

Jan. 12, 1932.

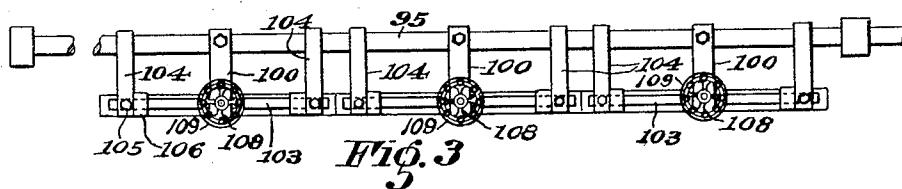
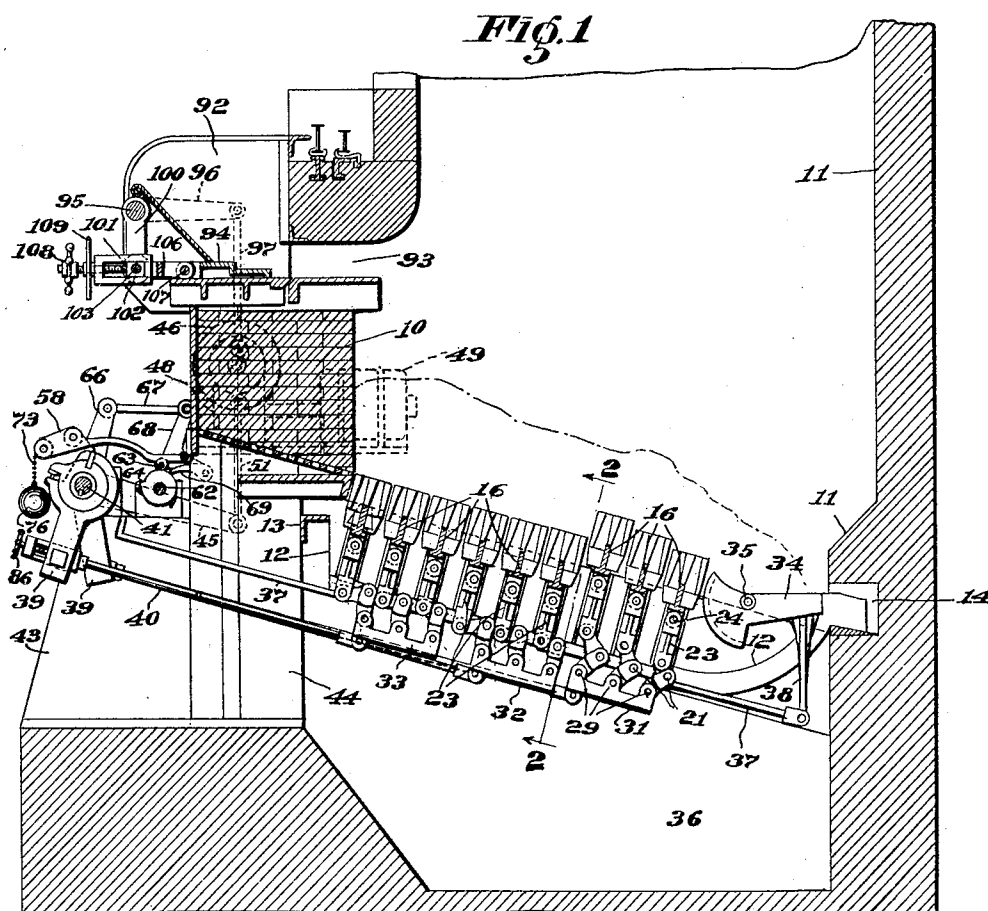
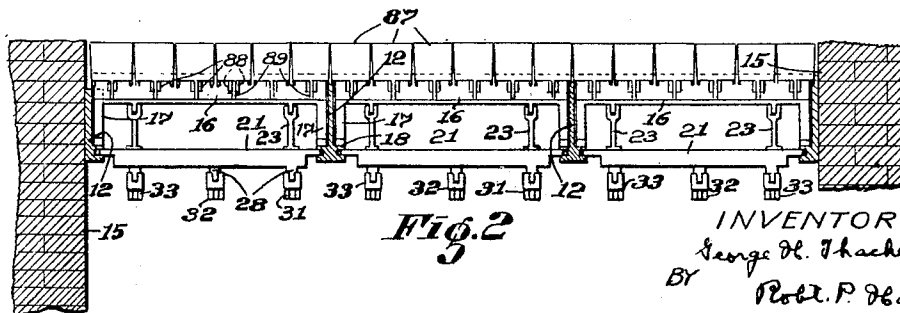
G. H. THACHER, JR

