No. 689,827. Patented Dec. 24, 1901.

W. McCLAVE.

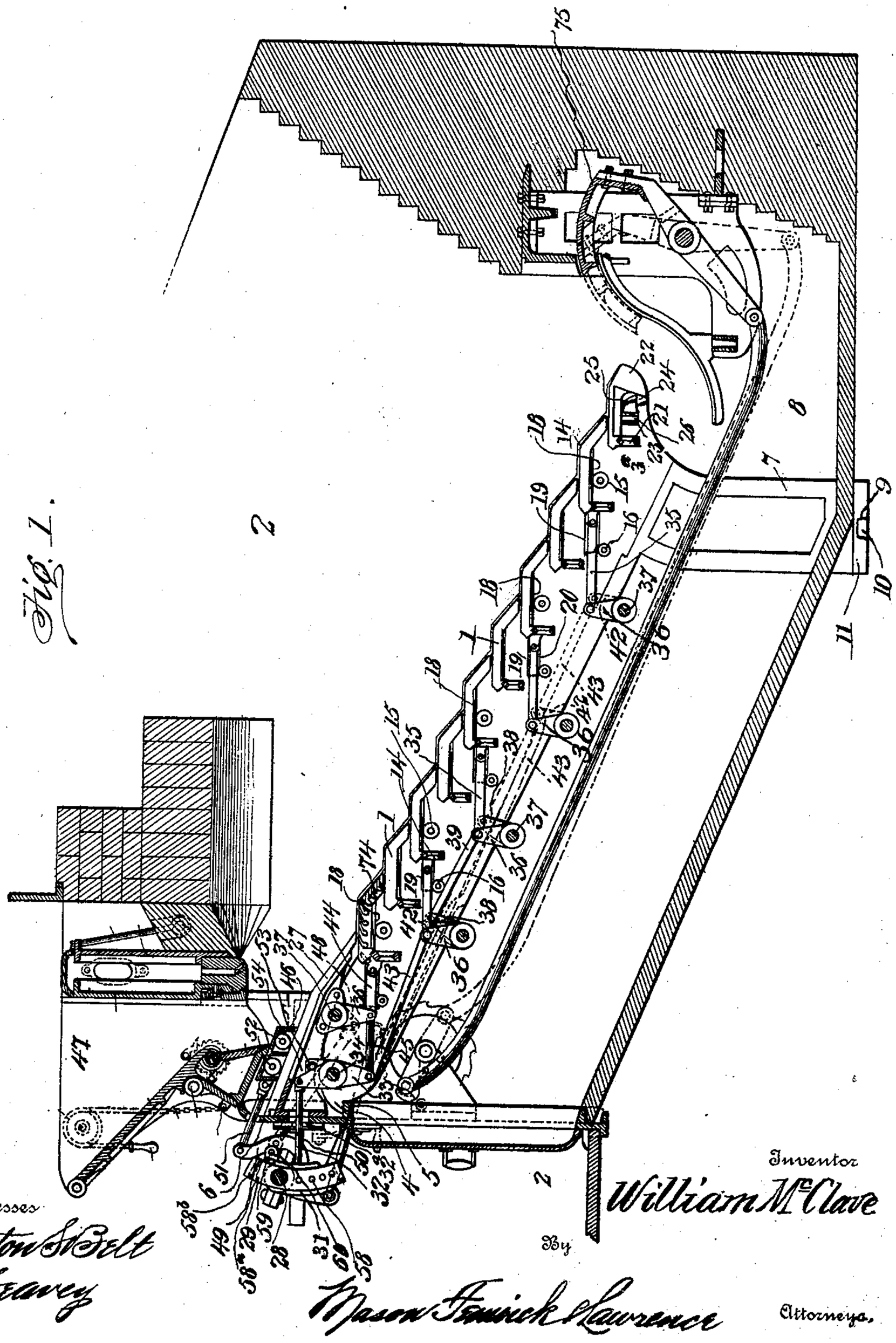
GRATE FOR FURNACES.

(Application filed Feb. 13, 1901.)

(No Model.)

5 Sheets—Sheet 1.

Fig. 1.



Witnesses

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No. 689,827. Patented Dec. 24, 1901.

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5 Sheets—Sheet 2.

