

F. C. WILLIAMS.
TUBULAR GRATE.

APPLICATION FILED NOV. 28, 1902.

NO MODEL.

5 SHEETS—SHEET 1.

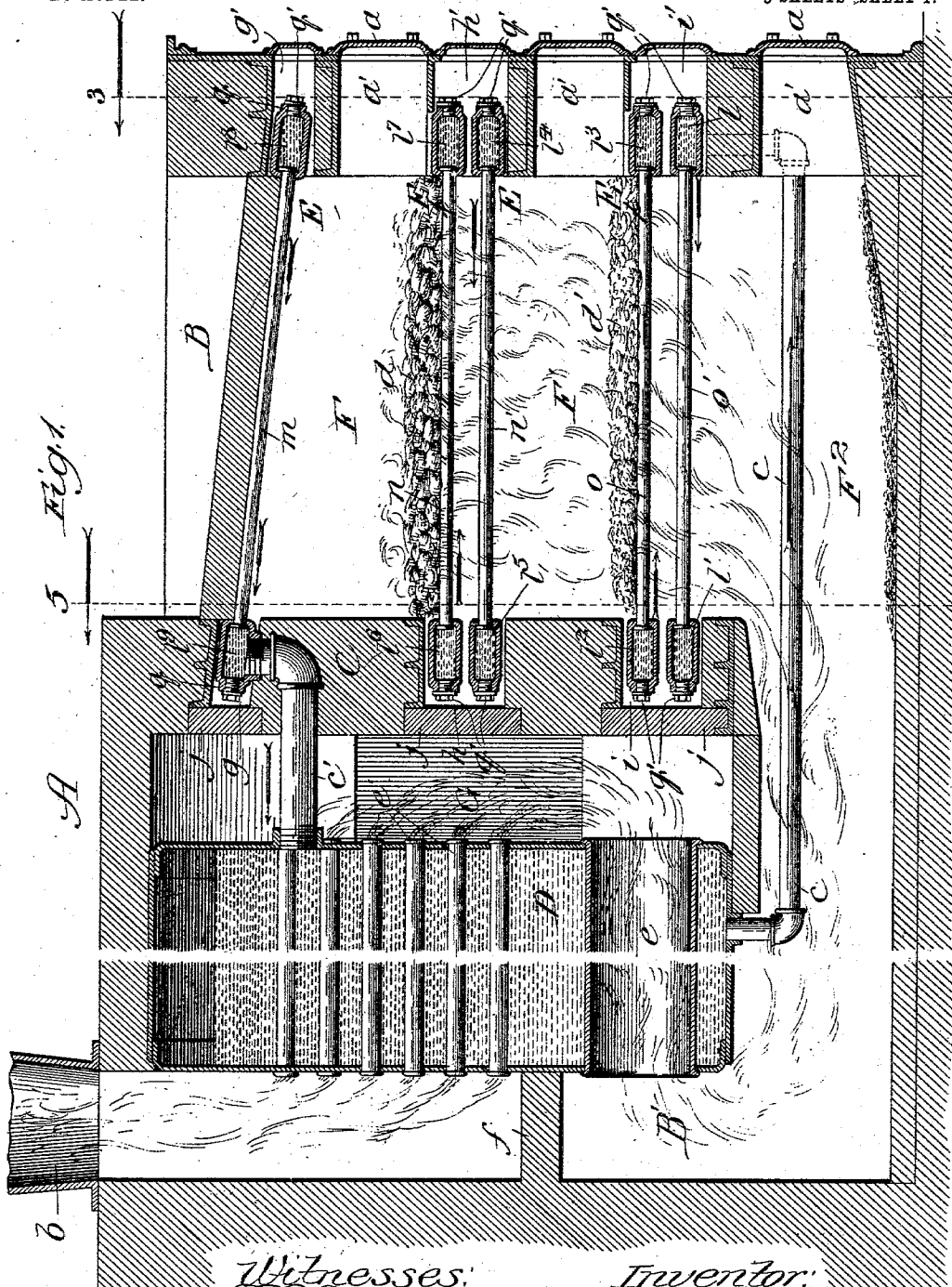


Fig. 1

Witnesses:
Ed. J. ...
Geo. C. ...

Inventor:
 Frederick C. Williams,
 By *Dymfreck, Dymfreck & Co.*

Attys.

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5 SHEETS—SHEET 2.

