No. 703,068. Patented June 24, 1902.

R. W. KING.

AUTOMATIC STOKER AND SMOKE CONSUMER.

(Application filed June 23, 1900.)

(No Model.) 3 Sheets—Sheet 1.

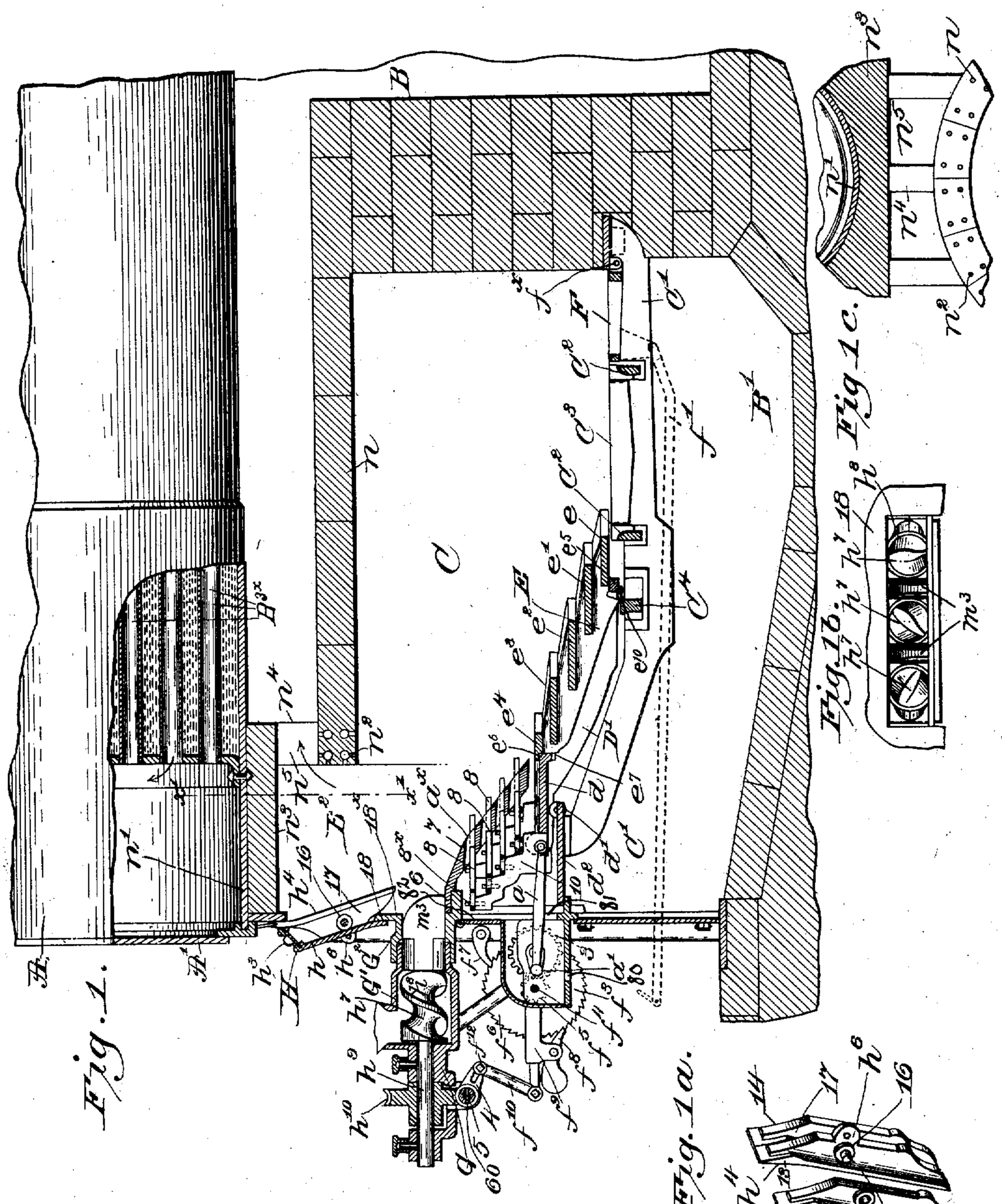

Fig. 1.

Fig. 1c.

Fig. 1b.

Fig. 1a.

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(No Model.) 3 Sheets—Sheet 2.

Fig. 2.