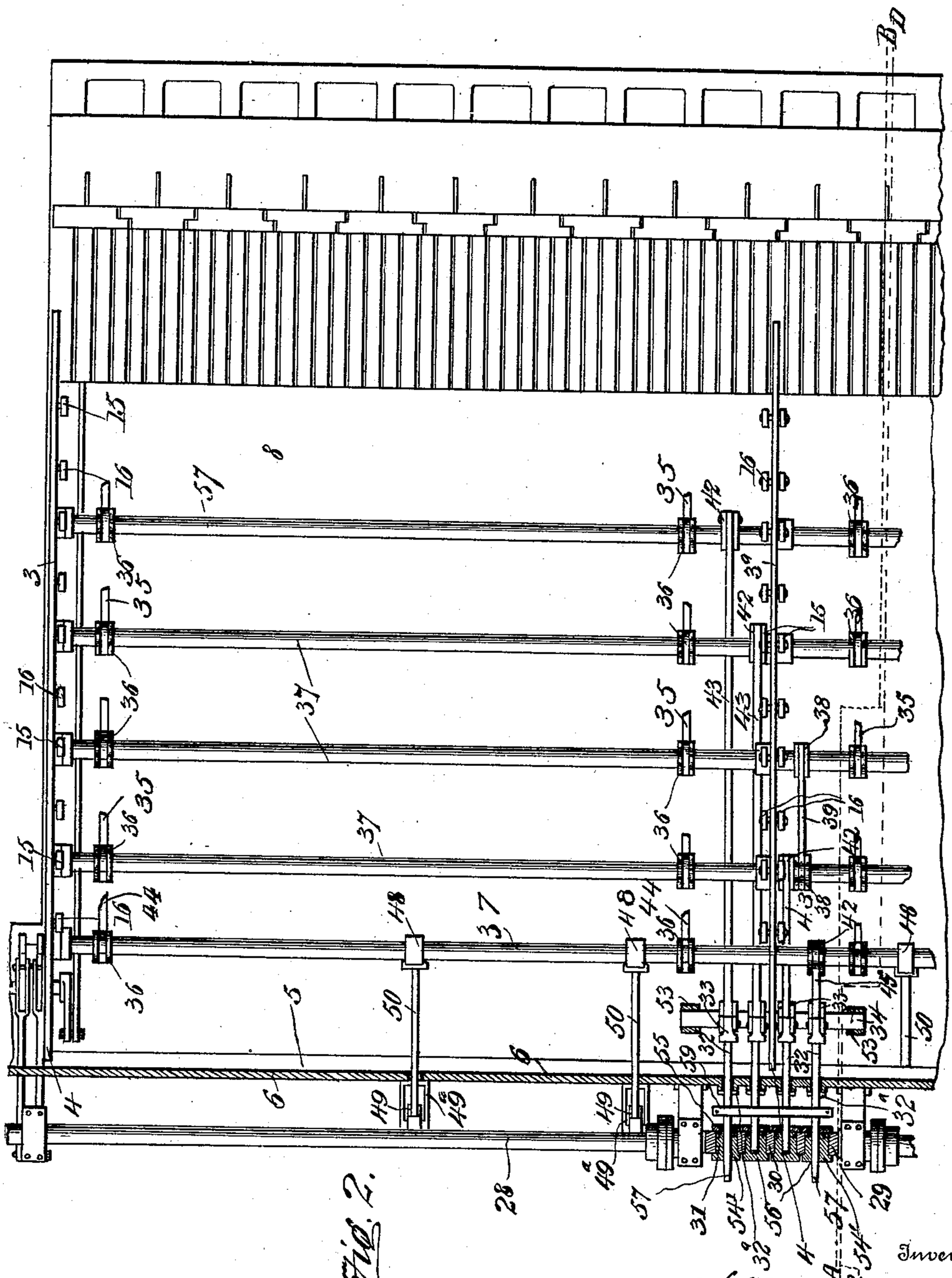

Fig. 2.

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(No Model.) 5 Sheets—Sheet 3.

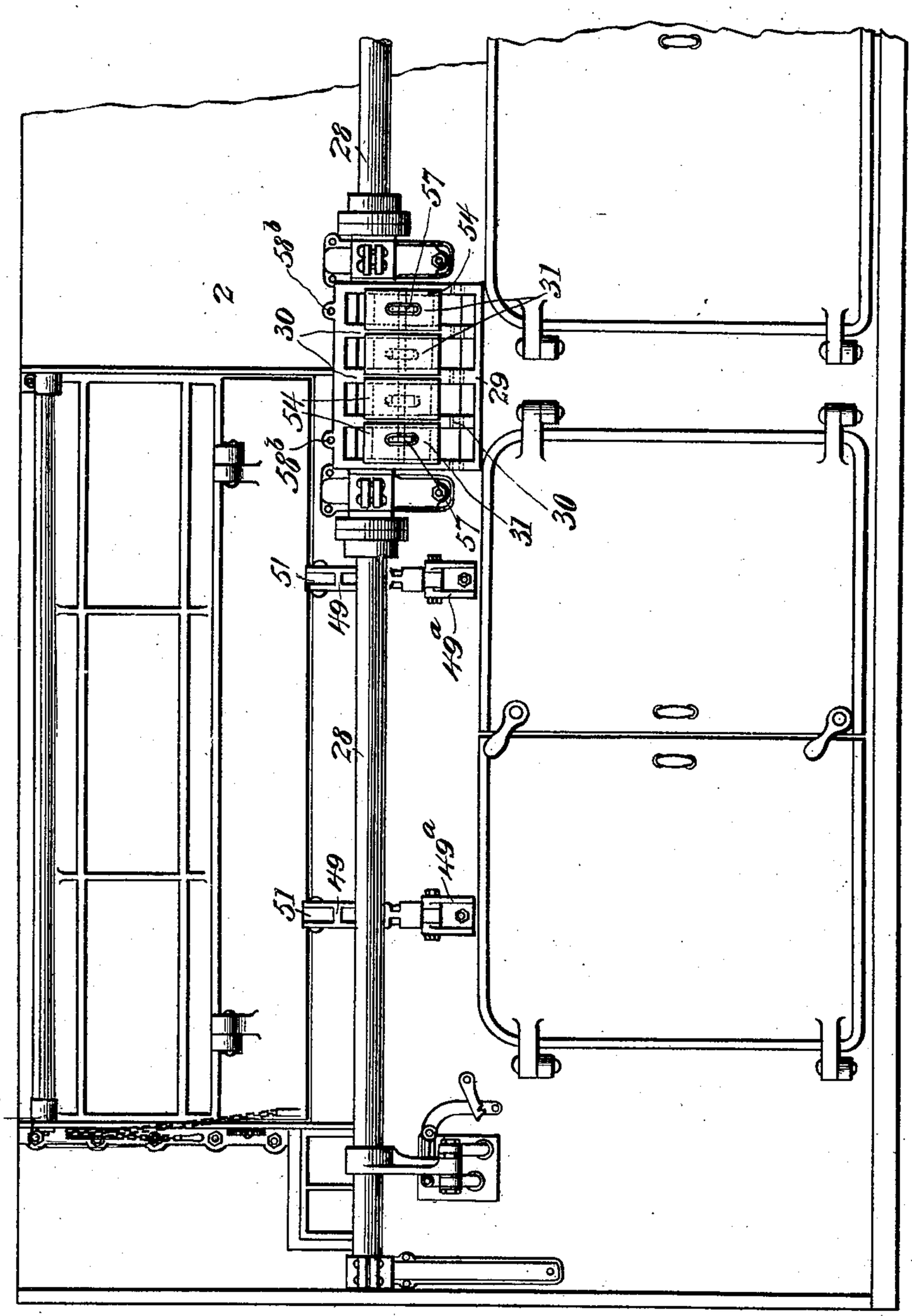

Fig. 3.

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No. 689,827. Patented Dec. 24, 1901.

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GRATE FOR FURNACES.

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(No Model.) 5 Sheets—Sheet 4.

Fig. 4.

