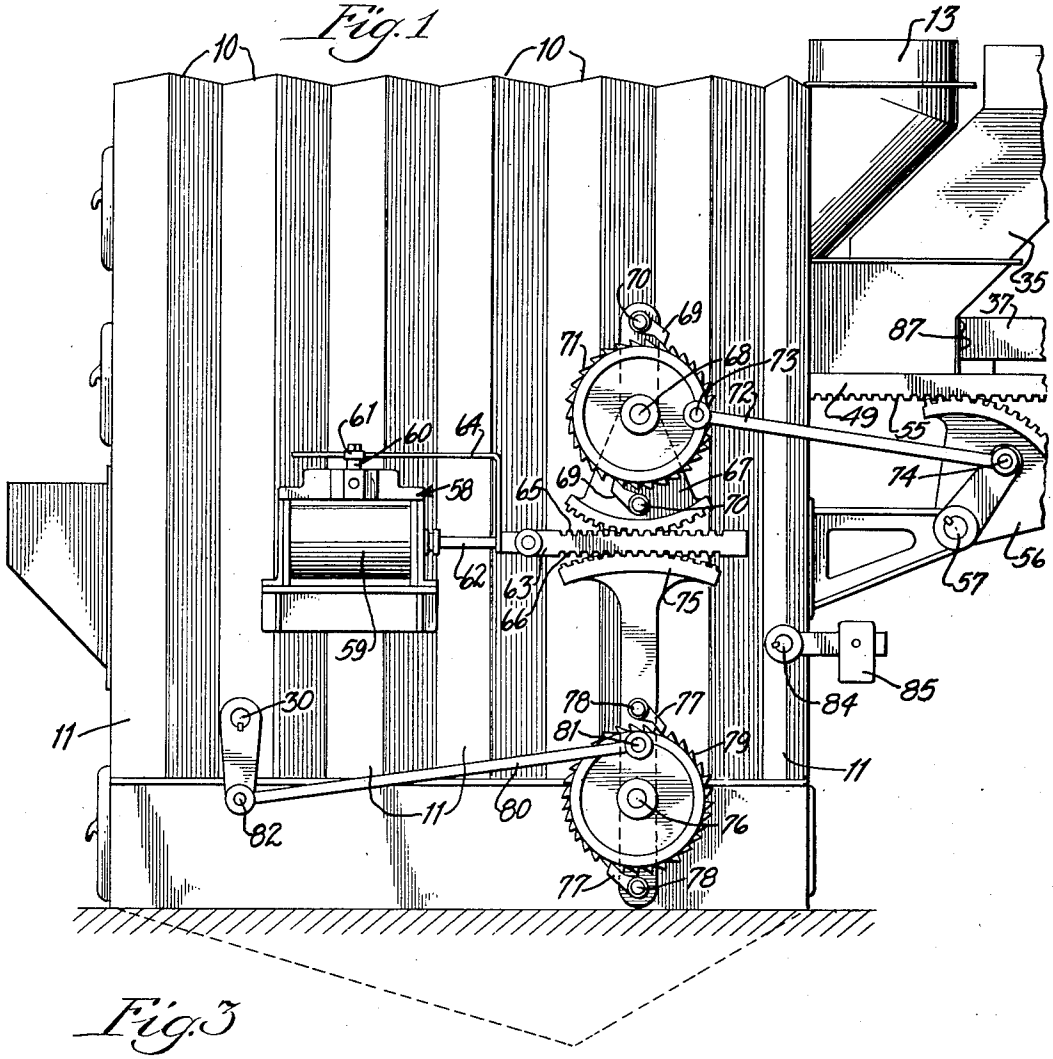
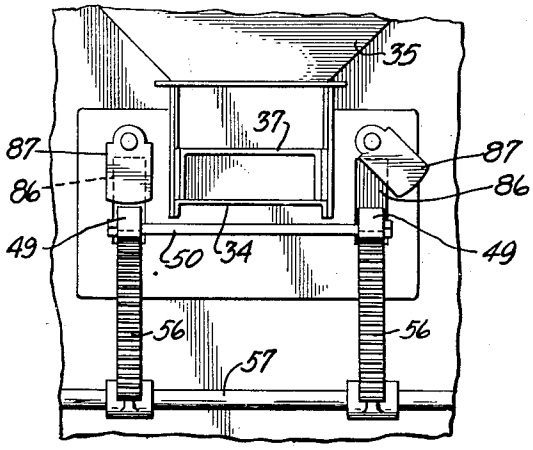



Fig. 3




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Jan. 30, 1934. O. KELLY 1,945,224