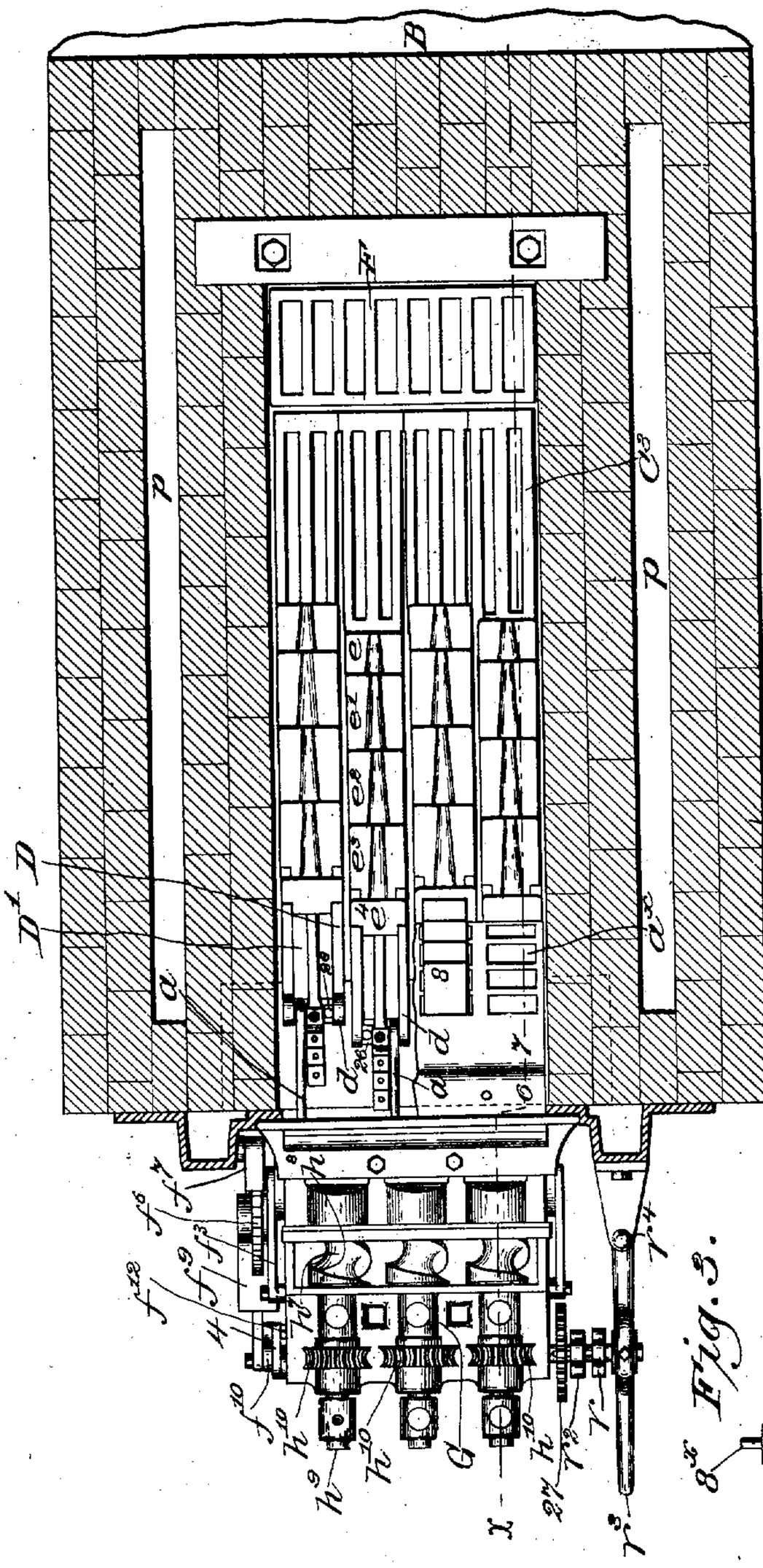

Fig. 4.

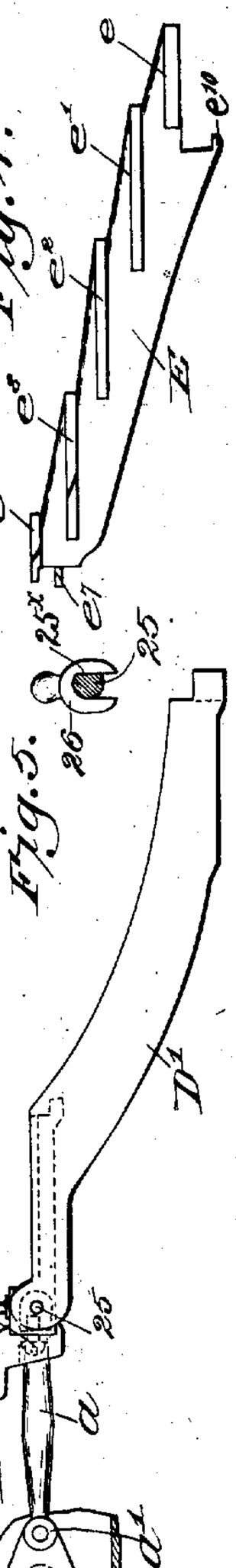

Fig. 5.

Fig. 3.