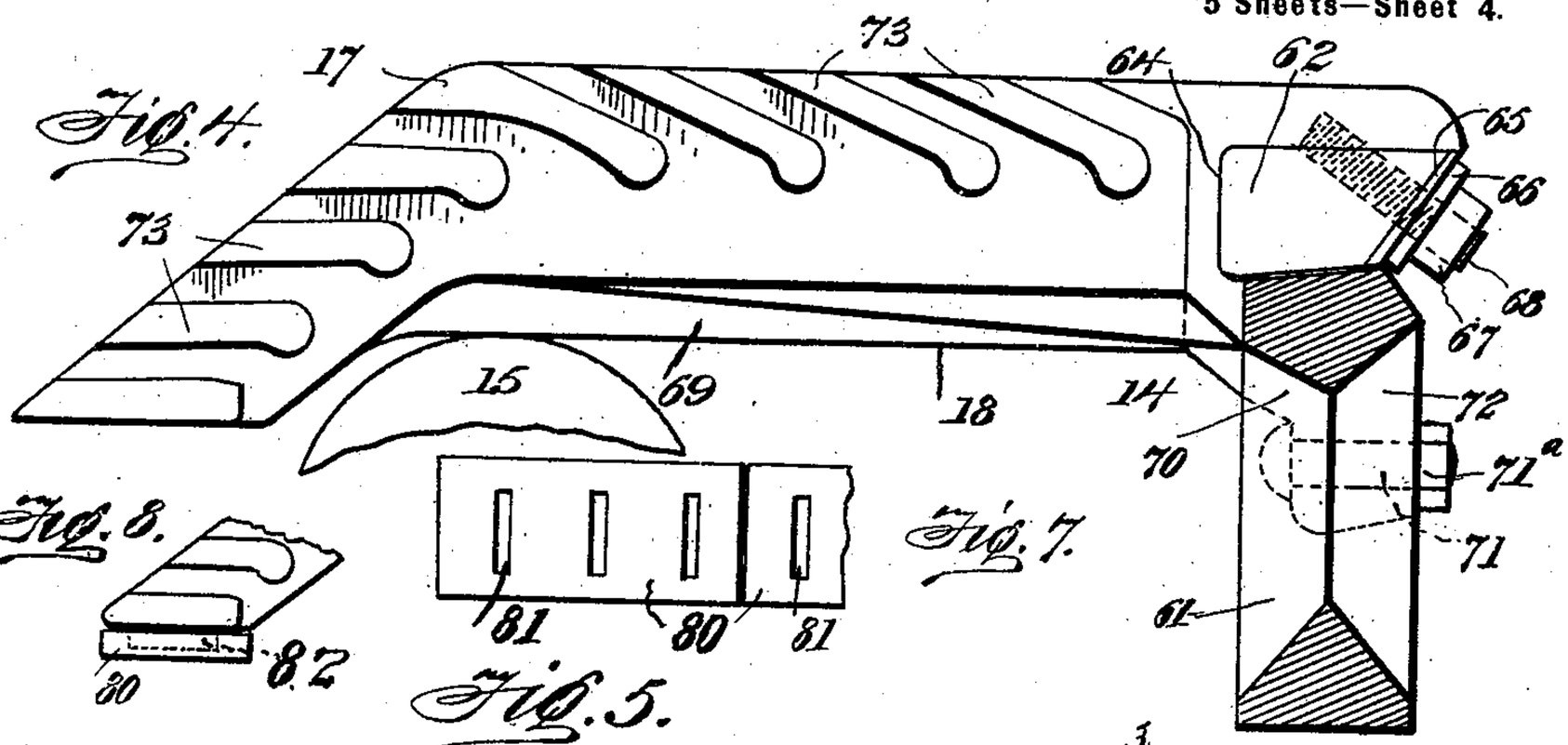


Fig. 8.

Fig. 7.

Fig. 5.

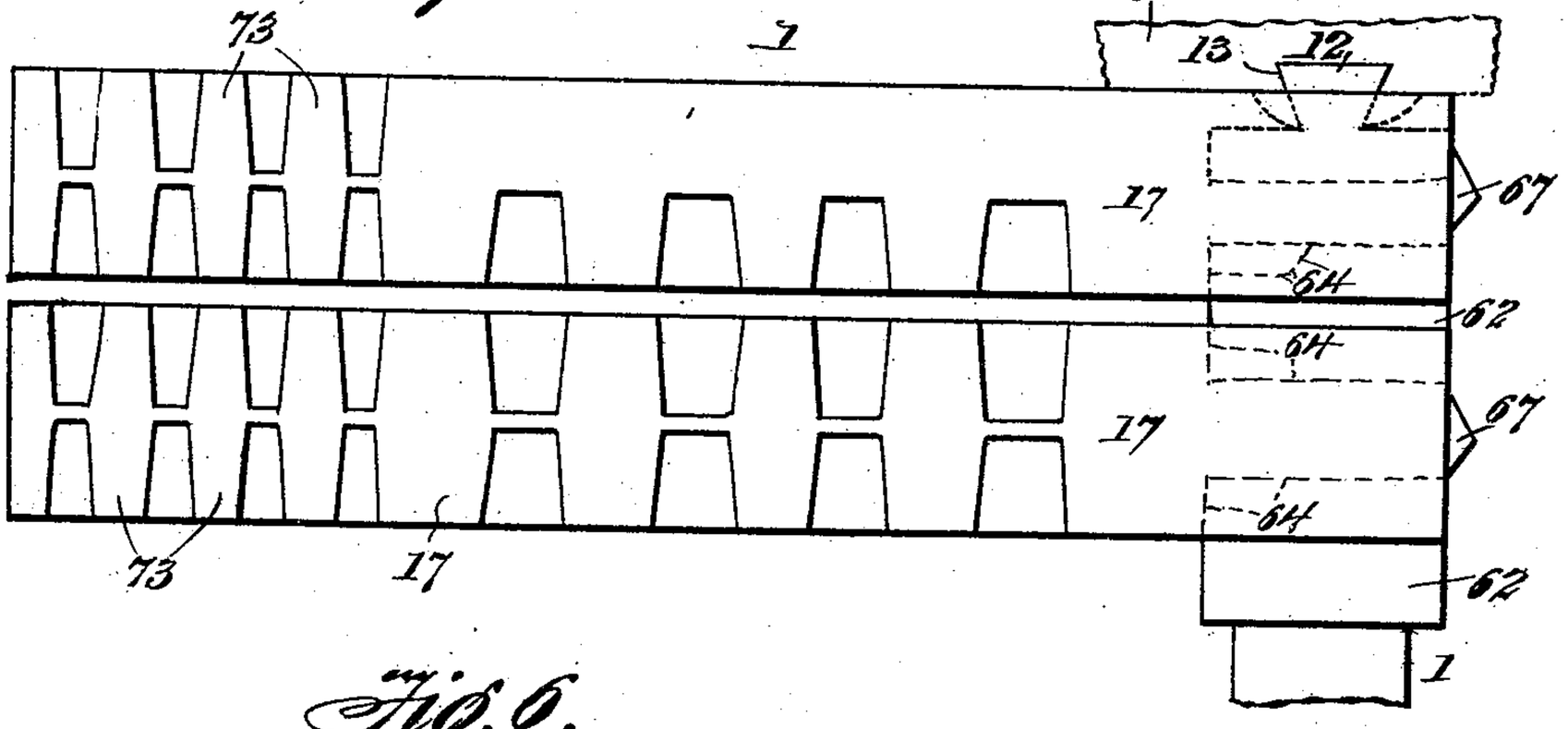
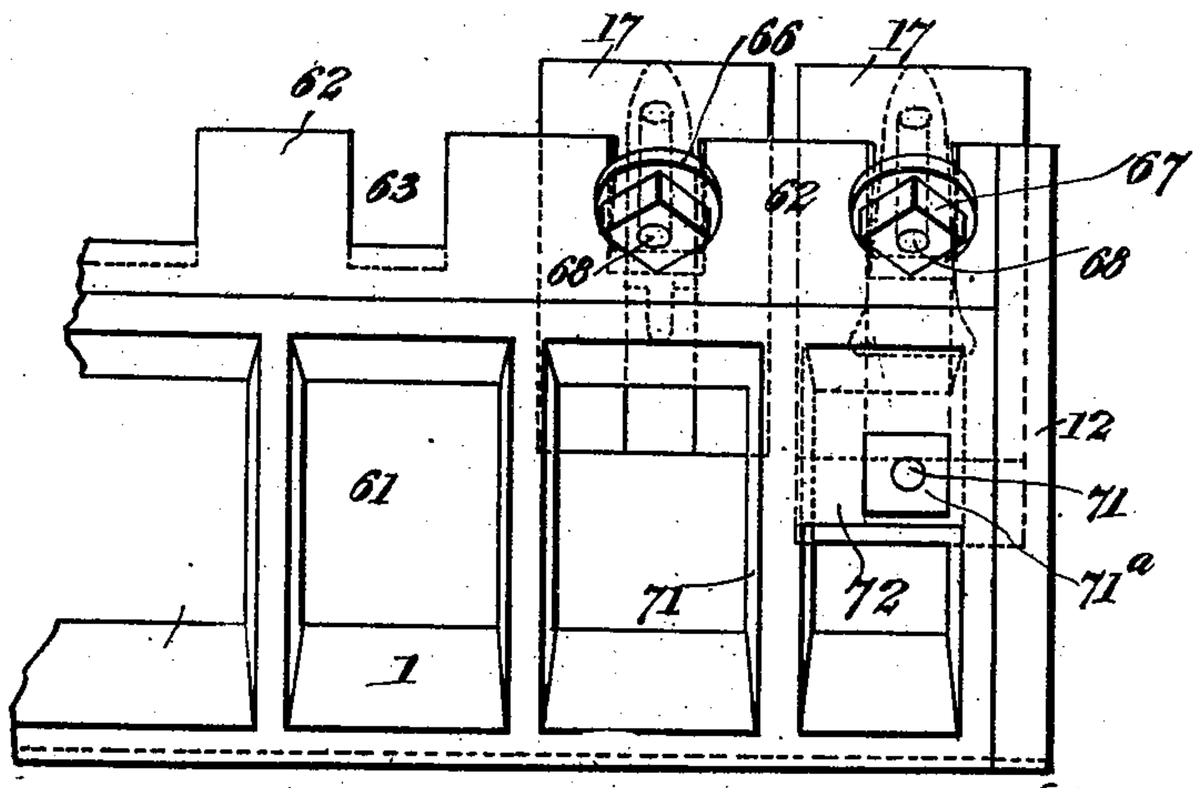