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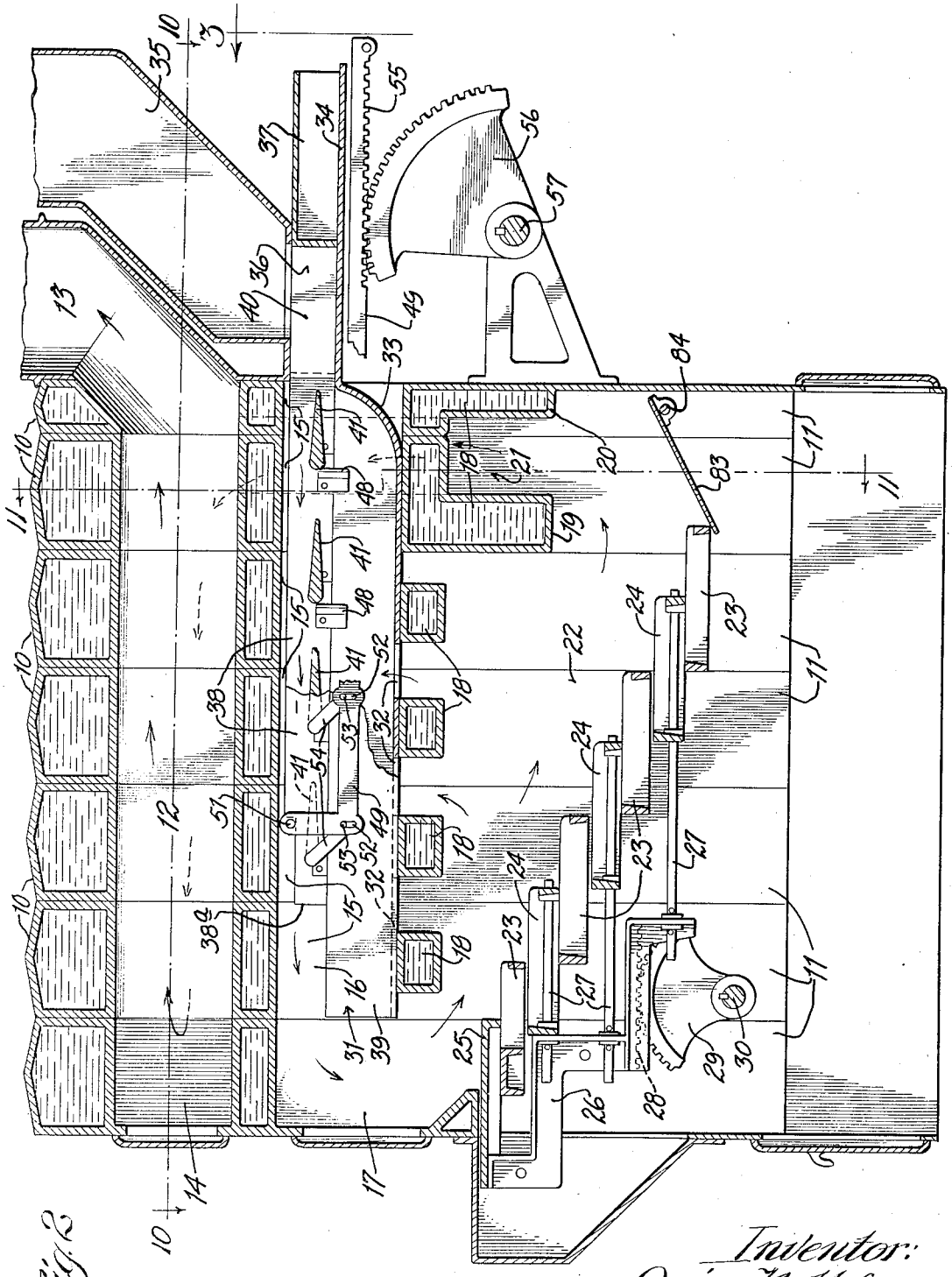