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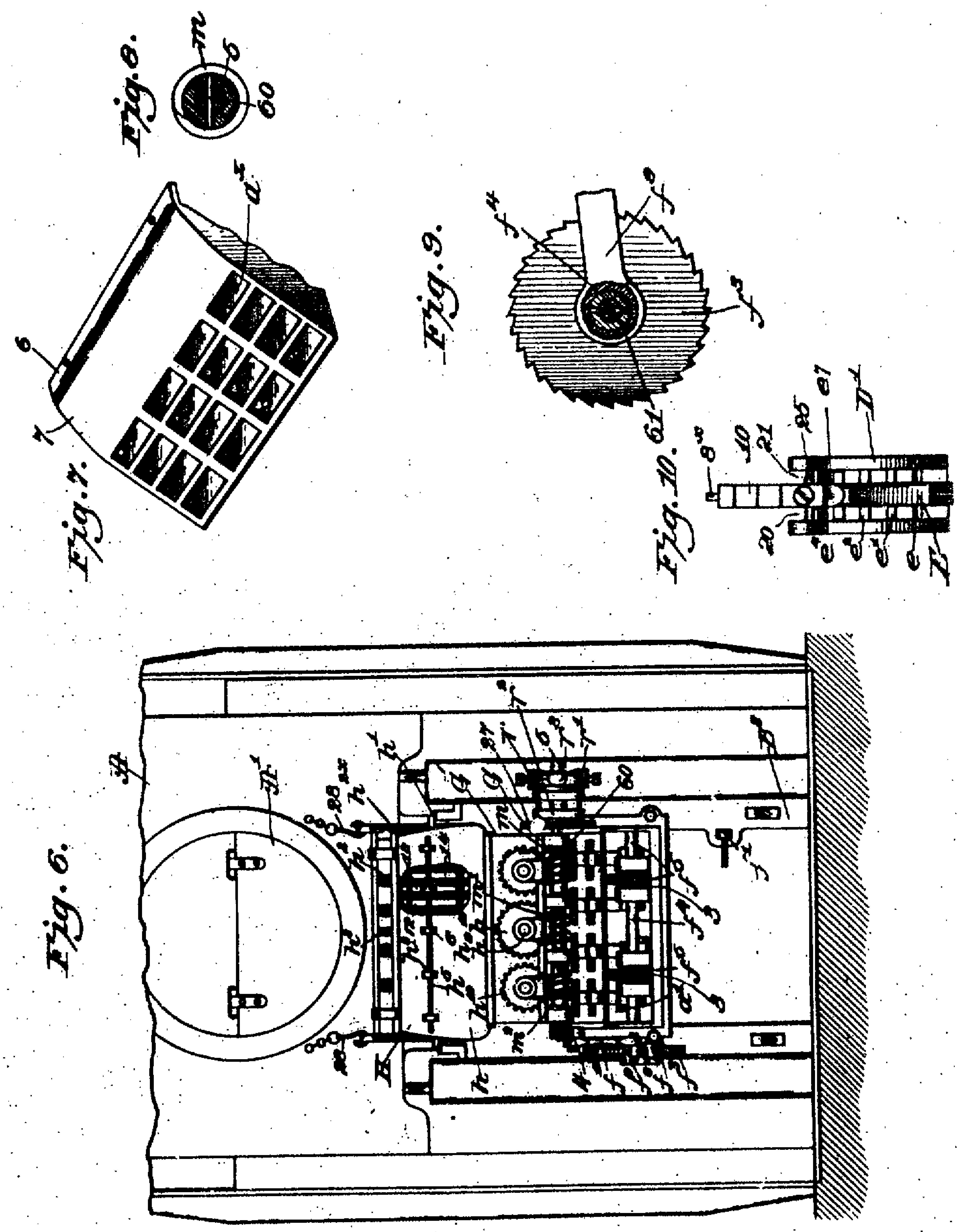
AUTOMATIC STOKER AND SMOKE CONSUMER.

(Application filed June 28, 1900.)

(No Model.) 3 Sheets—Sheet 3.



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UNITED STATES PATENT OFFICE.

ROBERT W. KING, OF TORONTO, CANADA.

AUTOMATIC STOKER AND SMOKE-CONSUMER.

SPECIFICATION forming part of Letters Patent No. 703,068, dated June 24, 1902.

Application filed June 23, 1900. Serial No. 21,378. (No model.)

To all whom it may concern:

Be it known that I, ROBERT W. KING, a subject of the Queen of Great Britain, residing at Toronto, Province of Quebec, Canada, have invented an Improvement in Automatic Stokers and Smoke-Consumers, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

This invention has for its object to provide novel stoking apparatus which may be operated automatically to feed fuel into the combustion-chamber of a furnace that it may be consumed therein substantially without smoke.

In my invention in the form in which I have herein chosen to illustrate it, one of the best forms now known to me, I supply within the combustion-chamber a bed-grate, and coöperating with it I employ a feeding-grate and pokers to move the coal or other fuel being consumed at the proper speeds. The coal or other fuel may be fed into the mouth of a suitable hopper, herein represented as having a substantially horizontal floor and receiving a plurality of fuel-feeding means, said means feeding the coal upon a plate located within the furnace-chamber, which when soft coal is used forms what I shall hereinafter designate as a "coking-plate," the upper portion of the combustion-chamber being so shaped and located as to cause the heat arising from the combustion of the coal to impinge directly upon the coal lying on the coking-plate. The combustion-chamber contains as a continuation of said coking-plate a downwardly-inclined surface provided with a series of coal-sustaining pockets, (shown as having horizontal surfaces,) they serving to detain the coal coming down the incline until, as in the case of soft coal, it is coked, and thereafter the poker-drivers, preferably mounted in series upon a series of carriages, are actuated to attack the coal in said pockets and feed it upon the feeding-grate. Air is admitted freely to the under side of the coking-plate and its inclined continuation from the front of the furnace to thereby supply air to control the combustion. The door by which access may be had to the combustion-chamber to examine the fire or for other purposes is located above the plate which receives the coal from the feeding means operable in the hopper, and said door, as represented, has a series of air-passages which deliver outside heated air to the surface of the coal at the point where it is giving off the most volatile gases, thereby supplying said gases with oxygen to insure substantially complete combustion of the gases. The quantity of air so introduced may be regulated by a damper. The hopper contains a plurality of feeding means, and I have devised means whereby the feeding means may be operated at different speeds, as I find it advisable under some conditions to feed the ends of the incoming layer of coal faster than the center of said layer, or it might be vice versa, or, in other words, the feeding of the fuel may be effected at different points at different speed. The speed of movement of each feeding means may be controlled independently, inasmuch as each feeding means is actuated by a separate worm and worm-gear, and changing the pitch of the worm the furnace may be fed as desired.