1,840,374

MECHANICAL STOKER

Filed Feb. 1, 1927

4 Sheets-Sheet 1



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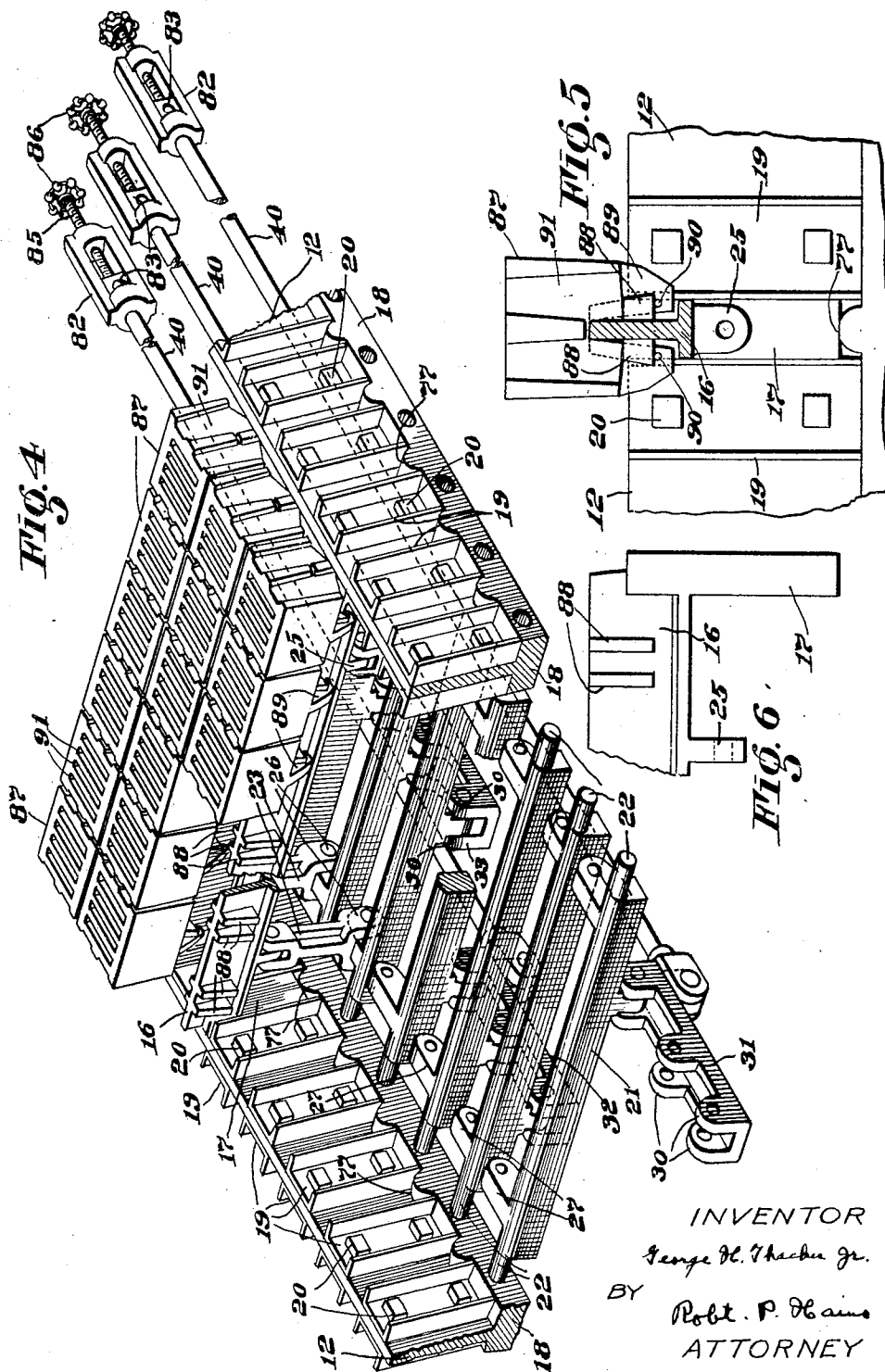
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MECHANICAL STOKER