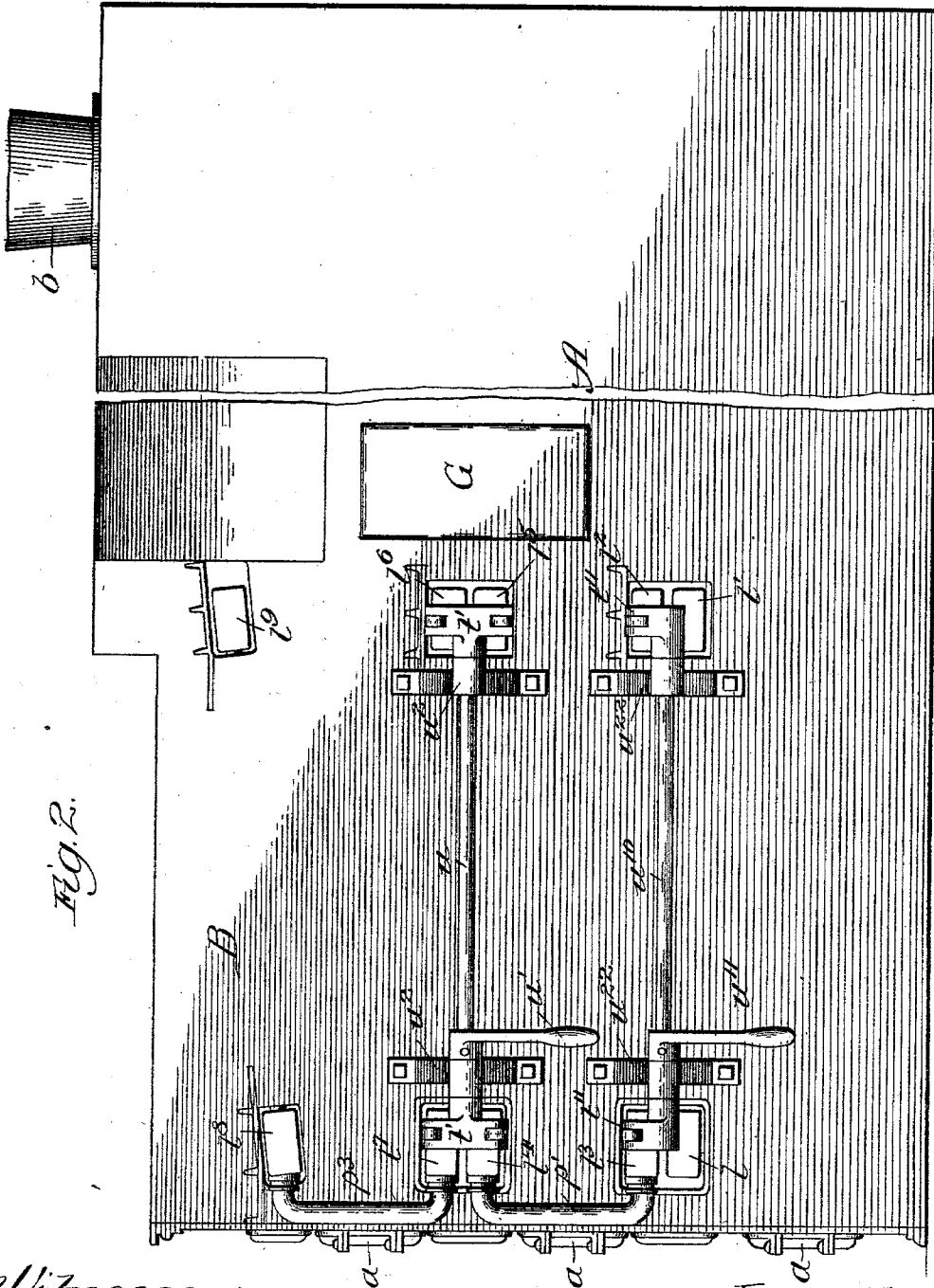


Fig. 2.

Witnesses:
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Geo. C. Rowan.

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5 SHEETS—SHEET 3.

Fig. 3.