Figure 1 is a perspective longitudinal section in the line x, Fig. 2, of a boiler, its setting, and my improved stoking apparatus. Fig. 1^a shows one of the baffle-bars detached from the door. Fig. 1^b is an inner side view of the hopper-mouth, showing the division-walls and the fuel-feeding apparatus. Fig. 1^c is a detail to the right of the dotted line x', Fig. 1. Fig. 2 is a section below the dotted line x^2, Fig. 1. Fig. 3 shows one of the feeding grate-bars detached and a connected poker-driver, said figure showing the crank and crank-shaft for moving the grate-bar. Fig. 4 shows the grate detached from the bar. Fig. 5 is a section of the pin for connecting the grate-bar with the link and the locking device for said pin. Fig. 6 is a front end view of the setting, with the ash-pit door omitted and the feeding-door partially broken out to show the baffle-bars. Fig. 7 shows in perspective the plates 6 7 detached. Fig. 8 shows the means for uniting the fuel-feeder with its operating-shaft. Fig. 9 is a detail of the ratchet-wheel for moving the worm-shaft and the means for uniting the same. Fig. 10 is a detail showing the inner end of one of the carriages.

Referring to the drawings, A is a portion

of an ordinary horizontal return tubular boiler, A′ representing any usual uptake. This boiler is mounted upon any usual or suitable boiler-setting, preferably brickwork, (designated B,) it having an ash-pit section B′ and an outlet at B^2 for the products of combustion, said products passing in the present instance of my invention around or about the boiler and through its tubes $B^{3\times}$ into any usual flue in any usual or suitable manner.

The combustion-chamber is designated by the letter C. The combustion-chamber has mounted in its sides a suitable frame C′, represented as notched in two places to receive grate-bearing bars C^2, which sustain the bed-grate C^3. Said bars C^2 also sustain an auxiliary bar C^4, upon which rest a series of carriages D D′, arranged, preferably, in pairs, one of said carriages being shown detached in Fig. 3. The front end of said carriages has suitable extensions *d*, which are represented as resting upon a roller-support *d*′, suitably sustained at the end of a plate d^2, which is united with or sustained by the outer ends of the frame C′. The carriages D D′ receive each a suitable feeding grate-bar E or feed-sustaining surface, (shown detached in Fig. 4,) represented herein as having a series of drivers e e' e^2 e^3 e^4 of any desired number, said drivers being herein represented as located at different levels or one above the other vertically and detachable from the carriage. The section-lines, Fig. 1, show the drivers of the grate-bar connected with the first carriage D of the series, the drivers of the next bar behind it in the carriage D′ being shown in elevation. Each of these grate-bars may be secured to its own carriage by suitable means, as a hook e^{10}, herein shown as embracing a bar e^5, connected with the carriage near its lower end, the upper end of the bar resting upon a shoulder, as e^6, of the plate *d*, a suitable pin e^7, passed through a lug at the upper end of the bar, retaining it in place.

The carriages referred to, of any desired number, arranged side by side, are reciprocated or moved longitudinally, as herein represented, by suitable links *a*, connected with crank-pins *a*′, carried by arms extended from a shaft 2, carrying between its ends a toothed wheel 3, the crank-arms being set, so that as one crank-pin and link moves a carriage forward the other crank-pin and link will move an adjacent carriage backward. I employ a plurality of these shafts and carriages, and by moving the carriages alternately it is possible to cause the driving grate-bars sustaining the coal to move the latter forwardly upon the bed-sections C^3.

I believe that I am the first to employ carriages having detachable grate-bars or fuel-sustaining surfaces, and I also believe that I am the first to employ a detachable grate-bar having drivers, so that a driver when used up may be readily replaced, and I desire to claim these features broadly, irrespective of the particular construction of the driver-sections or their number or their particular location on the grate-bar one with relation to the other.

At the rear end of the bed-section I have herein illustrated a drop-plate F, it being pivoted at *f* and having connected with it a suitable handle *f*′, projected through a suitable slide in the frame B^3 of the ash-pit door, the opening of the drop-plate enabling the discharge of coal or clinkers from the grate C^3. Above the ash-pit door as I have herein illustrated my invention is an extension f^3, which constitutes a support for the shafts 2 referred to, and also for a shaft f^4, provided with a plurality of pinions f^5. Said shaft f^4 at one end has a connected ratchet-wheel f^6, with which coöperates a detent f^7. The said wheel and shaft are moved intermittingly automatically by a suitable pawl f^8, mounted on a pawl-carrier f^9, having as its fulcrum the rod f^4. The extension or box f^3 is provided (see Fig. 1) with a series of holes 80 for the admission of air that the pinions and shaft f^4 may be kept cool, and the air entering at this row of holes passes to the fire through openings 81—openings through which the connections *a* work—said air rising to the under side of the inclined plate 7 and passing through the pockets $a^\times$, meeting the under side of the fuel passing thereover. The outer end of the pawl-carrier f^9 has jointed to it a link f^{10}, in turn adjustably connected, as by a set-screw f^{12}, with a crank-arm 4, extended from a suitable shaft 5, turning suitable bearings depending from a frame G, represented as sustained by or forming part of the hopper G′, the mouth of which enters and is suitably sustained in a throat-piece G^2, forming part of the front of the cast work of the combustion-chamber. The hopper-mouth and throat-piece are represented as oblong in cross-section, they extending substantially across the width of the combustion-chamber, and the throat sustains a plate 6, (see Figs. 1, 2, and 6,) which receives upon it the coal coming into the combustion-chamber, said plate sustaining the coal while the process of combustion is started. The plate 6 is prolonged by a surface 7, the lower end of which meets substantially the upper side of the portion *d* at the upper end of each carriage. The surface 7 has a series of slots $a^\times$, herein represented as substantially horizontal and extended through the said surface, said slots forming pockets upon which the coal applied to the plate 6 and coming down the surface 7 may lodge. This coal, however, has to be discharged or fed from the incline 7 onto the movable or feeding grate E, and to do this I have provided a series of pokers 8, suitably connected, as by pins $8^\times$, with a series of poker-drivers 10, herein represented as connected each to the upper end of one of said carriages by a suitable screw, as $12^\times$, so that said poker-drivers and pokers move with the carriages and driving grate-