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4 Sheets-Sheet 2



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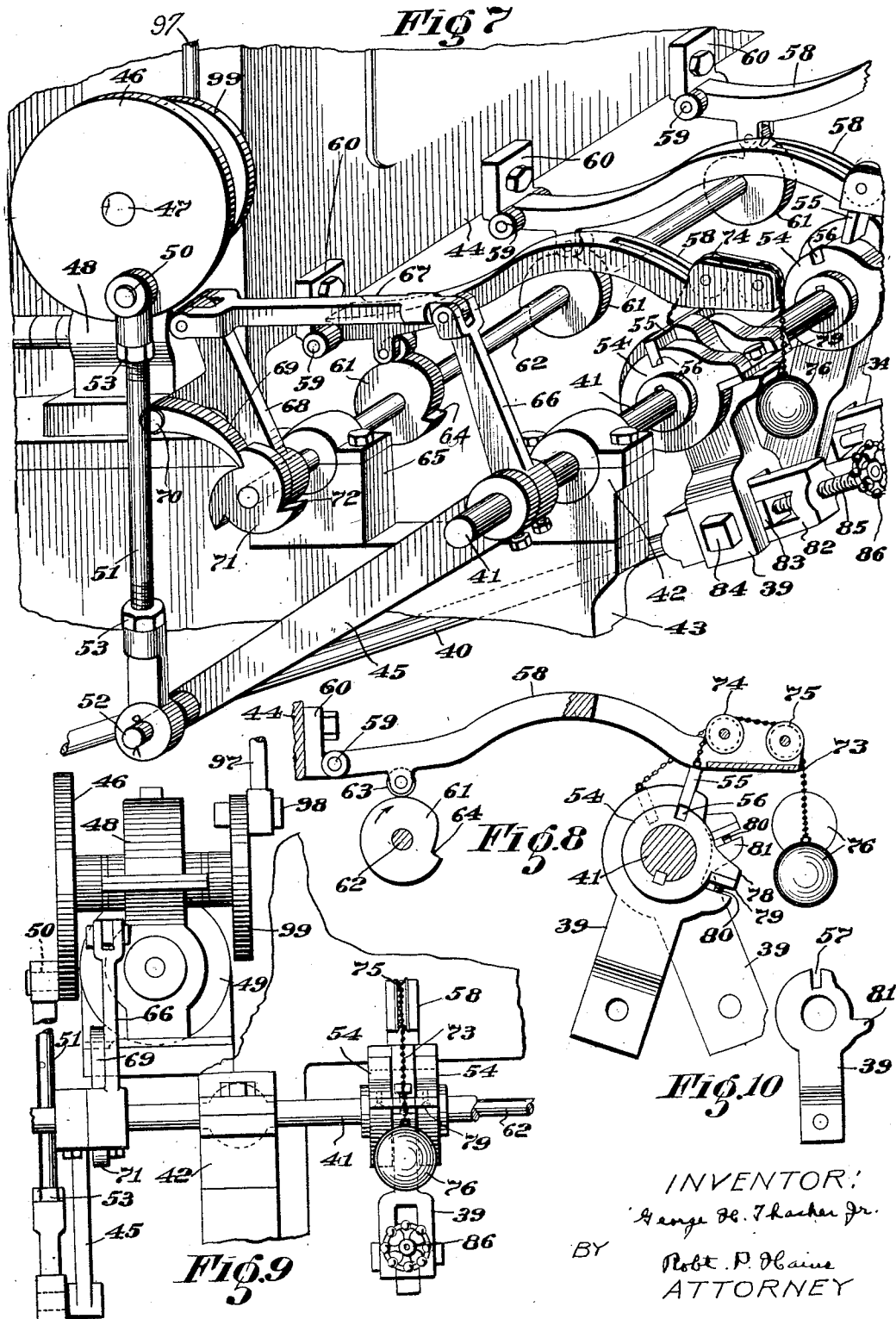
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MECHANICAL STOKER