Fig. 2

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Fig. 4

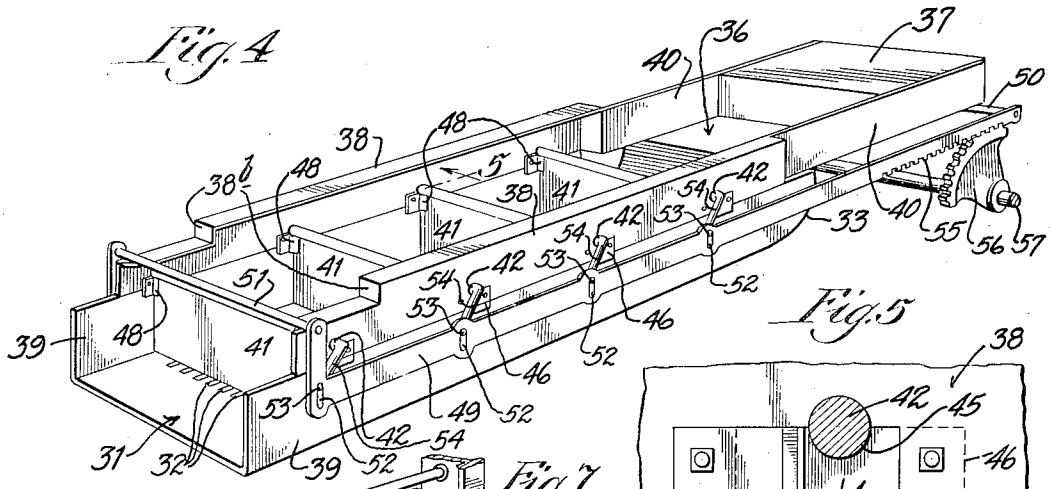



Fig. 5




Fig. 7

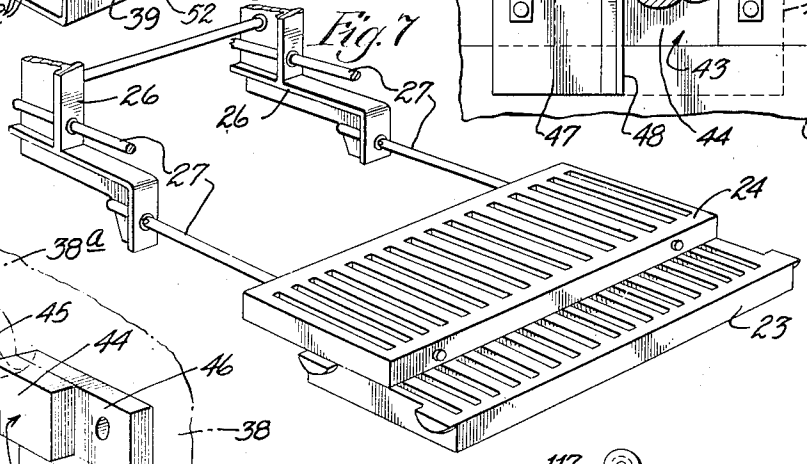



Fig. 6

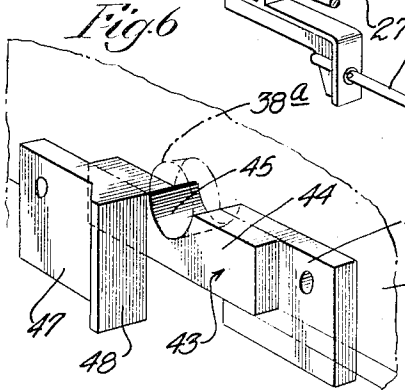
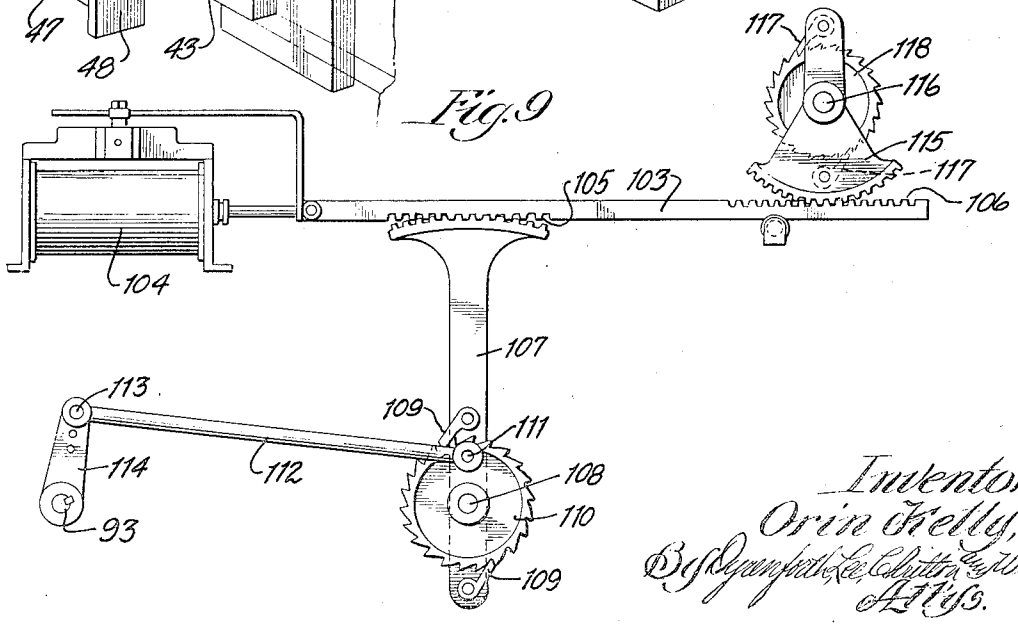