bars. When the poker-drivers are retracted, as represented in section-lines, Fig. 1, the coal lodges in the pockets made by the slots $a^{\times}$, and when ignited the pokers are moved to discharge the coal from said pockets, letting it slide down the incline 7. Viewing Fig. 1, it will be seen that the surface 7 has a plurality of series of pockets and that each series of pockets contain a series of pokers 8. In Fig. 1 one series of pokers are withdrawn into their pockets, the series of pokers next beyond being projected from their pockets.

The door H is composed, essentially, of an outer plate h, provided with ears h', which enter suitable notches made in lugs carried by the front of the boiler-setting. The upper end of the plate h is extended upwardly and shaped to present a suitable guideway $h^{2\times}$, provided with a series of holes, said guideway receiving a suitable register-slide h^3, having, preferably, holes h^2, the movement of the slide more or less closing the holes in the guideway. Inside the plate h I have mounted, as herein shown, detachably a series of air-directing baffle-bars h^4, which are held detachably to said plate by a suitable locking device, herein represented as a rod h^5, entering holes in a series of suitable ears h^6, and by removing said rod the bars may be removed when required. These baffle-bars are of peculiar construction and preferably they are arranged in groups. (See Fig. 1^a, which illustrates one of such groups.) The group shown is composed of three pieces 12 13 14, each having a double flange, said flanges facing the fire and substantially meeting. The central bar of each group may have a projection 15, which may enter a mortise $15^{\times}$ in an adjacent bar. The bars may be kept separated or have their sides alined by suitable projections 16, located at or near the projection referred to. The central bar of the group, as herein shown, is provided with an ear h^6, it being shown in Fig. 6 as extended through the plate h and as receiving the locking-pin. The baffle-bars when assembled leave spaces 17 between them, which receive and conduct air directly to the fuel coming from the throat of the hopper. The lower ends of the baffle-bars are extended below the plate h and inwardly therefrom, (see Fig. 1,) the lower ends of said bars when the door is in its operative position standing below the upper edge of the door-frame G^2, there being a space between the lower ends of the baffle-bars and the lower edge 18 of the plate h to fit over the edge $18^{\times}$ of the door-frame. The air which passes through the baffle-bars takes from the plate and the door-frame heat, which otherwise would injure the plate and frame, and the air by contact with said hot surfaces is heated and utilized to assist combustion.

I believe that I am the first to provide a door with air-conducting baffle-bars to direct air to the coal being burned, and also to prolong said bars below the edge of the door-opening, and also to provide for the ready detachment of said bars from the plate that they may be easily replaced when required.

The air entering the baffle-bars becomes heated more or less and is impinged directly upon the surface of the fuel at the point where the gases are being thrown off, and said air commingling with said gases assists in effecting substantially perfect combustion of the gases.

The fuel-feeding means to feed fuel from the hopper onto the plate 6 is herein represented as a series of screws h^7, three in number, each presenting a movable cutting edge h^8, adapted to act with a drawing shear cut against any coal or other material which is too large to be fed into the combustion-chamber, the feeders acting to reduce or comminute to the proper size the fuel, thus securing greater uniformity in size. The employment of screws, such as represented, for positively feeding fuel onto the coking-plate and thence onto the inclined continuation thereof enables coal of various irregular and uneven sizes to be used and obviates subjecting the coal to the preliminary action of a cracker to thereby bring the coal to substantially the same size. Each screw or rotatable feeder is carried by a shaft h^9, having suitable bearings in the hopper-frame, each shaft having a worm toothed gear h^{10} secured thereto. These gears are engaged, respectively, by suitable worms $m\ m'\ m^2$, the worms m and m^2 being herein represented as of coarser pitch than the worm m', so that the feeders deriving their movement from the worms m and m^2 may be moved faster than the feeder actuated by the worm m'. The provision for driving the feeders independently and at any desired speed one with relation to the other enables me to control the feeding of the fuel to the requirements of the work to be done. This invention is not, however, limited to driving the fuel-feeding means at different speeds one with relation to the other nor is the invention limited to the exact construction shown for each of the members of the fuel-feeding means, for I believe that I am the first to employ in one hopper a plurality of feeding means adapted to operate to feed the coal substantially throughout the width of the combustion-chamber upon a plate or surface inside the combustion-chamber.