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4 Sheets-Sheet 3



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MECHANICAL STOKER

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4 Sheets-Sheet 4

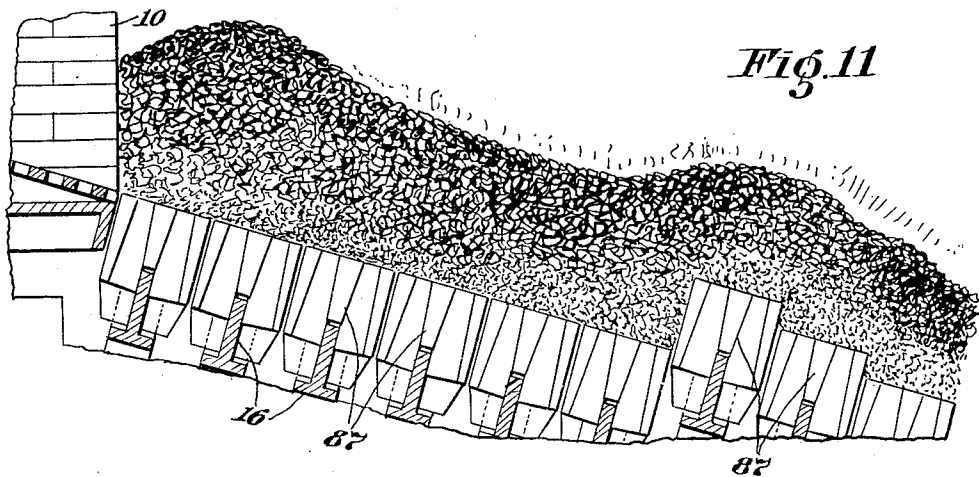


Fig. 11

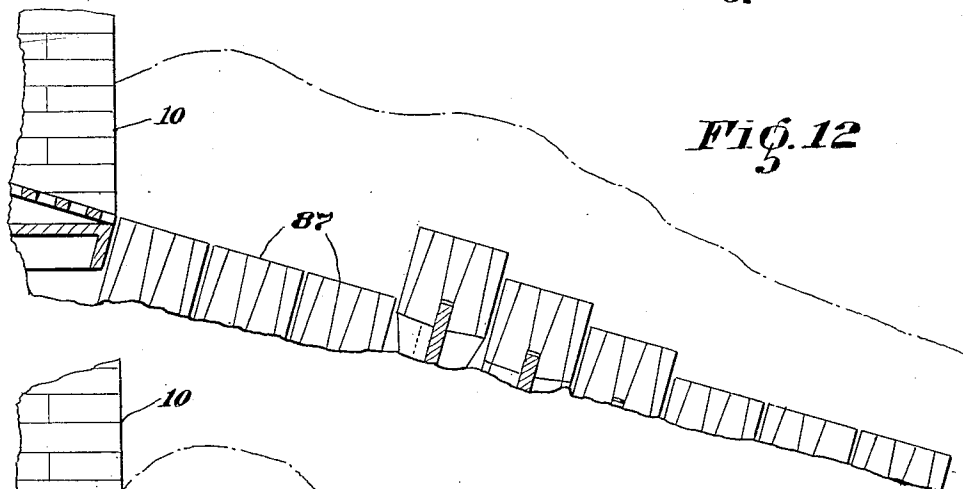


Fig. 12

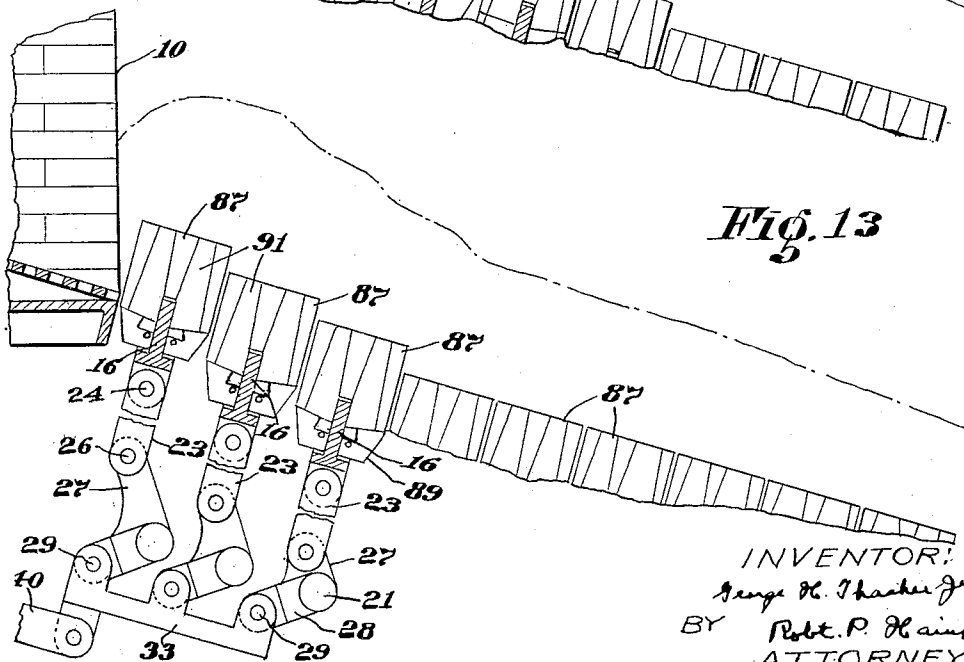


Fig. 13

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UNITED STATES PATENT OFFICE

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MECHANICAL STOKER

Application filed February 1, 1927. Serial No. 165,088.

This invention relates to a new method of stoking furnaces and also to novel stoking mechanism, and the invention is designed more particularly for use in the over feed type of furnace employing an inclined grate to support the fuel bed.

The stokers commonly employed heretofore have been of two well known types. In one of these types the grate or stoker bars are supported for rocking movement, and in the other type the grate or stoker bars are disposed one above the other in overlapping relation and move with a sliding movement in a direction longitudinally of the grate.

The rocking type of stoker bar is open to the objection that the portion of the bed lying directly over the pivotal axis of a bar may receive practically no movement, while the portion of the bed lying near the outer edge of the rocking bar may be given an excessive movement, and when such outer edge is forced upwardly into the hot fuel bed it will be subjected to destructive high temperatures. The sliding type of stoker above mentioned is open to the objection that the fuel engaging edges of the overlapping grate bars are subjected to an excessive temperature which causes them to burn out rapidly.

The stoker mechanism of the present invention differs from the types of stoker employed heretofore in that in the present invention the grate or stoker bars are mounted so that they may be raised and lowered along oblique paths to the vertical but at approximately right angles to the plane of the inclined fuel bed to thrust a portion of the bed upon the raised bars upward and rearward. As a result of this construction the bed engaging portions of the different grate bars normally lie in the same plane so that only the upper face of each bar is exposed to the fuel bed as long as the bars are in their lowered position, and when the bars are raised they impart a direct lifting movement to the portion of the bed they support to loosen up the same and move it towards the rear of the furnace.

One important feature of the present invention resides in a grate provided with grate or stoker bars that are movable bodily to-

ward and from the fuel bed in a direction at approximately right angles to the plane of the inclined grate.