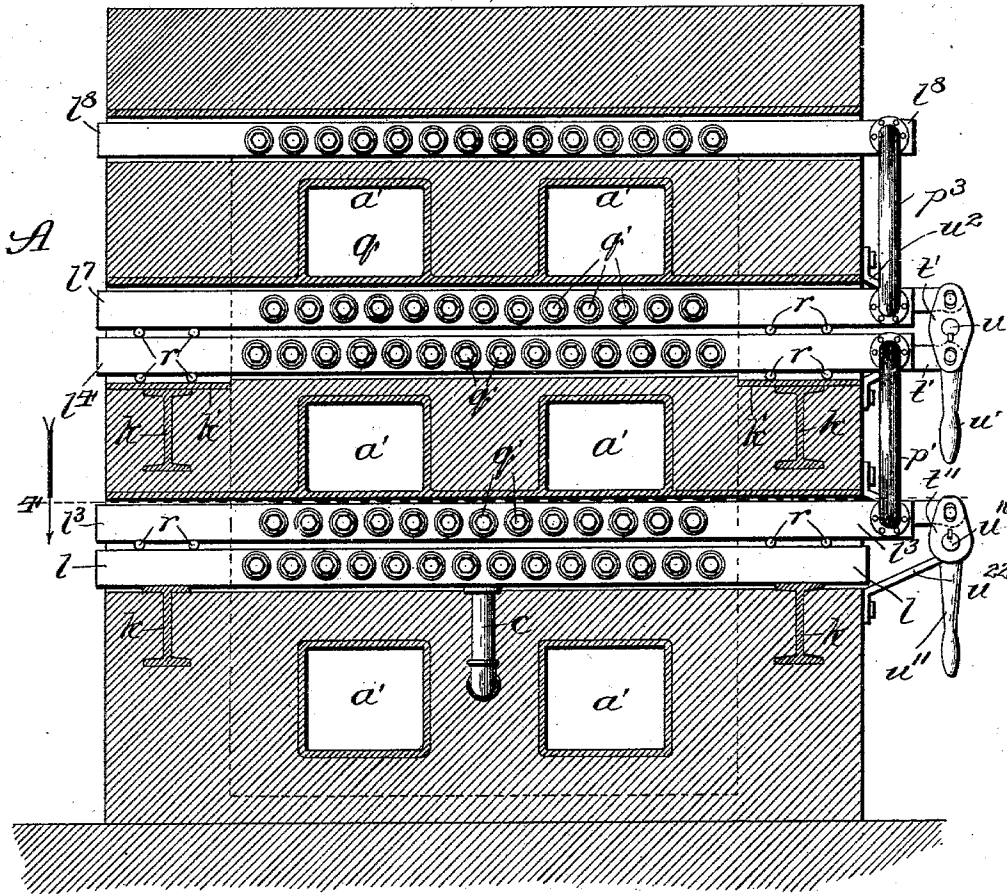
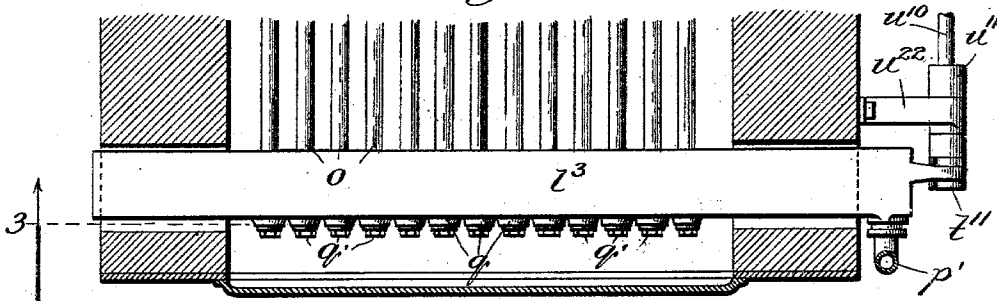


Fig. 4.



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5 SHEETS—SHEET 4.

Fig. 5.