Fig. 9




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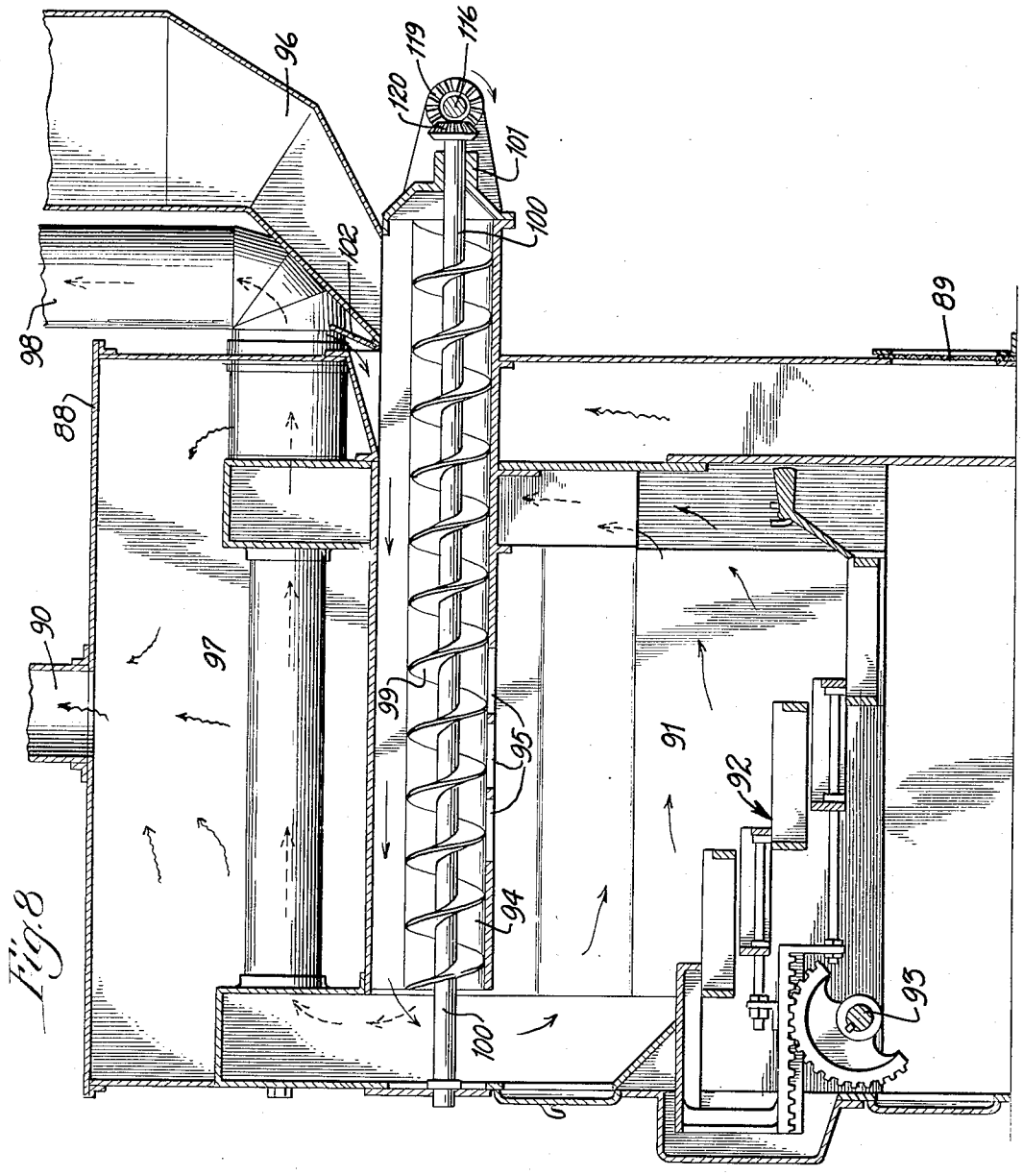



Fig. 8

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Fig. 10.

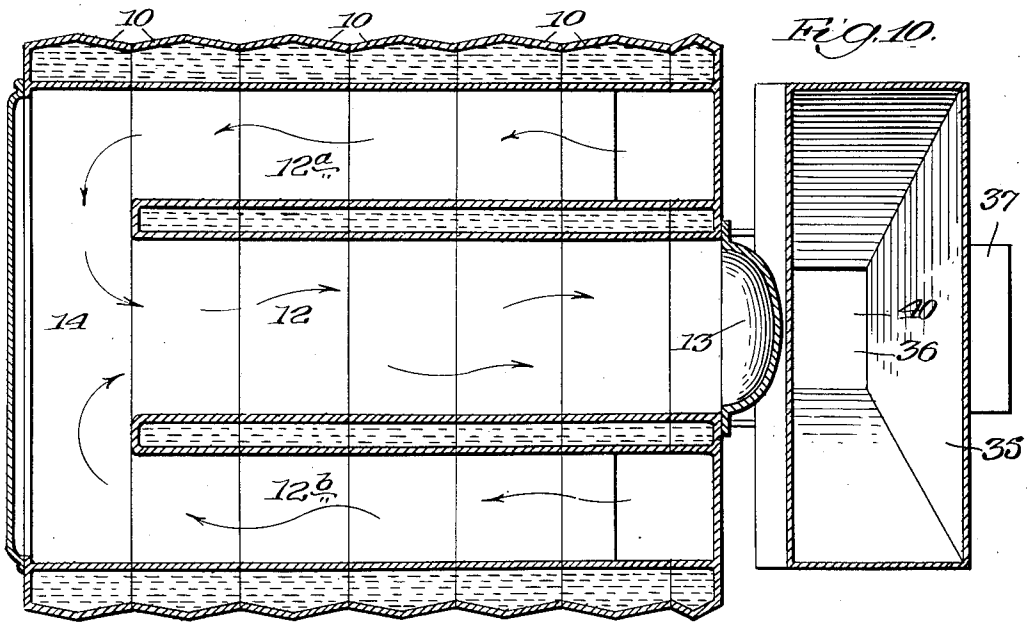
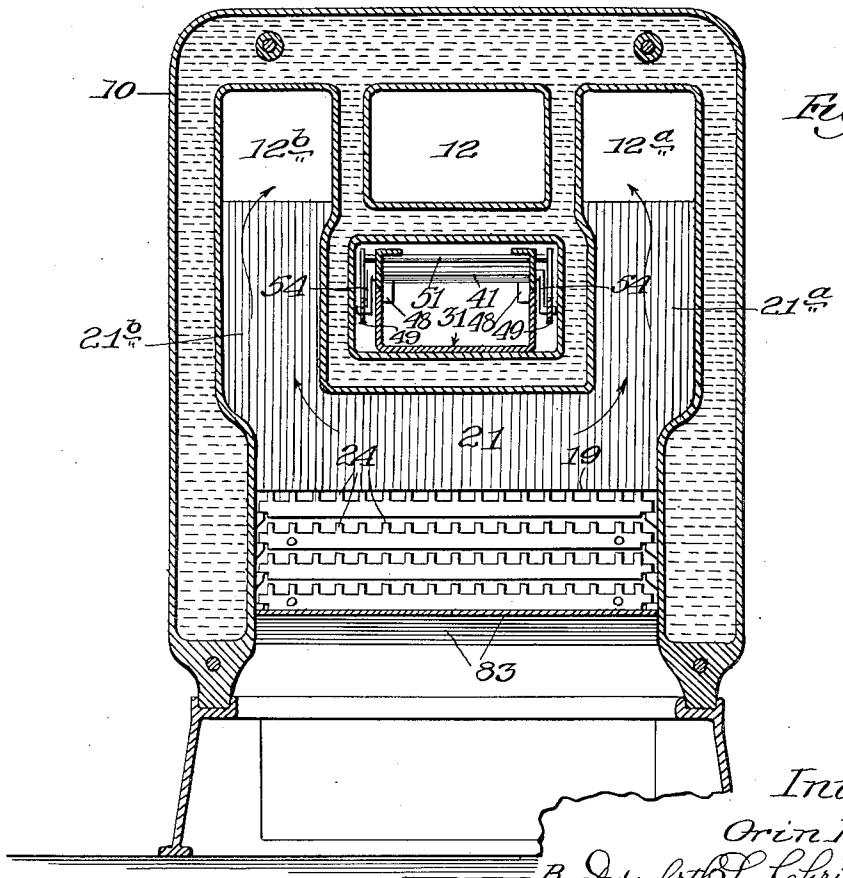