The throat or part of the hopper through which the coal passes on its way to the plate 6 is separated by dividing-walls m^3, made, preferably, thicker at their upper than at their lower edges. These dividing-walls partially separate the coal coming onto the plate 6 into several streams, which is of advantage in burning soft coal, for the reason that they form a line of weakness in the coal coked and incrusted upon its top while resting on and passing over the plate 6. The dividing-walls referred to are also of very material advantage in connection with the screws referred to, for the reason that they tend by their wider upper ends to retain the

coal in the grooves of the feeding-screws and coöperate with the same to break, crack, or cut the coal in its passage from the hopper onto the coking-plate. Portions of the coal which are not at the surface of the incoming mass slide downwardly at a faster speed than the surface of the coked mass, and said coal rests in and is detained in its movements by the pockets; but by moving the pokers from time to time to meet the coal lying in the pockets such coal is dislodged after it has become thoroughly ignited or coked and is made to travel by gravity downwardly upon the surface of the driving-grates.

As I have herein chosen to illustrate my furnace the combustion-chamber is separated from the under side of the boiler for the greater part of the length of the boiler by a main crown n, the latter terminating near the frame or door of the boiler-front n', and between the front end n^2 of the main crown and the frame I have located an auxiliary crown n^3, it occupying a position above the level of the main crown of the combustion-chamber. The auxiliary and main crowns are connected by suitable division-walls n^4, preferably of fire-brick, to thereby leave a series of passages n^5, through which the products of combustion from the combustion-chamber may enter under part of the boiler. The division-walls separating the spaces referred to become highly heated, and are thereby made available to aid in consuming gas that may have escaped ignition in the combustion-chamber.

I prefer to use two crown-surfaces, as shown in the drawings, yet this invention is not to be limited to the use of two surfaces, as I may use, if desired, only the main crown or the crown overhanging the main combustion-chamber, letting the products of combustion pass the front end of the main crown and travel under part of the boiler.

The construction of the crown of the combustion-chamber and the protrusion of the coking-plate within the combustion-chamber enables the gases eliminated and burning in the combustion-chamber to be impinged upon the coal or fuel lying on the coking-plate, so that the fuel is more effectually consumed and a greater amount of heat is generated in the combustion-chamber.

Herein the passage of the products of combustion in the combustion-chamber is forward rather than backward over a bridge-wall, and the forward travel of the products of combustion effects the heating of the air which comes into the combustion-chamber at the rear portion thereof, such air being heated by coming in contact with the coal being consumed. This air is gradually heated to a high temperature and as it passes over the incoming coal it ignites the less volatile gases or gases which require a high temperature for their combustion, while the other volatile gases are consumed by the admission of air at the furnace-door. In this way all the products of combustion when they first strike the boiler are in perfect ignition or in their greatest state of efficiency. In the apparatus herein described unignited volatile products of combustion are not permitted to leave the combustion-chamber and contact with the boiler-surface and go unconsumed to the chimney.

The upper portion of the main crown is so located (see Fig. 1) with relation to the door-opening in the furnace-front that the upper side of said crown may be readily reached and cleaned by a brush or other usual device when the door H is open.

The full and dotted lines p represent flues or air-ducts formed in the side walls of the combustion-chamber, said flues receiving outside air, which heated therein may be led by suitable air-passages in the front n^2 of the main crown, the air being delivered therefrom through suitable holes and meeting the under side of the flame-sheet leaving the combustion-chamber. The holes in this slab may be exposed at the end of the crown or at the under side of the crown near its end and the air-passages may be more or less in number, as may be desired.

The inner ends of the grate-carriages D (one shown in detail Fig. 10) are provided each with two open spaces 20 21. In one of these spaces 20 I enter one end of the link a, employed for reciprocating the carriage. This link must be connected with the carriage in such manner that the carriage may be removed when desired. To effect a proper coupling of the link with the carriage to enable them to be readily disconnected, I have employed a loose pin 25, which is notched at one side near one end, as at $25^{\times}$, to be engaged by a keeper 26, (see Fig. 5,) shown as a slotted plate, which is inserted in the space 21 of the carriage, the notch of the keeper embracing the pin and entering the notch thereof, said keeper preventing any longitudinal movement of the pin, the keeper holding the pin so that the latter may be readily withdrawn whenever the keeper is removed to retract it from the notch of the pin.

The speed or frequency of the movement of the grates and the pokers to feed the fuel onto the grate C^3 may be and is determined by or from the speed of the shaft 5, which imparts movement to the fuel-feeding device coacting with the hopper, and, as herein shown, when the fuel-feeding means is at rest the grates are at rest. To control the time of action and of rest of the fuel-feed shaft 5, I have provided said shaft with a driven pulley 27, loose thereon, and alongside said loose pulley said shaft has loose upon it a clutch device, shown as composed of a sliding sleeve r, provided with pins r', guided in a second sleeve r^2, the sleeve r being controlled by a suitable hand-lever r^3, pivoted at r^4.

The door H may have (see Fig. 2) chains 28, connected with it at its opposite ends, the opposite ends of said chains being connected with any usual or suitable shaft or device to

wind up and unwind the chains to open and close said door.