Another important feature of the invention resides in means for elevating adjacent grate bars different distances so that when several grate bars forming a group occupy an elevated position they increase the pitch of the fuel bed resting upon such elevated bars. When adjacent grate bars are forced upwardly into the fuel bed different distances in accordance with the present invention they present a stepped construction that tilts the portion of the bed resting thereupon in a direction to promote its movement toward the rear of the furnace.

Another important feature of the invention resides in means for operating first one group of the grate bars and then another so that successive portions of the entire fuel bed are actuated at frequent intervals to keep the bed in a loose, porous condition.

Still another feature of the invention of primary importance resides in the method of stoking a furnace, which consists in progressively raising and lowering successive groups of stoker bars obliquely to the vertical to impart to the fuel bed rising and falling waves that travel lengthwise of the furnace at frequent intervals. As a result of this method of operation, all portions of the fuel bed are raised and lowered at frequent intervals (say several times per minute), with the result that the bed is kept in an open porous condition and is gradually advanced toward the rear of the furnace, but the movement of the fuel bed is not sufficiently energetic to break up or rupture its upper surface.

In carrying out the present invention the grate bars are preferably so operated that the majority of the bars will always be in their lowered or protected position. This is desirable to prevent the bars from becoming overheated, since they will cool off while in the lowered position from the high temperature to which they are subjected while in the raised position. If the grate bars are operated progressively in three different groups each group may remain in the lowered position two-thirds of the time and may be in motion

one-third of the time. If four or more groups are employed each group will remain in the lowered or protected position a greater portion of the time.

5 The reciprocatory movement imparted to the grate bars along a path that lies at a slight inclination to the vertical, performs the double function of loosening up the bed and of advancing it toward the rear of the furnace, while it also permits the use of
10 grate bars that have an open construction which cools readily.

A further feature of the present invention resides in novel means for periodically operating the different groups of grate bars.

15 Other features of the invention and novel combination of parts in addition to the above will be hereinafter described in connection with the accompanying drawings which illustrate one good practical form thereof.

20 In the drawings:—

Fig. 1 is a vertical sectional view through a furnace showing the entire stoker in side elevation;

25 Fig. 2 is a sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is a front elevation of operating means for the fuel feeder;

30 Fig. 4 is a perspective view of a portion of the grate, showing means for supporting and operating the stoker bars;

Fig. 5 on an enlarged scale is a transverse sectional view through one of the grate or stoker bars;

35 Fig. 6 is a side view of a portion of one of the stoker bars;

Fig. 7 is a perspective view of mechanism for periodically operating the different grate sections;

40 Fig. 8 is a side elevation of the mechanism of Fig. 7 one rocking arm being shown in its normal or inactive position and the other arm in the stoking position;

45 Fig. 9 is a front view of the driving motor and associated parts;

Fig. 10 is a side view of a rocking arm to be described;

50 Fig. 11 on an enlarged scale is a vertical sectional view showing the effect upon the fuel bed of raising the lowest group of grate bars;

Fig. 12 is a similar view showing the effect of raising an intermediate group of bars; and

55 Fig. 13 is a similar view showing the effect of raising the uppermost group of bars.

60 The stoker of the present invention may be used in furnaces burning various grades of either anthracite or bituminous coal, and while designed primarily for use in furnaces employing an inclined grate, certain features of the invention may be employed in other types of furnaces.

65 The furnace shown has the usual front wall 10 and rear or bridge wall 11 and within the furnace are mounted the inclined beams 12

the forward ends of which rest upon the angle bar 13 and the rear ends of these beams project into a recess 14 formed in the bridge wall 11. In the construction shown four inclined beams 12 are provided, two being disposed adjacent the side walls 15 of the furnace, and the other two being spaced therefrom, but it will be understood that the number of these beams employed may be varied as found desirable. 70 75