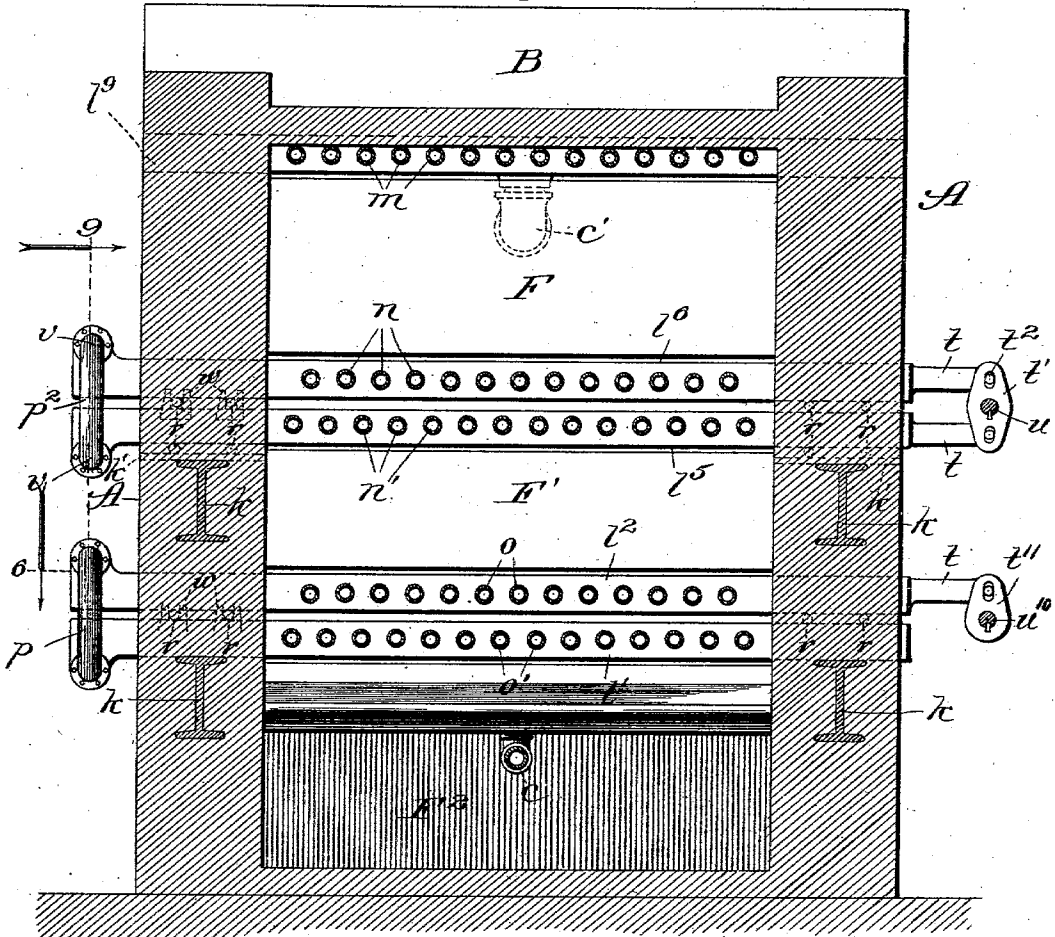


Fig. 6.

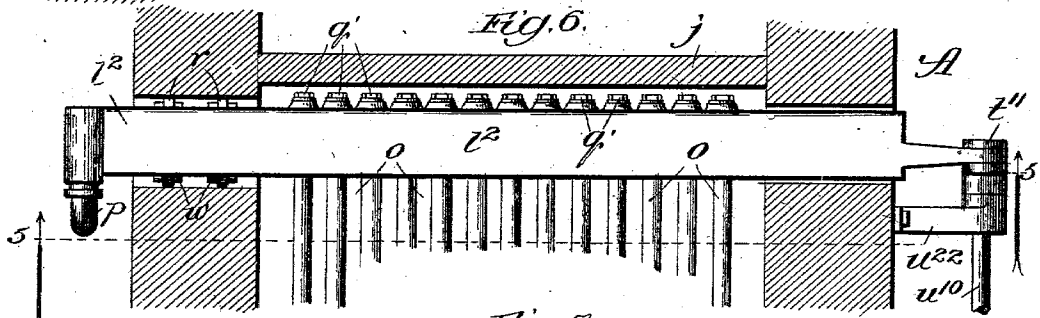
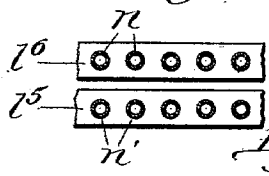


Fig. 7.