Fig. 11.




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Patented Jan. 30, 1934 1,945,224

# UNITED STATES PATENT OFFICE

1,945,224

## FURNACE

Orin Kelly, Columbus, Ohio

Application November 8, 1928. Serial No. 317,966

2 Claims. (Cl. 110—24)

My invention relates more particularly to furnaces of the self-stoking type.

It has been found in practice that furnaces as hitherto constructed, where the coal is fed directly from the bin to the grates, present the disadvantage of crowding the fire-bed with more or less raw coal regardless of the grade or kind commonly used, resulting in the production of a smoky fire even under forced draft, the amount of smoke produced being much greater where the coal is supplied to the bins in more or less wet condition, as is the common practice, and is fed to the fire-bed before it has become comparatively dry and heated to the ignition point.

Furthermore, in addition to the above disadvantage which is much more pronounced where the cheaper grades of coal, such as that in the form of slack, or nut and slack is used, and particularly where such grades of coal are used under low, natural, draft, furnaces as hitherto provided present the objection, when the cheaper, finer, grades of coal are used particularly under low, natural, draft, of presenting undue resistance to the passage through the fire bed of sufficient air for producing proper combustion due to the presence in the fire-bed of an excess of fine particles of coal causing the bed to be so compact as to present the resistance referred to.

Furthermore, relatively great waste of fuel results due to the dropping of the finer particles through the openings in the grates.

One of my objects is to prevent production of a smoky fire even when relatively wet coal containing fine particles is fed from the bin to the furnace and the furnace is operated under low, natural, draft.

Another object is to accomplish the above stated purpose and to utilize in the furnace the heat values in the finer particles of coal.

Another object is to provide improvements in furnaces to the end that greater economy in the operation thereof may be effected by the substantially complete combustion of the fuel.

Another object is to provide for the burning of relatively fine coal particularly slack, under low natural draft without danger of the choking of the fire bed with resultant decrease in efficiency and incomplete combustion, and other objects as will be manifest from the following description.

Referring to the accompanying drawings:

Figure 1 is a view in side elevation of a hot water or steam boiler embodying my improvements.

Figure 2 is a view in longitudinal sectional elevation of the furnace, the section being taken through the center line of the furnace with certain parts thereof shown in elevation.

Figure 3 is a broken end view of the furnace viewing it at the line 3 on Fig. 2 and in the direction of the arrow.

Figure 4 is a perspective view of that portion of the furnace to which the fuel is initially fed and a portion of the mechanism for feeding the coal thereto.

Figure 5 is an enlarged detailed view taken at the line 5 on Fig. 4 and viewed in the direction of the arrow.

Figure 6 is a perspective view of one of a number of similar trunnion bearings forming a part of one of the coal feeding means, this figure including a phantom showing of the plate carrying these bearings at one side of the structure.

Figure 7 is a perspective view, partly sectional and with certain parts omitted, of the grate structure of the furnace.

Figure 8 is a view like Fig. 2 of a hot air furnace embodying my invention.

Figure 9 is a view of somewhat diagrammatic character of the operating mechanism of the furnace of Fig. 8 for actuating the coal feeding means thereof.

Figure 10 is a section taken at the line 10—10 on Fig. 2 and viewed in the direction of the arrows; and

Figure 11, a section taken at the irregular line 11—11 on Fig. 2 and viewed in the direction of the arrows.

Referring to Figs. 1 to 7, inclusive, and 10 and 11 the furnace therein shown is formed of a horizontal series of separate, vertically disposed, hollow sections 10 forming water chambers each formed at its lower end with spaced apart water-leg portions, these portions at one side of the furnace being represented at 11.