The fuel-supporting grate, in accordance with the present invention, is formed of the grate or stoker bars 16 that extend transversely of the furnace and the ends of which are supported by the inclined beams 12. As above pointed out these bars are supported for movement bodily toward and from the fuel bed in a direction at approximately right angles to the plane of said bed. In the construction shown each bar 16 has the downwardly extending end portions 17 the lower ends of which normally rest upon the laterally extending flanges 18 of the beams 12. The grate bars 16 are held in spaced relation to each other by the channel blocks 19 which are fastened to the beams 12 by bolts 20 and between these blocks 19 are formed slide-ways in which the end portions 17 of the bars 12 slide. As a result of the construction just described the slide-ways for the end portions 17 of the stoker bars are disposed well below the fuel bed where they are relieved from the intense heat of the fuel. 80 85 90 95

The means shown for raising and lowering the grate or stoker bars 16 consists of the rocking bars 21 positioned below the stoker bars and the opposite ends of the rocking bars are reduced to form bearings 22 which are journaled in holes or bearing sockets formed in the flanges 18 of the beams 12. In order that the rocking bars may be readily assembled in their operative position the bearings 22 at one or both ends of the bars are made sufficiently long to permit them to be inserted a substantial distance into the bearing sockets of one beam 12 so that the bearing 22 at the opposite end of each rocking bar may be readily inserted in the bearing socket in the other beam 12. After the ends of the rocking beams 21 have been journaled in the supporting beams 12 the rocking beams are prevented from moving in the direction of their length by the operating connections to be described. 100 105 110 115

As previously pointed out it is desirable to operate the grate bars 16 in groups and to elevate the different bars of a group different distances so that when the grate bars are supported in their raised position they will present the stepped construction clearly shown in Fig. 1, wherein three bars are shown raised; and it should be noted that by raising these bars different distances as shown they support the portion of the fuel bed resting thereupon at an increased inclination 120 125 130

which promotes the movement of the fuel bed towards the rear of the furnace.

Any desired number of grate bars 16 may be included in a group to be operated simultaneously, and in the construction shown the three bars forming a group are actuated by providing the operating links 23 between each grate bar 16, and the rocking bar 21 lying below it. The upper end of each link 23 may be bifurcated as shown and may be pivotally secured by a pin 24 to a lug 25 that projects downwardly from the lower face of a grate bar 16. The lower end of each link 23 is bifurcated and is pivotally secured by means of a pin 26 to a lug or arm 27 that extends laterally from the rocking bar 21. In order to raise the grate bars 16 of a group different distances the arms 27 of a group of rocking bars may be successively increased in length, as will be apparent from Fig. 1, wherein it will be seen that the arms of the bar 21 lying nearest the rear end of the furnace are quite short, whereas the arms of the third bar 21 from the rear of the furnace are relatively long.

The three rocking bars 21 of the rear group are actuated simultaneously by providing each of these bars with a downwardly extending lug 28 which is secured by a pin 29 to a pair of upwardly extending ears 30 formed upon a casting 31. The casting 31 is suspended below the rocking bars 21 by the operating connections just mentioned and movement of this casting in the direction of its length will serve to rock the bars 21 to raise and lower the group of grate bars just mentioned. The number of groups of grate bars mounted between a pair of inclined beams 12 may be varied as desired, three groups being shown in the present drawings. The bars of the group lying nearest the rear end of the furnace are actuated in the manner just described by movement of the casting 31 in the direction of its length. The three bars 16 forming the intermediate group are raised and lowered by operating a similar casting 32, and the three bars forming the upper group and lying nearest the front wall of the furnace are operated by movement of a third casting 33 in the direction of its length.

It is desirable to operate first one group of grate bars as shown in Fig. 1 and then another at frequent intervals to loosen up the fuel bed of the entire grate surface. The order in which the different groups of grate bars are actuated may be varied as desired, but in many cases it will be desirable to operate the bars in the order in which they are shown raised in Figs. 11, 12 and 13, wherein it will be noted that the group of bars lying nearest the rear end of the furnace is first raised, then the intermediate group of bars is raised, and finally the group of bars lying nearest the front of the furnace is raised.