Fig. 6.



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GRATE FOR FURNACES.

(Application filed Feb. 13, 1901.)

(No Model.) 5 Sheets—Sheet 5.

Fig. 10.

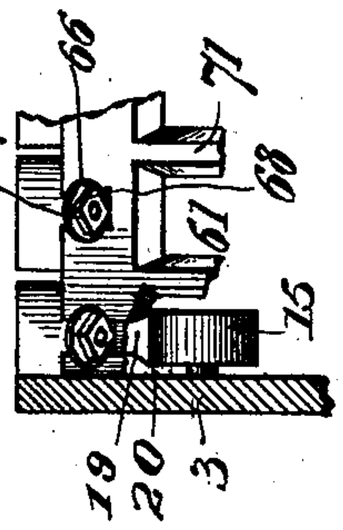

Fig. 11.

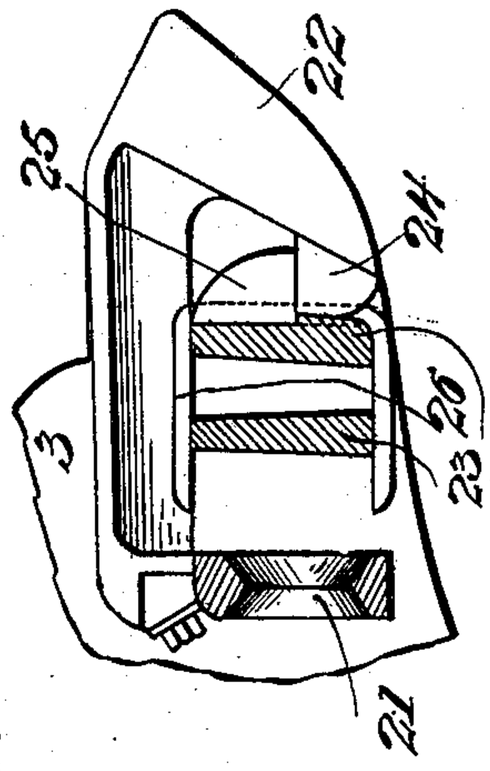

Fig. 9.

Fig. 12.

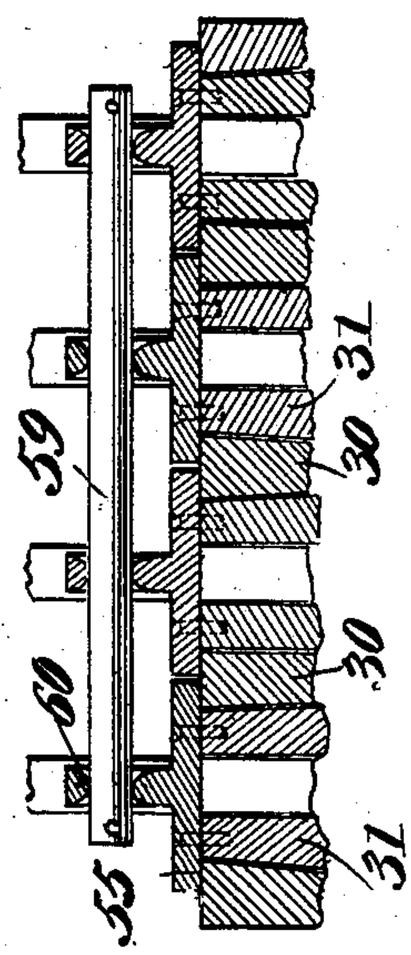

Fig. 14.

Fig. 13.

Inventor

William McClave.

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UNITED STATES PATENT OFFICE.

WILLIAM McCLAVE, OF SCRANTON, PENNSYLVANIA.

GRATE FOR FURNACES.

SPECIFICATION forming part of Letters Patent No. 689,827, dated December 24, 1901.

Application filed February 13, 1901. Serial No. 47,163. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM MCCLAVE, a citizen of the United States, residing at Scranton, in the county of Lackawanna and State of Pennsylvania, have invented certain new and useful Improvements in Grates for Furnaces; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improvements in grates for furnaces, and particularly to inclined grates which are adapted to have fuel fed down over their surfaces and which assist in the stoking operation, in connection with other feeding means.

It consists in an inclined grate for a furnace comprising stationary grate-bars and movable grate-bars, a rock-shaft for actuating the movable grate-bars, adjustable means carried and moved by said rock-shaft and connected with the said movable grate-bars, the construction and arrangement being such that the said movable grate-bars may be given a uniform movement throughout or may have a graduated movement from one end of the grate to the other.

It also consists in an inclined grate for a furnace comprising stationary grate-bars and movable grate-bars, a rock-shaft, means carried and moved by said rock-shaft for actuating the movable grate-bars, and means for adjusting said actuating means, whereby some or all of the movable grate-bars may be stopped in their movement without stopping the movement of the rock-shaft.