All of the sections 10, except the forwardmost one thereof, contain at their upper portions a horizontal series of horizontal gas flues arranged side by side and preferably three in number, these flues being represented at 12, $12^a$, and $12^b$. The middle flue 12 opens at its rear end into a stack 13 and all three of these flues open at their forward ends into a cross flue 14 formed in the forwardmost one of the sections 10 and extending entirely across the three flues referred to. All of the sections 10, except the forwardmost one thereof, contain openings 15 therethrough which together form a chamber 16 located below and out of direct communication with the flues above referred to, this chamber being located midway

between the sides of the furnace and being relatively narrow compared with the width of the sections 10 the chamber 16 communicating at its forward end with the space 17 defined by the water-legs of the forwardmost section 10.

The bottom of the chamber 16 is formed of a horizontal series of hollow cross members 18 forming water-chamber portions of certain of the sections 10, these cross members, except the one thereof on the rearwardmost section 10, being spaced apart as shown to provide spaces therebetween for a purpose hereinafter described. The cross member 18 of the one of the sections 10 next to the rearwardmost one thereof is preferably relatively deep at its forward portion as shown at 19 and the rear portion of the cross member of the rearwardmost one of the sections 10 is also relatively deep as represented at 20 thereby providing a horizontal gas-passage 21 which opens, at its opposite ends, into upwardly-extending flues $21^a$ and $21^b$ in these two sections 10 communicating with the rear ends of the flues $12^a$ and $12^b$, respectively.

The cross members 18 are located above the bottom of the furnace and thus at the upper portion of the combustion chamber 22 thereof.

The furnace also comprises mechanical stoking means for feeding fuel to the fire-bed, these means also comprising the grate portion on which the fire bed is supported. The combined grate forming and stoking mechanism shown comprises a series of stationary grate sections 23 extending entirely across the combustion chamber 22 these grate sections being spaced apart vertically and arranged in the form of steps as shown.

Interposed between adjacent ones of the stationary grate sections 23 are grate sections 24 mounted to be reciprocated lengthwise of the furnace and operating to advance the fire bed toward the rear end of the furnace and replenishing the fire bed with fuel delivered thereto at the front end of the furnace as hereinafter described.

The movable grate sections 24, together with a plunger member 25 located directly above the uppermost stationary grate section 23, are rigidly connected together at opposite sides of the furnace by brackets 26 one only of which is shown, the plunger 25 being directly connected with this bracket and the reciprocable grate sections 24 connected thereto as through the medium of the rods 27.

The brackets 26 are each formed with a rack portion 28 which meshes with a rack-segment 29, there being two of these segments, one at each side of the furnace and rigidly connected with a rock shaft 30 actuated as hereinafter described.

Located in the chamber 16 is a trough-like member 31 the bottom of which is apertured at 32, preferably slotted as in the case of ordinary grate constructions, the rear end of the bottom of the member 31 curving upwardly and rearwardly as represented at 33 and terminating in a horizontal rearwardly-extending plate-extension 34 outside of the main furnace structure, the trough member 31 forming, in effect, a combined coking plate and conveyor trough in which the coal to be consumed in the furnace is subjected to the heat generated in the fire bed and through which the coal is advanced preliminary to the feeding thereof to the grate.

The coal for firing the furnace is charged into a bin the lower spout portion of which is represented at 35, the outlet of this spout extending directly above, and opening into a trough 36 the bottom of which is formed of the plate 34, this trough being located in direct line with the trough 31.

Means are provided for feeding the coal into the rear end of the trough 31 and thence therethrough for discharge at its forward end upon the grate. These means comprise a plunger 37 reciprocable across the outlet of the spout 35 to feed the coal into the rear end of the trough 31, and drag mechanism operating in the trough 31 to move the coal along the bottom of the trough to the front end thereof.

The drag mechanism shown comprises a pair of bars 38 mounted on the upper edges of the sides 39 of the trough 31 to be reciprocable thereon, the plunger 37 being mounted on the rear ends of these bars, intermediate portions of which latter, and represented at 40, form the sides of the trough 36. The drag mechanism also comprises a series of drag-plates 41 located between, and extending crosswise of, the bars 38 and swingably mounted thereon at trunnions 42 located at the upper edges of these plates at opposite ends thereof, the plates being preferably of wedge shape in cross-section as shown.

Each bar 38 is provided, adjacent the ends of the trunnions 42 with guide lugs 43. These lugs are preferably of the form shown presenting a central portion 44 containing a semi-circular recess 45 in its upper edge to receive a trunnion 42, and end portions 46 and 47 located at opposite sides of the portion 44 and depending below the underside of the part 44, the portion 47 affording a stop surface 48.

The bottom edge portions of the bars 38 are recessed to receive the portions 44 of the lugs 43 as shown in Fig. 6, the bottom edges of the portions 44 and bars 38 being flush and the portions 46 and 47 of the lugs depending below the lower edges of the bars 38 and forming guides for preventing displacement of these bars on the side walls 39 of the trough 31 in the reciprocatory movements of said bars. The lower edges of the bars 38 contain semi-circular recesses $38^a$ in registration with the recesses 45 in the lugs 43, the recessed portions of these bars and lugs forming journals for the ends of the trunnions 42.