Witnesses:
Ed. O. Lyford,
Geo. C. Johnson,

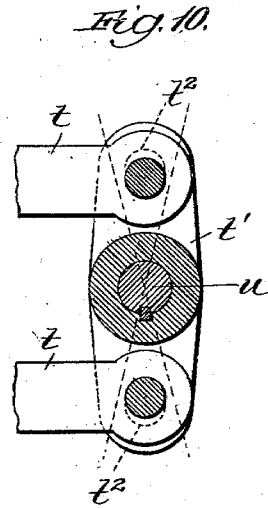
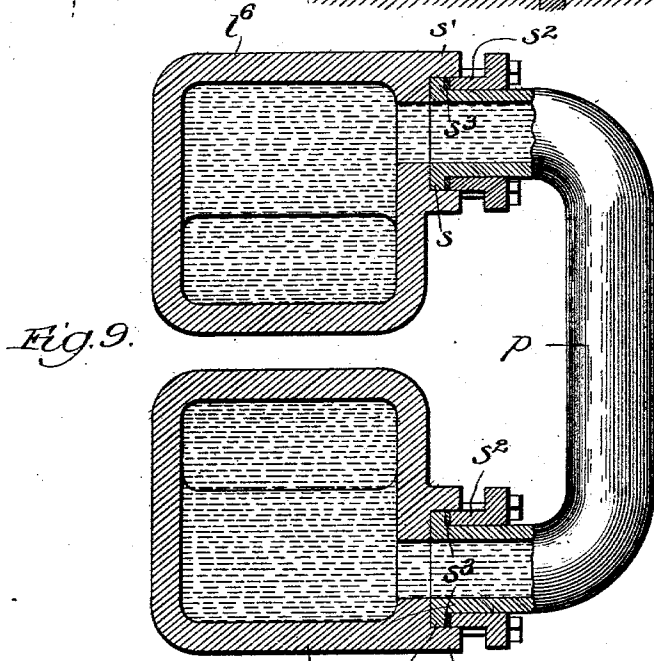
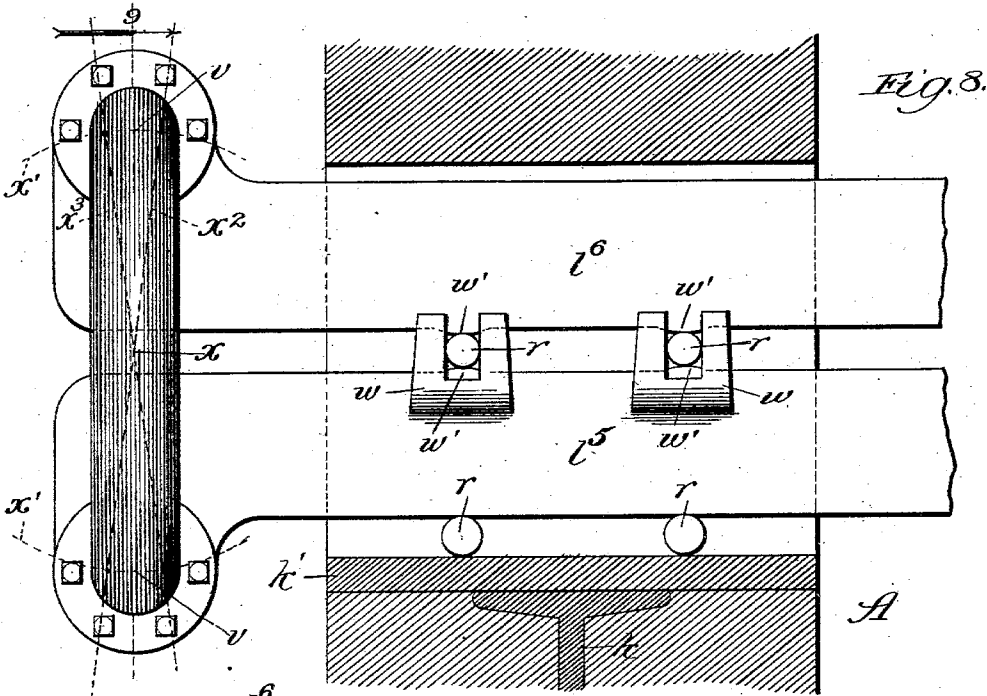
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F. C. WILLIAMS.
TUBULAR GRATE.

APPLICATION FILED NOV. 26, 1902.

5 SHEETS—SHEET 5.

NO MODEL.



Witnesses:
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Geo. C. Dawson

Inventor:
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UNITED STATES PATENT OFFICE.

FREDERICK C. WILLIAMS, OF CHICAGO, ILLINOIS.

TUBULAR GRATE.

SPECIFICATION forming part of Letters Patent No. 720,867, dated February 17, 1903.

Application filed November 26, 1902. Serial No. 132,869. (No model.)

To all whom it may concern:

Be it known that I, FREDERICK C. WILLIAMS, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Tubular Grates, of which the following is a specification.

My invention relates to an improvement in the class of tubular grates in which the tubular grate-bars through which water is circulated from and to the boiler form an upper fire-chamber and a lower fire-chamber, into which latter the live coals drop from the upper chamber through the spaces between the grate-bars that separate the two chambers and lodge on the lowermost grate-bars between which the ashes fall into the ash-pit.

The primary object of my invention is to generally improve the construction of grates in the class referred to; and it is my further and especially important object to adapt the fuel-bed-supporting grate-bars to be shaken to effect more free passage between them of the material from the fuel imposed upon them.