It further consists in an inclined grate comprising a series of stationary grate-bars and a series of reciprocating grate-bars, a rock-shaft, connections between the rock-shaft and each of the reciprocating grate-bars, means for connecting the outer two connections with the inner connections, whereby the inner connections will be adjusted in correspondence with the adjustment of the outer two connections.

It also consists of certain other constructions, combinations, and arrangements of parts, as will be hereinafter fully described and claimed.

In the accompanying drawings, Figure 1 is a vertical longitudinal section through an inclined grate, showing the arrangement of the same within a furnace and in connection with a stoking-hopper and a clinker and ash cut-out mechanism, parts being shown in side elevation on line C D of Fig. 2. Fig. 2 is a top plan view of a portion of the grate-supporting frame as the same is mounted in a furnace, the dead-plate and the grate-bars being removed. Fig. 3 is a front elevation of a portion of a furnace provided with a grate constructed in accordance with the present invention and illustrating the means for operating the movable parts of said grate. Fig. 4 is an enlarged detail sectional view of one of the grate-bars composing the said grate, showing the manner of securing its fingers or leaves thereto. Fig. 5 is a detail top plan view of a portion of one of said bars. Fig. 6 is a detail side elevation of one end of a grate-bar, showing some of its fingers in position and some removed. Fig. 7 is a detail view of a shoe or plate used to prevent fuel from collecting beneath the noses of the movable grate-bars. Fig. 8 is a detail view showing the manner of applying such shoe to a grate-bar. Fig. 9 is an enlarged vertical sectional view through the upper part of the grate on the line A B of Fig. 2. Fig. 10 is a detail sectional view through one of the carrier-bars, showing one of the antifriction-wheels carried thereby and the end of the grate-bar resting upon the same. Fig. 11 is a detail sectional view of the lower edge of the grate, showing the means for locking the lower grate-bar in position. Fig. 12 is a detail sectional view through the upper part of the rocking yoke upon the furnace-front, showing the rod for connecting the movable blocks in the said yoke. Fig. 13 is a detail perspective view of the members of one of the movable blocks of the said yoke. Fig. 14 is a detail sectional view through one of the said blocks when it is in position.

My improved grate is designed for use with a wider range of fuel than is possible with grates of other types and enables me to employ all kinds of fuel, even those which would ordinarily require a steep grate, upon a grate of comparatively slight angle. Grates having stationary grate-bars and movable grate-

bars have, however, been heretofore employed; but it is not possible with such grates as heretofore used to give a graduated feed to the fuel upon the grate—that is to say, it has not been possible to move the fuel at the lower end of the grate with more positive action than the new unburned fuel at the top of the grate. By the present invention it is possible to graduate the action of the movable grates from the top of the inclined grate downwardly, and vice versa, according to the manner in which it is desired to treat the fuel upon the grate-surface. This is a very desirable feature, especially in the use of many fine fuels which have to be employed in large plants In the use of such fuels before the fine material has become caked upon the grate-surface a large amount of movement of the grate-bars for feeding the same down the inclined surface of the grate is not necessary or desirable. When, however, the material upon the grate-surface becomes more or less coked or caked and filled with clinkers, it is necessary to give a more extended motion to the grate-bars in order to break up the cake and clinkers and force the same farther down the grate.

My improved grate mechanism is adapted for imparting a slight motion to the movable bars at the top of the grate and increasing or diminishing said motion toward the lower end thereof, so as to properly treat the fuel in all of its stages of combustion. The extent of such gradation can also be altered at will and will be gradual throughout.

By the present invention also the movable grate-bars can be given a uniform motion throughout or may have a graduated movement from one end of the grate to the other by means of mechanism carried by the main rock-shaft upon the furnace-front. A similar result has been accomplished heretofore; but it was necessary before the present invention to employ two sets of mechanism, one carried by such a rock-shaft and the other at a distance therefrom and connected therewith. Both of these members were necessary in the previous art for accomplishing the functions just referred to; but by the present invention the means carried by the rock-shaft is capable of producing these results. By placing all this mechanism upon the rock-shaft I obtain another advanced result also—namely, the ability to cause some of the grate-bars to cease their movement while others continue to operate, or all of the grate-bars can be brought to a standstill without stopping the movement of the rock-shaft.

In embodying these features in practical form I employ a series of stationary bars, as 1 1, extending across the combustion-chamber of an ordinary furnace 2. These bars are preferably supported at their ends upon carrier-bars, as 3, and where there are two or more grate-sections in a furnace also upon intermediate carrier-bar 3^a. The carrier-bars 3 and 3^a are formed with supporting noses or projections 4 at their forward ends, which rest upon inwardly-projecting flanges 5, secured to the furnace-front 6. The lower end of the carrier-bars 3 are preferably provided with downwardly-extending standards, as 7, which extend into the brickwork of the floor of the ash-pit 8 at their lower ends. In order to make these standards stable, I provide their lower ends with notches 9, adapted to engage upwardly-extending lugs 10, formed upon base-plates 11. These plates 11 are preferably inclosed at a suitable depth within the brickwork at the bottom of the furnace. In employing stoking-grates of this character the grate-surface may be composed of one section; but usually furnaces large enough to require a stoking-grate are made of sufficient width to use two or more grate-sections. I have therefore in the drawings shown a grate which is composed of two sections, and which therefore employ outer or side carrier-bars 3 and an intermediate carrier-bar 3^a of the same shape and structure as the outer bars. The stationary grate-bars 1 1 are preferably provided at their ends with dovetailed tenons, as 12 12, adapted to engage correspondingly-shaped mortises 13, formed by projecting ribs upon the sides of the carrier-bars. The intermediate carrier-bar will of course have such mortises upon each side thereof.

When the stationary bars are placed in position so that their tenons 12 engage the mortises 13, the carrier-bars will be firmly tied together and the whole structure made rigid throughout. A sufficient space is left between the stationary bars 1 1 to accommodate movable bars 14 14, which are provided with fuel-bearing surfaces similar to the fuel-bearing surfaces of the stationary grates and which project outwardly to a sufficient distance between the said stationary bars to form equally with them fuel-supporting surfaces for the grate. These movable bars are adapted to rest upon antifriction-wheels, as 15 and 16, secured to the carrier-bars 3. The under surface of and the end fingers 17 of the grate-bars are provided with horizontal bearing-surfaces, as 18, adapted to engage the antifriction-wheels 15. Each of the said bars 14 is also provided with a laterally-extending projection 19, having a bearing-surface 20 upon its under side, so that it is adapted to engage and rest upon one of the antifriction-wheels 16. These rollers may be made of any suitable construction and are preferably loosely mounted upon studs projecting from the carrier-plates 3 3. By employing two wheels, as 15 and 16, at each end of each movable grate-bar it will be seen that the said bar is capable of a movement in a fixed plane irrespective of the movement of its actuating mechanism, the said bars being preferably pivotally connected with said actuating mechanism and affected by the same in no other way except as it receives therefrom a reciprocating motion on the wheels 15

and 16. As the grate-bars are moved back and forth upon the said wheels they will recede to some extent between the stationary grate-bars and will then be forced outwardly as far beyond their normal position as they were previously moved to the rear of the same. The fuel falling in front of these movable bars will therefore be pushed outwardly upon the stationary bars as the movable bars are moved outwardly, and the material resting upon the top of the movable bars will be pushed from the same as the said movable bars recede beneath the stationary bars. A feeding action of the fuel is thus obtained from both sets of bars.