The drag mechanism also comprises bars 49 extending lengthwise of the trough 31 at opposite sides of the latter and connected together at their rear ends by a tie-rod 50, and at their forward ends, at upwardly projecting extensions thereof, by a rod 51 which is slidable on the upper edges of the bars 38, the latter presenting stops $38^b$ for a purpose hereinafter described.

The bars 49 contain at intervals vertical slots 52 into which the ends 53 of cranks 54 provided on the outer ends of the trunnions 42, extend. The rear ends of the bars 49 are formed with rack portions 55 which mesh with gear-segments 56 (one only of which is shown) secured to the ends of a shaft 57 journalled on the furnace structure.

In the construction shown the reciprocatory grate sections 24 and plunger 25 and the mechanism for actuating the plunger 37 and moving the coal through the chute 31, are operated from a single power device, which may be of any desirable construction. That shown is in the form of a fluid-pressure-operated piston and cylinder mechanism represented at 58 the cylinder of which is shown at 59, and may be of any suitable construction, it having a valve mechanism (not shown) operated by a rock shaft 60 having a crank 61 which, in its partial rotation in opposite

directions, controls the inlet of fluid pressure to the opposite ends of the cylinder 59 and the exhaust therefrom for effecting reciprocation of the piston therein.

The piston of the mechanism 58 is connected, by a stem 62, to a bar 63 provided with an arm 64 connected with the crank 61, and having rack portions 65 and 66, the rack portion 65 meshing with a gear segment 67 journalled on a shaft 68. This gear segment is equipped with two oppositely disposed pawls 69 pivoted thereto as represented at 70 and cooperating with a ratchet wheel 71 journalled on the shaft 68. By this arrangement reciprocatory movement of the bar 63 is translated into intermittent rotary movement of the ratchet 71 to which a link 72 is pivoted eccentric of the axis of this ratchet as represented at 73, the other end of this link being pivotally connected with a crank arm 74 rigid on the shaft 57 thereby translating intermittent rotary movement of the ratchet 71 into intermittent oscillatory movement of the segments 56 for reciprocating the plunger 37 and the drag mechanism operating in the trough 31.

The rack 66 meshes with a gear segment 75 journalled on a shaft 76 and carrying oppositely extending pawls 77 pivoted thereto at 78 and cooperating with a ratchet wheel 79 journalled on the shaft 76, this ratchet wheel being connected, eccentrically of its axis, with one end of a link 80, as represented at 81, the opposite end of this link being pivotally connected with a crank 82 rigidly connected with the shaft 30 whereby reciprocatory movement of the bar 63 is translated into intermittent reciprocatory movement of the grate sections 24 and plunger 25, it being preferred that, as shown, the pawls 69 and 77 are so disposed that the plunger 37 and drag mechanism are operated only when the bar 63 moves in one direction and the movable grate sections and plunger 25 are operated only when this bar moves in the opposite direction, this being desirable as thereby the minimum power is required for operating these mechanisms.

A description of the operation of the furnace is as follows:

Referring now to the operation of the plunger 37 and the drag mechanism, assuming that the bars 49 are in the extreme back position to which they are moved by the gear segments 56 as shown in Fig. 2, in which position the plunger 37 is withdrawn from a position in which it closes the outlet of the chute 35 and the drag plates 41 assume substantially horizontal position as shown, the initial forward movement of the bars 49 rotates these plates downwardly and forwardly to a position in which they engage the stop surfaces 48 (Fig. 4) of the lug 43, whereupon continued forward movement of the bars 49 moves the bars 38 bodily forwardly and the plates 41 and plunger 37 connected therewith, the plunger operating to feed a charge of coal into the trough 31 and the drag plates advancing along the trough the coal in the front of them. Upon the beginning of the rearward stroke of the bars 49 the drag plates 42 first swing into the position shown in Fig. 2 at which time the tie rod 51 engages the shoulders $38^b$ on the bars 38. The continuing rearward movement of the bars 49 thus moves the bars 38 and the parts connected therewith to their rearwardmost position as shown in Fig. 2.

It is preferred that the drag plates 41 be spaced apart a distance slightly less than their horizontal travel, so that these plates in swinging to vertical position will always become positioned behind the coal as advanced by the preceding drag plate, thereby avoiding wedging of the plates by the coal which might happen if these plates were so arranged that in swinging to vertical position they would cut through a relatively thick bed of coal.

It is also preferred that the radius of the curved portion 33 of the trough 31 be substantially equal to the height of the rearwardmost drag-plate 41, as shown, whereby this drag-plate, in engaging the coal pushed into the trough 31 by the plunger 37, sweeps downwardly and forwardly with its lower edge close to the curved portion 33 and as the plunger 37 may be caused to deliver an equal amount of coal at each stroke, choking or sticking of the drag mechanism thus may be avoided.

Referring now to the operation of the combined grate and stoking mechanism, reciprocation of the movable grate sections 24 and the plunger 25 operate to advance the coal along the grate, feeding the coal to the upper front end thereof and discharging the ashes at the rear end portion of the grate. It being preferred that the space between the rearwardmost grate section 23 and the rear wall of the furnace be provided with a plate 83 secured at its rear edge portion to a rock shaft 84 equipped with a counterweight 85 causing the plate 83 to normally close the space referred to, this plate normally inclining upwardly and rearwardly and extending into the path of the forward movement of the lowermost movable grate section 24 the plate 83 being moved to open position to discharge any clinkers thereon, by engagement therewith of the grate section referred to.