Referring to the accompanying drawings, Figure 1 is a view in longitudinal sectional elevation of a furnace provided with my improved tubular grate connected with a boiler. Fig. 2 is a view of the same in side elevation, presenting the outer surface of a side wall of the furnace which is shown in inside elevation in Fig. 1. Fig. 3 is a section taken at the line 3 on either Fig. 1 or Fig. 4 and viewed as indicated by the arrows; Fig. 4, a section taken at the line 4 on Fig. 3 and viewed in the direction of the arrow; Fig. 5, a section at the inner end of the fire-chamber of the furnace, taken either at the line 5 on Fig. 1 or at the line 5 5 on Fig. 6 and viewed as indicated by the arrows; Fig. 6, a section taken at the line 6 on Fig. 5 and viewed in the direction of the arrow; Fig. 7, a broken view of two headers or manifolds, one above the other, carrying tubular grate-bars shown in the relative positions they occupy at one end of their throw in shaking them; Fig. 8, a broken enlarged view showing the two inner headers of the middle section of the tubular grate-bars with their elbow-pipe, flexible connection, and other details adapting them to be shaken; Fig. 9, a section taken at the line 9 on Fig. 8, viewed as indicated by the arrow and en-

larged; and Fig. 10, a broken view, in sectional elevation, of the shaking attachment on the outer ends of said headers, showing details of construction.

A is a furnace having a fuel-combustion compartment B in its forward end provided with the required number of hinged doors *a*, covering openings *a'* in the front wall and separated by a hanging bridge-wall C from the rear compartment B', containing a boiler D and provided with an outlet *b* for products of combustion.

E is my improved tubular grate disposed in the compartment B to form the upper combustion-chamber F and the lower combustion-chamber F' above the ash-pit F² in a downdraft-furnace, through which the boiler is connected from its base by a pipe *c* with the system of grate-tubes at the lower end thereof, they being connected from the upper end by a pipe *c'*, as shown, or in any other suitable manner with the boiler above the water-line therein. Thus circulation is established from the base of the boiler through the tubular grate back to the boiler. Fuel introduced through the upper door or doors *a* into the chamber F burns on the grate-section forming the base of that chamber, and the live coals on the bottom of the fuel-bed *d* in the chamber F drop between the bars upon the bed *d'* in the chamber F', from which the ashes escape between the lower grate-bars into the pit F². While the furnace is in operation the upper doors *a* are open and the draft is downward from them through the fuel-beds *d* and *d'* and ash-pit, carrying the products of combustion to the rear of the furnace-compartment B' for passage through the large flue *e* of the boiler from its inner end, being stopped from rising above such inner end by a diaphragm *f* in their path. From the forward end of the flue *e* the products of combustion pass through the boiler-flues *e'* and escape at the outlet *b*. The described course of the products of combustion through the boiler-tubes applies to the particular type of boiler illustrated; but it may vary according to the type of boiler used, which has nothing to do with my invention.

My improved grate comprises in detail the following-described construction: In the inner or rear wall of the compartment B are

provided, one above the other, the longitudinal bores or openings g , h , and i , and corresponding openings g' , h' , and i' are provided in the front wall of the furnace, the wall-section below each of the openings h and h' having by preference I-beams k embedded in them to extend flush with the bases of the openings, which are lined with metal bearing-plates k' , and the wall-section below each opening i and i' having similar beams k embedded in them to project slightly above the bases of the openings and afford bearings. In the opening g is immovably supported a manifold or header l^9 , and a similar header l^8 is supported in the same way in the opening g' . These headers are connected across the top of the compartment B by a series of tubular grate-bars m . Headers l^7 and l^5 are supported in the opening h' one upon the other with interposed steel rollers r , and the lowermost of the two headers rests upon similar rollers r , which bear on the plates k' , and headers l^6 and l^3 are similarly supported one upon the other through the medium of rollers r in the opening h . The headers l^7 and l^6 , which are movable, are connected across the center of the compartment by a horizontal series of tubular grate-bars n , forming the base of the chamber F, and immediately below them the headers l^5 and l^4 , also movable, are similarly connected by a horizontal series of tubular grate-bars n' , which are normally in staggered relation to the bars n . Headers l^3 and l are supported one upon the other, with interposed rollers r in the opening i' , and headers l^2 and l' are similarly supported in the opening i . The headers l^2 and l^3 , which are movable, are connected across the base of the compartment by a horizontal series of tubular grate-bars o , forming the base of the chamber F', and the headers l and l' , which are stationary, are similarly connected by a horizontal series of tubular grate-bars o' , normally in staggered relation to the bars o above them.

The pipe c leads from the base of the boiler into the header l . Beyond one end of the rear wall of the compartment B the headers l' and l^2 are flexibly connected, in the manner hereinafter described, at their projecting ends to intercommunicate by an elbow-pipe p . In a similar manner the headers l^3 and l^4 are connected at their ends which project beyond the front wall of the compartment B by an elbow-pipe p' , the headers l^6 and l^5 are connected at their ends projecting beyond said rear wall by an elbow-pipe p^2 , and the headers l^7 and l^8 are connected at their ends projecting beyond the front wall by an elbow-pipe p^3 . The pipe c' (shown in Fig. 1 as connecting the header l^9 with the boiler) is represented as leading downward from the header. In practice it leads either straight or upward; but it had to be shown as represented in the drawings because of the limitations of the latter and the desire to represent the parts of the structure upon a comparatively large scale.