The lower ends of the carrier-bars 3 are preferably tied together by a stationary grate-bar 21, which is preferably made a little different from the other stationary bars, particularly in that it has fingers formed with thickened noses, as 22 22. This bar 21 also rests upon a transversely-arranged connecting-bar 23, engaging at its ends the carrier-bars. In order to prevent the possibility of the bar 21 being accidentally lifted from the cross-bar 23, I preferably provide the noses 22 of the fingers of said bar with locking projections, as 24 24, adapted to extend beneath correspondingly-formed locking projections 25, secured to the said bar 23 opposite to each of the noses 22. By this structure it is impossible for any movement of the clinkers or ashes in the furnace to dislodge the fixed bar 21 or move it so that it will interfere with the action of the movable bar 14 above it. The bar 23 is preferably held in position by means of ribs 26, secured to the inner faces of the carrier-bars 3 and 3^a and open to one side of the said bar. By this structure, after the stationary grate-bar 21 has been secured in position by means of its dovetailed tenons 12 engaging the mortises 13 of the carrier-bars, the said bar 23, which has first been put in place in engagement with the ribs 26, may be pushed laterally in the said ribs until its locking-lugs 25 overhang the locking-lugs 24 upon the noses 22. The structure of these parts is simple, and yet such as to protect them from the action of the fire to a large degree, and provides the lower end of the grate with a stable structure. The upper grate-bar, which is preferably a movable one, is arranged to operate beneath the lower end of the ordinary dead-plate 27 of the furnace, which dead-plate is secured to the furnace-front plate 6 in a suitable manner.

The manner in which the movable grate-bars are actuated forms a very important feature of the invention, since all the varied movements given to the said bars are imparted by a single rock-shaft mounted outside the furnace-front.

The movable grate-bars are adapted to receive their motion from a power rock-shaft 28, arranged along the front of the furnace or furnaces, the said shaft carrying a movable member or frame, as 29. The frame 29 is preferably formed with a series of partitions, as 30 30, between which are mounted movable blocks, as 31 31. These blocks 31 are connected by means of rods 32 32 with loosely-mounted rocking levers 33 33, preferably arranged inside the furnace-front and supported upon a counter-shaft 34, suspended from the under side of the dead-plate. The blocks 31 are adjustably mounted in the frame 29, as will be hereinafter fully described.

The movable grate-bars are connected singly or in pairs with the rocking levers 33, whereby they are adapted to receive their reciprocating motion from the frame 29 and the shaft 28. Each of the moving grate-bars 14 except the top one is connected by means of one or more links or rods 35 35 with arms 36, secured to transversely-arranged rock-shafts 37, which extend across the grate beneath the fuel-bearing surface thereof and are supported at their ends upon the carrier-bars 3, finding suitable journal-bearings thereon. It will be apparent that by connecting two or more of said rock-shafts 37 motion imparted to one of them, if desired, may be imparted to others, and by this means two or more of the grate-bars may be made to operate simultaneously where this course is found desirable. To illustrate this, such an arrangement will be found in Fig. 1 of the drawings, in which two rock-shafts 37 37, near the top of the grate, are provided with arms, as 38 38, the said arms being connected with each other by a link or rod 39. The upper shaft 37 of this pair is provided with an actuating-arm 42, which is connected by means of a link or rod 43 with the lower end of one of the rocking levers 33. It is usually, however, not desirable to connect many of the moving bars together, and I find it especially advantageous to connect the moving bars at the lower portion of the grate singly with the rocking levers 33. Thus each of the lower rock-shafts 37 37 is provided with an actuating-arm 42, which is connected by a separate link or rod 43 with one of the rocking levers 33. By connecting the bars singly it is possible to vary the motion of the grate-bars with respect to each other to a much greater degree than where they are connected in pairs. The rock-shaft 37 for the upper grate-bar is preferably arranged above the said bar and beneath the dead-plate 27, its actuating-arms 36 being connected by short links 44 with the upper grate-bar. A short rod 45 connects an arm of the shaft 37 with one of the rocking levers 33. I find it preferable also to move this upper grate-bar in connection with a movable plunger or pusher 46, mounted in the stoking-hopper 47 at the top of the grate. For this purpose I connect arms 48 on the upper shaft 37 with arms 49, pivoted upon suitable brackets 49^a on the furnace-front, the said arms 48 and 49 being connected by links or rods 50. The upper end of the arm 49 is connected with the pusher 46 by means of rods or links 51. The pusher 46 is also preferably mount-

ed upon antifriction-wheels, as 52 52, similar to the wheels which support the movable grate-bars. By this structure the pusher in the hopper will operate simultaneously with the upper grate-bar for feeding additional fuel down the dead-plate as the fuel on the grate-surface is pushed farther down the said grate. By connecting the hopper-pusher with the upper grate-bar also it receives the same amount of movement as the said grate-bar and will feed a quantity of fuel upon the grate which is just sufficient to fill a gap which would otherwise be made by the upper grate-bar.

Each of the grate-bars 14 14 is preferably pivotally connected with two or more actuating-arms 36 36 upon the rock-shafts 37, so that each end of said bar will be positively moved simultaneously with the other end of said bar and to exactly the same extent. This will prevent any twisting or binding in the action of said bars. The pusher 46 in the hopper is also connected with two or more arms 49, so that each end of said pusher will be positively moved in unison with the other end thereof. The counter-shaft 34 may be made comparatively short and is preferably secured at its ends by brackets 53 to downwardly-projecting webs 54, formed upon the dead-plate support. This shaft of course does not rock, since the levers 33 are loosely mounted thereon and moved with respect to the shaft. The movable blocks 31 in the frame 29 are preferably formed in two sections, one part comprising the body of the block and a front flange 54′, while the other part consists of a plate 55, adapted to be secured to the block 31, so as to bear against the rear face of the frame 29 of the body portion of the said block for holding it movably in engagement with the partitions 30, formed in the said frame. The ribs or partitions 30 may be slightly tapered from rear to front when desired, and the body portions of the said blocks will be correspondingly tapered upon their outer surfaces. The plates 55 are secured to the body portions of the blocks by means of screws, rivets, or the like. Each of the blocks is provided with a central slot or recess, as at 56 56, the slots in the outer blocks extending entirely through the same, each slot being adapted to receive one of the outer ends of the connecting-links 32, which join them to the rocking levers 33. Where the connecting-links pass through the furnace-front 6, the said front is sealed by means of slides, as 32ª. The outer connecting-links 32 are preferably extended entirely through their movable blocks 31 and are formed at their outer ends with lever-butts, as 57, which may be engaged by levers having sockets in their ends for raising or lowering the said links. The outer blocks 31 31 are also adapted to be held in different adjusted positions in the frame 29 by passing pins, as 58, through apertures formed in the outer partitions and walls of the said frame 29. When in their highest positions, the blocks 31 are held in place by pins passed through apertures 58ª in the rear plates of the blocks and apertures 58ᵇ on the top of the frame 29.