I unite the sleeve r^2 to its shaft 5 by a pin 60, (see Fig. 8,) which in case of such obstruction to the feeding means as would break the apparatus will be cut off between the sleeve and its shaft 5, enabling the sleeve r^2 to turn and leave the shaft 5 at rest. I also unite the ratchet-wheel f^3 with the shaft f^4 for reciprocating the carriers and feeding grate-bars by a connection 61, (shown as a pin,) which in case of undue obstruction offered to the carriage will be cut off and enable the ratchet-wheel to turn without moving the carriage. I shall designate these pins in the claims by the term "destructible connections."

By adjusting the cranks a' on the shaft 5 it is possible to effect any desired difference in timing of the action of the pokers—*i. e.*, when adjusted as represented in the drawings alternate series of pokers work oppositely one to the other; but by an adjustment of the cranks they may be arranged to work on quarter rather than half time or might all be made to work simultaneously in the same direction. The furnace-frame is provided under the plate 7 with a door 82, (see Fig. 1,) which admits the direct supply of air to the under side of the fuel traveling gradually over the coking-plate and down its incline, the air at this point being absolutely necessary to insure perfect combustion of the fuel passing down the incline.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In an apparatus for feeding furnaces, a horizontal plate for supporting the fuel as it is fed into the furnace, an inclined surface in prolongation of said plate and having a series of pockets for sustaining coal fed upon said inclined surface, a series of pokers movable in said pockets to feed the coal over said surface, and means for moving said series of pokers beyond the inclined surface and into the under surface of the coal resting thereon.

2. In an apparatus of the class described, a coking-plate and an inclined pocketed continuation thereof, combined with a series of pokers operable in said pockets.

3. In an apparatus of the class described, a plate for supporting the fuel as it is fed into the furnace, an inclined surface in prolongation of said plate and provided with pockets for sustaining coal fed upon said inclined surface, a series of drivers, a plurality of pokers connected to each driver and means to actuate said drivers to reciprocate the series of pokers into said pockets and beyond the inclined surface.

4. In an apparatus of the class described, an inclined plate to sustain coal, said plate having pockets arranged in a plurality of vertical series, combined with a plurality of series of pokers operable in said pockets in different vertical planes corresponding to the vertical series of pockets, and means to alternately move said series of pokers in said pockets and beyond the inclined surface of the plate to enter the under surface of the coal.

5. In an apparatus of the class described, a coking-plate having a continuation provided with fuel-sustaining pockets arranged in different vertical series, and a plurality of series of pokers arranged in series and entering said pockets, and means to operate said pokers whereby after the fuel has been coked the pokers are thrust forward through said pockets to advance the fuel.

6. In an apparatus of the class described, a surface provided with pockets to sustain coal, a series of driving grate-bars arranged below the pocketed surface and means to actuate said bars for advancing the coal fed thereupon from the pocketed surface.

7. In an apparatus of the class described, a series of carriages provided with a detachable fuel-sustaining surface, each detachable fuel-sustaining surface comprising a series of drivers.

8. In an apparatus of the class described, a series of carriages having a detachable fuel-sustaining surface comprising driving-surfaces located in different planes, and means for moving the said surfaces to feed the fuel.

9. In an apparatus of the class described, a stationary bed-grate, a cross-bar, a series of carriages provided each at its upper outer end with a plate d, the lower inner ends of said carriages resting on said cross-bar, means to sustain the lower side of each of said plates d, and a series of driving grate-bars carried by each of said carriages.

10. In an apparatus of the class described, an inclined pocketed plate to receive fuel, a plurality of pokers, a series of feeding grate-bars, a bed-grate, and means for operating said pokers and feeding grate-bars to feed the fuel upon said bed-grate.

11. In an apparatus of the class described, an inclined pocketed plate to receive fuel, a plurality of pokers movable in said plate, a movable grate adjacent said pocketed plate, and means for operating said pokers to feed the fuel upon said grate, and a bed-grate to receive the fuel from the movable grate.

12. In an apparatus of the class described, a series of grate-carriages having detachable grate-bars each having at its inner end a hook to engage a part of a carriage, the upper end of each detachable grate resting upon and being secured to a portion of each carriage near its outer end, and means to reciprocate said carriages.

13. In an apparatus of the class described, a coal-sustaining surface having a plurality of series of pockets, a grate-bar for each series of pockets, a series of pokers in alinement with each of said grate-bars, and movable in said pockets, and means to move said pokers and grate-bars to and fro in the same direction.

14. In an apparatus of the class described, a hopper for receiving fuel, a series of feeding devices located therein, a throat having a series of feed-passages leading to the combustion-chamber and means to actuate the series of feeding devices to feed the fuel from said hopper through the series of feed-passages into the furnace.

15. In an apparatus of the class described, a hopper, a throat having a series of feed-passages, a series of feeding devices shaped to cut or comminute the coal being fed into the combustion-chamber through the separate feed-passages.

16. In an apparatus of the class described, a hopper, a throat having a series of feed-passages leading from said hopper to the combustion-chamber combined with a series of rotatable feeding devices each provided with a spiral groove to present cutting-vanes.

17. In an apparatus of the class described, a hopper, a passage leading from said hopper into the combustion-chamber, a feeding and cutting device located in the said passage and presenting a drawing and shear cutting edge within the passage to cut and feed the fuel as it passes from the hopper into said passage.