In the movement of the coal along the trough 31 the coal is thus subjected to the heat generated by the fire bed on the grate causing it to become heated with the result of drying the coal and at least partially coking it, the finer particles of the coal dropping through the apertures 32 in the trough and upon the hot fire bed below, and, being in dried and heated condition, these finer particles readily ignite, very much the same as in the case of gas, with almost complete combustion.

The coal in passing through the coking trough 31 will give off more or less of the volatile matter therein and this gas mixed with air entering the chamber 16 through openings 86 in the rear wall of the chamber shown as located immediately above the racks 55 and controlled by swinging doors 87 and which becomes heated in the chamber, travels, under the action of the draft in the stack 13 along the chamber 16 to the front end thereof and thence into the combustion chamber above the fire bed where it will be burned without waste or smoke.

The coal which is thus delivered to the grate sections, is in dried and preferably at least partially coked condition, thereby eliminating the production of smoke and ensuring practically complete combustion of the coal supplied to the furnace.

Referring now to the construction shown in Figs. 8 and 9, this construction constitutes a desirable embodiment of my invention for incorporation in a hot air furnace.

In this construction the outer shell of the furnace is represented at 88, this shell having a cold air inlet in the form of a screen 89 at its lower end and an outlet 90 at its upper end for the heated air.

Located within the shell and spaced therefrom and out of communication therewith is a combustion chamber 91 having a combined grate

and stoker mechanism at the lower end thereof as represented at 92 and of the same general construction as that shown in Fig. 2, the shaft by which this mechanism is operated, and corresponding with the shaft 30, being represented at 93.

Above the combustion chamber 91 is a chamber 94 and corresponding with the trough 31, the bottom of this chamber being apertured as represented at 95 and as shown and described of the bottom of the trough 31, the forward end of the chamber 94 being open for discharge therethrough and upon the grate and stoker mechanism below it, of coal advanced through this chamber as hereinafter described.

The rear end of the chamber 94 communicates with the spout portion 96 of a coal bin not shown and through which the coal flows into the chamber 94.

The combustion chamber 91 is provided with vertical flues located at opposite sides of the chamber 94 which open into horizontal flues (not shown) in which the products of combustion pass forwardly to the front end of the furnace and thence upwardly to a series of horizontal flues 97 in communication at their rear ends with the stack 98.

The chamber 94 is shown as provided with a spiral conveyor 99 comprising a shaft 100 journalled at its forward end in the front wall of the furnace and at its rear end in a bearing 101 at the rear end of the chamber 94, this conveyor operating to feed the coal supplied from the spout 96 along the chamber 94 for the purposes described in connection with the construction of the preceding figures. Air is supplied to the chamber 94 through damper-equipped openings 102 in the rear wall of the furnace (one only of such openings being shown) this air mixing with the gases evolved from the coal as it passes along the chamber 94, the only outlet of this chamber being into the combustion chamber 91 which compels the gases referred to to travel through the combustion chamber on their way to the stack 98.

The mechanism for operating the conveyor and the combined grate and stoker mechanism and which preferably is so constructed as to operate these two mechanisms alternately as in the case of the construction of the preceding figures of the drawings, comprises a reciprocable bar 103 actuated by mechanism represented at 104 and shown as of the same construction as that illustrated and described for actuating the rack bar 63. The bar 103 is provided with rack portions 105 and 106, the rack portion 105 meshing with a gear segment 107 pivotally supported at 108 and having pawls 109 for intermittently driving a ratchet wheel 110 having a crank 111 pivotally connected with one end of a link 112 the other end of which is pivotally connected at 113 with a crank 114 on the shaft 93.

The other rack portion 106 meshes with a gear segment 115 pivotally supported on a shaft 116 and having pawls 117 operating to intermittently drive a ratchet wheel 118 fixed on the shaft 116, the shaft 116 being connected through bevel gears 119 and 120 with the shaft 100 thereby operating to intermittently rotate the conveyor 99.

While I have illustrated and described certain embodiments of my invention, I do not wish to be understood as intending to limit it thereto as the same may be variously modified and altered and the invention embodied in other forms of construction without departing from the spirit of my invention.

What I claim as new, and desire to secure by Letters Patent, is:

1. In a furnace, the combination of a grate, a coal-supporting member arranged above said grate and subjected to the heat generated by the fire bed on said grate, said member having an apertured bottom for discharge, upon said fire bed, of fine particles of coal sifting through said member, means for feeding the coal along said apertured bottom, and means for conducting the gases generated by the heating of the coal on said member into the space between said grate and member.

2. In a furnace, the combination of a combustion chamber, a grate at the bottom of said combustion chamber, a second chamber above said combustion chamber, and located at substantially the median line of the furnace, said second chamber communicating at one end with said combustion chamber, means for feeding coal in said second chamber for discharge into said combustion chamber, and a series of flues above said chambers the central one of which communicates at one end with the stack-outlet of the furnace and at its opposite end with adjacent ends of the others of said flues, which latter communicate at their other ends with said combustion chamber.

ORIN KELLY.