The members or frames 29 are preferably constructed like that shown and claimed in my Patent No. 622,515, dated April 4, 1899, and are therefore formed so as to be curved upon an arc having the connecting-links 32 as their radii and their pivotal points as a center. These frames could, however, be curved to a greater or less degree or may be entirely straight, if desired, without altering the spirit of the invention or rendering them inoperative. They are, however, preferably made as illustrated in Fig. 1 of the drawings. The blocks are made to conform to the shape of the frames and are movable up and down therein, so that the said blocks may be brought to points at different distances from the axis of the power-shaft 28. The frames 29 are preferably secured to the said shaft 28 so that the greater portion thereof is below the axis of the said shaft 28. By adjusting the blocks 31 31 with respect to the said shaft 28 their throw or movement can be altered, they receiving a greater movement of course when they are farthest from the said shaft. By altering the position of these blocks the amount of movement communicated to the movable bars will be correspondingly affected. Thus the blocks connected with the upper grate-bars may be arranged at points comparatively close to the axis of the rotation of the shaft 28, while the blocks connected with the lower grate-bars may be arranged at a suitable distance from the said shaft. In order to obtain a graduated movement of the bars from one end of the grate to the other, the blocks must be proportionately moved from one side of the frame to the other. I employ a simple means for producing this gradation, using a bar or rod 59, which extends through apertures formed in lugs 60 60, secured to the rear faces of all the movable blocks 31 31. The apertures through which this bar passes are made sufficiently large to permit the bar to accommodate itself to the movement of the said blocks. It will thus be seen that when an outer block 31 at one end of the frame 29 is raised and the outer block at the other end of the frame 29 is lowered the intermediate blocks will arrange themselves correspondingly by the action of the rod 59. By this simple contrivance any desired gradation of movement in the bars of the grate may be secured, every bar or group of bars moving with proportionate speed to the others.

While I contemplate employing grate-bars of any suitable or ordinary construction, I preferably form them, as shown in the drawings, with a body portion having a series of fingers, as 17, projecting at right angles to the said body portion and extending so far from the same as to thoroughly protect the said bars and also to allow of a sufficient range of movement of the fire-bearing sur-

face of each bar with respect to the adjacent bars. I form the body portions of the said bars 1 and 14 with a series of openings, as 61, so as to lighten the said bars and form upon the upper edges of each bar a series of projections, as 62, having notches or recesses 63 between them of a suitable depth to receive the finger-attaching mechanism. The apertures 61 of the said bars also afford means for inspecting the grates from the furnace-front as well as openings through which slice-bars or pokers may be inserted, if it is found needful to do so.

The projections 62 at the top of the bars are preferably arranged to overhang the body portions of the bars to some extent, and thereby fit recesses, as 64, formed in the ends of the fingers. The opposite faces of the projections 62 are preferably inclined, as at 65, and are adapted to be engaged by means of washers 66 and nuts 67 for holding the fingers in position. The nuts 67 are screwed upon threaded bolts 68, which are embedded in the material of the fingers and are adapted to project through the recesses 63 for receiving said washers and nuts. By this simple structure it will be seen that each finger is tightly clamped to the body portion of the bar. The outer fingers of each bar are preferably formed with thicker webs 69 than the intermediate fingers, and these outer fingers are also provided with downwardly-projecting lugs 70, which can be bolted by means of bolts 71 and nuts 71^a to a web portion 72, formed on the body portion of the bar. It is needful to make these outer fingers at each end of the bars stronger than the intermediate fingers, because they rest upon the antifriction-wheels 15 and assist in supporting the movable grate-bars, and even where the fingers are on a fixed bar it is well to form them in this manner. The fingers 17 17 of the bars are formed with webs having horizontal portions and inclined portions for forming a stair-step outline along the top of the grate, and laterally-projecting teeth, as 73 73, which present short lines of metal to the action of the fire and yet sufficiently support fuel upon the grate-surface. They also afford an opportunity for a sufficient amount of air to be fed through the grate-surface to the fuel. These teeth 73 are preferably in the form of shelves at the side of the bars and more or less overlap each other to prevent fuel from running through.

As illustrated in Fig. 1 of the drawings, I preferably form one or two of the upper bars and the lower bar of the grate with long longitudinally-arranged shelves or fingers, as 74 74, to guard against material running through the grate at this point. This is particularly useful at the top of the grate when fine fuels are employed, since it prevents the said fuels from running through the fingers until it becomes coked or caked. For ordinary use the movable grate-bars are supported so that their lower edges will be slightly lifted from the upper surface of the fixed bars—say about three-sixteenths of an inch—and allow for the expansion of the metal under the action of heat and to prevent friction at this point. If, however, the fine material is not sufficiently scraped from the surfaces of the fixed bars, the lower ends of the fingers of the movable bars may be provided with loose shoes or plates 80, which are apertured, as at 81, so as to engage depending projections 82, formed upon the said fingers. The shoes 80 will thus be moved back and forth upon the fixed bars by means of the projections 82, and since they rest directly upon the said fixed bars will scrape all material from them. These bars 80 may be made of sufficient length to engage the projections 82 upon two or three of the said fingers, and where they abut the adjacent shoes 80 will have a slight space left between them to allow for contraction and expansion of the metal.

In connection with a grate of this character I preferably employ a feed-hopper, as 47, and a suitable cut-out mechanism 75 at the lower end of the grate for removing the ashes that accumulate there, and as these features form the subject-matter of other applications for patents which bear even date herewith I do not deem it necessary to give a further description of the same in the present application. It will be apparent that many details of construction in a grate of this character may be altered without departing from the spirit of the invention. In the operation of the grate the shaft 28 is rocked continuously by any suitable source of power. If it is not desired to impart motion to the movable members of the grate, the blocks 31 are all brought opposite the axis of the said shaft and not receiving any throw from the frame 29 will impart no movement to the grate-bars. When it is desired to actuate the bars, the blocks are adjusted at greater or less distances from the shaft 28 to produce the desired throw of the bars, and the movement of the same will be at once commenced. The motion of the said bars can be graduated while the frame 29 is rocking and while the bars are in motion. As the movable bars recede beneath stationary bars the stationary bars will thereby be caused to push the material off the movable bars, and when the movable bars are moved outwardly they will in turn push the material from the tops of the stationary bars, and so on throughout the feeding operation.