As shown, the grate-bars are reamed at their

opposite extremities to secure them against withdrawal in their respective headers, which are tapped at flanges q on their outer sides coincident with each grate-bar, the openings being closed by screw-plugs q' . This particular construction facilitates the removal and insertion of any grate-bar in case of need. Such removal may readily be performed, since the taps on the leaders are accessible, those at the rear of the furnace through a manhole G on removing the slabs j , that cover the openings g , h , and i , as represented in Fig. 1, and by cutting off the reamed ends of any tubular bar it may be drawn out at the front of the furnace, the particular covering-plate being removed for the purpose. In the same way a new tube may be adjusted in place, and when inserted its ends are reamed to secure it.

The several elbow-pipes, which afford communication between the headers, are connected in the manner represented in Fig. 9. Each elbow-pipe is provided with flanges s at its opposite ends, which enter and fit in sockets s' , projecting from the headers to be connected by it, and glands s^2 are fitted against the flanges s with interposed packing s^3 and are fastened by bolts. Thus the flexible connection is formed between the headers, which permits the members of connected pairs to be slidingly reciprocated longitudinally with relation to each other, as and for the purpose hereinafter described. Only the headers l^2 and l^3 , l^4 and l^5 , and l^6 and l^7 require to be moved. To this end they are each provided with a headed solid extension t , projecting from one end. The expanded ends of the extensions on the headers l^5 and l^6 are perforated and enter, respectively, the bifurcated opposite ends of a rocking head t' , wherein they are pivotally fastened by bolts passing through such expanded ends and through elongated openings l^2 in the bifurcated ends of the head. The headers l^4 and l^7 are flexibly connected together in a similar manner by a head t' , and a rock-shaft u , carrying an operating-handle u' , Fig. 2, and supported in bearings u^2 on the side wall of the furnace, through which the headers project, connects the two heads t' at their centers. The expanded extension end of each header l^2 and l^3 enters the single bifurcated end of a rocking head t'' , also having elongated openings like the openings t^2 in the heads t' to receive the bolts which connect the heads pivotally with such expanded header ends, and the heads t'' are connected together by a rock-shaft u'' , supported in the bearings u^{22} (shown in Fig. 2) and carrying an operating-handle u'' .

As will be understood from the foregoing description of the mechanism, the course of water circulation through the tubular grate is from the boiler through the pipe c , header l , tubes o' , header l' , elbow-pipe p , header l^2 , tubes o , header l^3 , elbow-pipe p' , header l^4 , tubes n' , header l^5 , elbow-pipe p^2 , header l^6 , tubes n , header l^7 , elbow-pipe p^3 , header l^8 ,

tubes *m*, header *l*³, and pipe *c*' back to the boiler.

By working the handle *u*' back and forth the headers *l*⁵ *l*⁶ are reciprocated longitudinally in relatively contrary directions owing to their connection *t*', and the headers *l*⁴ *l*⁷ are simultaneously reciprocated in the same way, with the effect of reciprocating the tubes *n* *n*' to bring the members on different horizontal planes, forming each pair into vertical alinement, as represented in Fig. 7, at one end of the throw of the operating-lever and to restore them to their normal staggered relation at the opposite end of the throw. Thus the spaces between horizontally-adjacent tubes are widened and narrowed, and the middle section of the tubular grate is "shaken" to feed live coals from the bed *d* to the bed *d*'. The headers *l*² and *l*³ may be reciprocated relative to the stationary headers *l*' and *l*, respectively below them, to widen and narrow the spaces between the adjacent members of tube pairs *o* *o*' for shaking the lower grate-section to facilitate the evacuation of ashes from the chamber *F*'. If desired, the shaking operation may be continuous, and to that end the handles *u*' and *u*'' may be coupled with a suitable engine (not shown) for actuating them.

The movements of the lower headers *l*⁴ and *l*⁵ are, as will be observed, in horizontal lines without deviation therefrom, while the rocking-head connections *t*' and *t*'' cause the upper headers *l*⁶ and *l*⁷ and the upper headers *l*² and *l*³, respectively, to tilt toward their ends opposite those connected by the heads. It is to decrease the extent of this tilt from a horizontal line that the elbow connection between headers is preferably made, as represented in Fig. 8. It will be noticed that the connected ends of the headers *l*' and *l*² in that figure are expanded, respectively, in a downward and in an upward direction, so as to separate the centers *v* and *v*' of the points of connection with the elbow-pipe that much farther apart. Thus the arc *x*' of the circle having its center at *x*, through which the center *v* travels, is increased in radius, thereby decreasing the extent of tilt from a horizontal line of the end of the upper header, which extent is from the inclined line *x*² to the inclined line *x*³. The rollers *r* between the upper and lower headers are confined by lugs *w* between convex bosses *w*' on the header-surfaces to insure bearing of the upper header on its supporting-rollers throughout its entire reciprocating movement involving the tilting at one end referred to, and to prevent binding at the ends of companion headers where they are connected by the rocking heads *t*' and *t*'' the bolt-holes *l*² in their bifurcated ends are elongated, as shown and described.