18. In an apparatus of the class described, a hopper to receive fuel, a plate on which the fuel is fed, a throat located between said plate and hopper and presenting a plurality of fuel-passages, and a plurality of rotatable feeding devices presenting each cutting edges, each feeding device feeding the fuel from the throat through a separate passage therein onto the plate referred to.

19. In an apparatus of the class described, a hopper, a throat having a series of feed-passages to separately feed fuel therefrom into the combustion-chamber, and a series of feeding devices, each of said feeding devices having a connected worm-toothed gear, a shaft having a series of worms in operative engagement with said worm-toothed gears, and means to actuate said shaft to operate all of said feeding devices.

20. In an apparatus of the class described, a coal-sustaining plate, a hopper to supply coal, and a door having air-passages to deliver external heated air to the coal lying on the said plate to facilitate combustion.

21. In an apparatus of the class described, a hopper, a coal-sustaining plate, a series of feeding devices having worm-toothed wheels, a series of worms to actuate said worm-toothed wheels, some of the worms being adapted to actuate said feeding devices to feed the coal at varying speeds one with relation to the other.

22. In an apparatus of the class described, a hopper, a fuel-sustaining plate provided with pockets for sustaining fuel, means for feeding coal from the hopper substantially continuously onto said pocketed plate, a series of pokers movable in said pockets, a movable grate below said fuel-sustaining plate and pokers, and means for simultaneously operating the pokers and movable grate.

23. In an apparatus of the class described, a hopper, a fuel-sustaining plate provided with pockets, means for continuously feeding coal from the hopper onto said plate, a series of pokers operable in said pockets, a movable grate located below the fuel-sustaining plate and pokers and receiving coal through the operation of said pokers, means for automatically and simultaneously operating the pokers and grate.

24. In an apparatus of the class described, a fuel-sustaining plate, a hopper for receiving fuel to be fed to said plate, fuel-feeding devices in said hopper, a pocketed plate, a series of pokers movable in the pocketed plate, a fuel-driving grate to receive the fuel from the pocketed plate, means to actuate the fuel-feeding devices in the hopper to feed the coal upon the fuel-sustaining plate, and adjustable connecting devices operable by the means for actuating the fuel-feeding means, whereby the feeding movement of the fuel-driving grate may be varied according to the requirements of combustion.

25. In an apparatus of the class described, a plate to receive coal fed to the combustion-chamber, an inclined plate in continuation thereof, said inclined plate being provided with pockets, combined with a series of driving grate-bars below said inclined plate to receive the coal therefrom and feed the same farther into the combustion-chamber, and means for moving said series of driving grate-bars.

26. In an apparatus of the class described, a grate-carriage, a movable link for actuating the same, and a notched loose pin connecting said carriage and link, combined with a keeper applied to the notch of said pin.

27. In an apparatus of the class described, a coking-plate, an inclined pocketed plate in continuation thereof and leading downwardly therefrom, said plate having a series of pockets to sustain the fuel, means to feed the fuel positively and continuously over said coking-plate and upon said inclined plate, and means acting intermittingly upon the fuel lodged in the pockets of the inclined plate to insure the traveling of said fuel down said inclined plate.

28. In an apparatus of the class described, a coking-plate, an inclined pocketed plate in continuation thereof having a series of horizontal fuel-sustaining surfaces open to supply air to the fuel passing over said inclined plate, and means for acting intermittingly on the fuel resting on said sustaining-surfaces to insure the traveling of the fuel downwardly over said plate from one to another of said horizontal surfaces and a feeding-grate below said inclined plate.

29. In an apparatus of the class described, a bed-grate, a coking-plate, an inclined pocketed plate in continuation thereof having a series of horizontal fuel-sustaining surfaces

open to supply air to the fuel passing over said inclined plate, and means for acting intermittingly on the fuel resting on said sustaining-surfaces to insure the traveling of the fuel downwardly over said plate from one to another of said horizontal surfaces, a grate to receive the fuel from said inclined plate and means to move the grate to feed the fuel onto the bed-grate.

30. In an apparatus of the class described, a coking-plate located within the furnace-chamber and having in continuation thereof an inclined pocketed plate provided with fuel-sustaining surfaces open for the communication of air to the under side of the fuel passing over said plate, means to move the fuel from said inclined plate means to feed fuel to the coking-plate and upon the said inclined plate, and a furnace crown-shaped and set to concentrate the heat and impinge the heated products of combustion upon the fuel lying on said coking-plate.

31. In an apparatus of the class described, a coking-plate located inside the furnace-chamber and having as a continuation thereof a downwardly-inclined pocketed plate, a hopper, fuel-feeding devices, communicating with said hopper and means to actuate said devices to feed the fuel onto the coking-plate and over the same upon the inclined continuation thereof.

32. In an apparatus of the class described, a carriage, a detachable series of grate-bars supported thereby, a link for reciprocating the carriage and grate-bar, an adjustable crank-pin actuating each link, and means for actuating the crank-pins, the adjustment of the crank-pins providing for any desired variation in stroke of the grate-bars.

33. In an apparatus of the class described, a hopper, a coking-plate, and feeding means provided with annular grooves to receive and feed the fuel, means to rotate said feeding means positively, the said feeding means having provisions for cutting and cracking fuel as the latter is fed from the hopper upon the coking-plate.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ROBERT W. KING.

Witnesses:

GEO. W. GREGORY,

EDITH M. STODDARD.