A grate of this character can be made of a sufficiently slight angle to prevent fine fuels from running down the same too rapidly and yet will be capable of feeding such fuel, as well as fuel which does not have such a tendency, positively down the grate. The fuel also upon a grate of such a slight incline will always rest with sufficient body or thickness upon the grate-surface to prevent forced drafts, where such are used, from blowing the said fuel off the grate-surface before it becomes caked or clinkered.

Having now described my invention, what

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

1. An inclined grate for a furnace, comprising stationary grate-bars, and movable grate-bars, a rock-shaft for actuating the movable grate-bars, adjusting means carried and moved by the said rock-shaft, and connected with the said movable grate-bars, said adjusting means constructed to give a uniform movement throughout, or a graduated movement from one end of the grate to the other.

2. An inclined grate for a furnace, comprising stationary grate-bars, and movable grate-bars, a rock-shaft for actuating the movable grate-bars, adjusting means carried and moved by the said rock-shaft, and connected with the movable grate-bars, the said adjusting means constructed to give a uniform movement throughout, or a graduated movement from one end of the grate to the other, and also to vary the extent of either the uniform or graduated movements of the grate-bars.

3. An inclined grate for a furnace, comprising stationary grate-bars, and movable grate-bars, a rock-shaft, means carried and moved by said rock-shaft for actuating the movable grate-bars, means for adjusting said actuating means, constructed to stop the movement of some or all of the movable grate-bars when desired without stopping the movement of the rock-shaft.

4. An inclined grate for a furnace, comprising stationary grate-bars, and movable grate-bars, a rock-shaft for actuating the movable grate-bars, a frame carried and moved by said rock-shaft, a series of blocks movably mounted in said frame, and connected with the said movable grate-bars, constructed to vary the throw of the same.

5. An inclined grate for a furnace, comprising stationary grate-bars, and movable grate-bars, a power rock-shaft for actuating the movable grate-bars, a frame carried and moved by said rock-shaft, blocks movably mounted in said frame, a series of rock-shafts suitably located in relation to the said movable grate-bars, means connecting each movable grate-bar with a rock-shaft at two or more points, the said connecting means constructed to give the said bars an equal movement from end to end, and means connecting each of the said series of rock-shafts with the actuating rock-shaft the said means constructed to vary the throw of the movable grate-bars.

6. An inclined grate for a furnace, comprising stationary grate-bars, and movable grate-bars, a rock-shaft for actuating the movable grate-bars, a frame carried and moved by said rock-shaft, a series of movable levers pivotally supported between the said frame and the said movable grate-bars, means connecting the said levers with the said movable grate-bars, and adjustable means connecting the said levers with the said frame.

7. In an inclined grate, the combination of a series of stationary grate-bars and a series of movable grate-bars, a rock-shaft, connections between the rock-shaft and each of the movable grate-bars, means connecting the intermediate grate-bar connections with one of the outer grate-bar connections, constructed to permit one of the outer grate-bar connections to remain at a fixed point, while the intermediate grate-bar connections are adjusted to secure graduated movements of the grate-bars, by adjusting the other outer grate-bar connection.

8. In an inclined grate, the combination of a series of stationary grate-bars, and a series of reciprocating grate-bars, a rock-shaft, connections between the rock-shaft and the reciprocating grate-bars, said connections including adjustable elements to vary the throw of the grate-bars, and an adjustable rod or shaft connected to the adjustable elements of the several connections, said rod or shaft adapted to be adjusted by moving either or both of its ends for adjusting said adjustable elements.

9. An inclined grate comprising stationary and reciprocating bars, a series of rocking levers connected with the bars, a rocking yoke mounted outside the furnace-front, adjustable blocks mounted therein, a rod connecting each of the blocks with a rocking lever inside the furnace, a loose rod connecting all the said blocks, and means for adjusting the outer blocks to different points in the yoke, giving to said outer blocks greater or less movement, according to their distances from the axis of rotation of the said yoke, the intermediate blocks being correspondingly adjusted by the action of the loose rod and the movement of the grate-bars graduated to a greater or less extent from either end of the grate, substantially as described.

10. An inclined grate comprising carrier-bars, a series of fixed bars dovetailed thereto for joining them together, movable bars moving between the fixed bars, and means for reciprocating them, tie-bars at the lower end of said grate and having dovetailed connections with the carrier-bars, a locking-bar also engaging the said carrier-bars and having a series of locking-lugs formed thereon, fingers secured to the lower bar and provided with locking-lugs, the structure being such that after the bar has been in position the locking-bar may be moved so as to engage the locking-lugs on the said fingers and prevent the raising or accidental displacement of the lower grate-bar, substantially as described.

11. An inclined grate comprising carrier-bars, fixed bars for connecting the same, movable bars moving between the fixed bars, the lower bar of the grate having fingers projecting outwardly therefrom and formed with thickened noses for protecting them against the action of heat, and locking means for holding the said bars in position, substantially as described.

12. An inclined grate comprising carrier-

bars, fixed bars for connecting them together, movable bars moving between the fixed bars, said movable bars being made up of body portions, fingers projecting toward the fuel and supporting projections extending in the opposite direction, and antifriction means mounted on the carrier-bars for engaging some of the fingers and the said projections, substantially as described.

13. An inclined grate comprising fixed and movable bars, means for reciprocating the movable bars for feeding fuel down the incline of the grate, the said bars being made up of body portions having apertures formed therein, projections arranged at the upper edges of the said bars, fingers forming fuel-bearing surfaces of the grate and secured to the body portion of the said bars, and means for locking the said fingers to the said bars, substantially as described.

14. An inclined grate comprising fixed and movable grate-bars, means for reciprocating the grate-bars, the said fixed and movable bars being made up of body portions having attaching projections formed at their upper edge, the projections extending beyond the body portion at one side thereof for engaging recesses formed in grate-fingers, and the other side of said projections being inclined, fingers adapted to be attached to the said body portions and having bolts adapted to extend between the projections on the said bars, nuts and washers for engaging the inclined surfaces of the bar projections, arranged to firmly lock the fingers in position upon the bars, and laterally-projecting teeth upon the said fingers, substantially as described.

15. An inclined grate comprising fixed and movable bars, means for reciprocating the movable bars between the fixed bars, the said bars being made up of body portions, fingers secured thereto, loose shoes arranged beneath the fingers of the movable bars having a series of slots formed therein, and projections upon the said fingers for engaging the said slots, substantially as described.

16. In an inclined grate, the combination of a series of stationary grate-bars and a series of reciprocating grate-bars, a rock-shaft, connections between the rock-shaft and each of the reciprocating grate-bars, said connections comprising outer and inner connections, means for connecting the said outer connections with the inner connections, and arranged to adjust the inner connections in correspondence with the adjustment of the outer connections, substantially as described.

In testimony whereof I hereunto affix my signature in presence of two witnesses.

WILLIAM McCLAVE.

Witnesses:
FENTON S. BELT,
RICHARD B. CAVANAGH.