I have herein for the sake of clearness minutely described the details of the mechanism illustrated for the embodiment of my invention; but it is not limited to such details, for they may be variously modified without

departure from my invention, which I consider to be broadly new with respect to the general construction of the tubular grate and as to its shaking feature.

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

1. In a furnace, a tubular grate comprising, in combination, upper, intermediate and lower headers supported on each of the forward and rear walls of the combustion-compartment, and series of tubes connecting opposite headers and dividing said compartment into an upper combustion-chamber and a lower combustion-chamber having a tubular base, said headers being connected one to another to communicate throughout the grate.

2. In a furnace, a tubular grate comprising, in combination, an upper header supported on each of the forward and rear walls of the combustion-compartment, a series of tubes connecting said headers, a pair of intermediate headers supported one above the other on each of said walls and having corresponding members of each pair connected by a series of tubes, and a pair of lower headers supported one above the other on each of said walls and having corresponding members of each pair connected by a series of tubes, said headers being connected one to another to communicate throughout the grate and said tubes forming in said compartment an upper combustion-chamber and a lower combustion-chamber.

3. In a tubular furnace-grate, the combination of headers supported one above the other in pairs on opposite walls of the combustion-compartment of a furnace, and a series of tubes connecting opposite members of each pair of the headers, said members of each pair of headers being relatively movable for shaking the grate and said headers being flexibly connected to communicate from one to the other.

4. In a tubular furnace-grate, the combination of headers supported one upon the other in pairs in openings in opposite walls of the combustion-compartment of a furnace, the members of each pair being relatively movable longitudinally, a series of tubes connecting opposite members of each pair of the headers, said headers being flexibly connected to communicate from one to the other, and means for actuating said movable members to shake the grate.

5. In a furnace, a tubular grate comprising, in combination, an upper header supported in an opening in each of the front and rear walls of the combustion-compartment, a series of tubes connecting said headers, a pair of intermediate headers supported one above the other in an opening in each of said walls, the members of each pair being longitudinally movable and connected to reciprocate in relatively contrary directions, a series of tubes connecting opposite members of each pair of said intermediate headers, a pair of lower headers supported one above the other

in an opening in each of said walls, the upper member of each pair being longitudinally reciprocable, a series of tubes connecting opposite members of each pair of said lower headers, said headers being flexibly connected to communicate from one to the other throughout the grate, and means for actuating said movable headers to shake the grate.

6. In a furnace, a tubular grate comprising, in combination, an upper header supported in an opening in each of the front and rear walls of the combustion-compartment, a series of tubes connecting said headers, a pair of intermediate headers supported one above the other on rollers in an opening in each of said walls, the members of each pair being longitudinally movable and connected at one end to reciprocate in relatively contrary directions, a series of tubes connecting opposite members of each pair of said intermediate headers, a pair of lower headers supported one above the other in an opening in each of said walls, the upper member of each pair being supported on rollers and longitudinally reciprocable, a series of tubes connecting opposite members of each pair of said lower headers, elbow-pipes flexibly connecting said headers from one to another, and means for actuating said movable headers to shake the grate.

7. In a furnace, a tubular grate comprising, in combination, an upper header supported in an opening in each of the front and rear walls of the combustion-compartment, a series of tubes connecting said headers, a pair of intermediate headers supported on rollers one upon the other, with rollers interposed between them, in an opening in each of said walls, the members of each pair being longitudinally movable, a rocking-head connection between the members of each pair of said intermediate headers at each end thereof, a rock-shaft connecting the opposite rocking heads, and series of tubes connecting the opposite members of each pair, a pair of lower headers supported one upon the other, with interposed rollers, in an opening in each of said walls, the upper member of each pair being longitudinally reciprocable and provided at each end with a rocking head, a rock-shaft connecting the rocking heads on the upper members of the lower headers, a series of tubes connecting opposite members of each pair of said lower headers, and elbow-pipes flexibly connecting the headers in series from one to another throughout the grate.

FREDERICK C. WILLIAMS.

In presence of—

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