When the grate bars are actuated in this manner they produce rising and falling waves that travel lengthwise of the furnace, and these waves are preferably provided at sufficiently frequent intervals to keep part of the fuel bed moving throughout the furnace operation. As soon as one group of bars has been raised and lowered the next group of bars may be immediately actuated, and as soon as the movement of the second group of bars is completed the third group of bars is immediately actuated, and then the series of movements may be promptly repeated, and the entire group of bars may be actuated several times a minute throughout the operation of the furnace, with the result that the fuel bed is maintained in continuous or practically continuous movement. The rising and falling movement imparted to the bed by the grate bars is not sufficient to break up or rupture the upper surface of the fuel bed, but the movement serves to keep the entire bed loose and porous so that air may readily pass through the same. The rising and falling movement of the stoker bars 16 at a slight inclination to the vertical position serves also to gradually work the fuel rearwardly towards the rear wall of the furnace.

Adjacent the bridge wall 11 of the furnace may be provided the usual clearing grate 34 which extends transversely of the furnace between a pair of beams 12 to which it is pivotally secured by the pivot pins 35, as is usual, and this clearing grate may be actuated manually from time to time to dump the ashes into the ash pit 36. The means for dumping the clearing grate 34 may comprise a shaft (not shown) that projects through a side wall 15 of the furnace, or may consist of the operating bar 37 disposed below the grate supporting structure, and which bar is secured to the arm 38 that projects downwardly from the clearing grate 34.

Due to the frequent intervals at which the different groups of grate bars are actuated it is practically essential to provide power means for operating the series of grates. Various forms of power operated means may be provided and one good practical construction to this end will now be described. Each of the castings 31, 32 and 33 for controlling a group of grate bars is operatively connected to a rocking arm 39 by means of an actuating rod 40. The rocking arms 39 are pivotally mounted upon a power shaft 41 which extends across the front of the furnace and is rotatably supported by the bearing brackets 42 provided upon the supporting frame 43 which constitutes part of the front plate or casting 44 at the front of the furnace. Rocking movement is imparted to the power shaft 41 by a rocking arm 45 which is bolted or otherwise rigidly secured to said shaft. The means shown for rocking the arm 45 consists of a disk 46 which is rigidly secured to

and is rotated by the shaft 47 that is journaled within the gear casing 48, in which casing are mounted suitable reducing gears which are driven from a motor 49. The rotating disk 46 is provided with a pin 50 which is disposed at one side of the central axis of the disk, as will be apparent from Figs. 1 and 7, and movement is imparted from the pin 50 to the rocking arm 45 by the connecting rod 51 the upper end of which is journaled upon the pin 50 and the lower end of which is connected to the arm 45 by a pin 52. The connecting rod 51 is preferably provided with the nuts 54 which may be adjusted to vary its effective length.

The rocking shaft 41 is provided with as many rocking arms 39 as there are groups of stoker bars to be actuated. The present rocking shaft 41 is provided with nine rocking arms 39, three arms being provided to control the intermediate row of grate bars shown in Fig. 2, and the remaining six arms control the rows of grate bars at the opposite sides of the furnace. Each arm may be operated independently of the other arms but the arms are preferably so operated that similarly located groups of stoker bars across the furnace will be raised and lowered together. Each rocking arm 39 is mounted between and is held from movement lengthwise of the power shaft 41 by a pair of hub members 54 which are keyed or otherwise rigidly secured to the shaft 41; the arrangement is such that if a rocking arm 39 is secured to its hub members 54 by the sliding key 55 the rocking movement of the shaft 41 will be imparted to the arm 39 to move the latter back and forth from the position shown in heavy lines in Fig. 8 to the position shown in light lines in this figure. If the key 55 is elevated as shown in Fig. 8 so that it is disengaged from the slots 56 formed in the hub members 54 then the rocking movement of the shaft 41 will not be imparted to the rocking arm 39. The rocking arm 39, as will be apparent from Fig. 10, is provided with a relatively deep slot 57 in which the key 55 is slidably mounted, the arrangement being such that when the key 55 is raised sufficiently to disengage it from the slots 56 of the hub members, the key will still remain in the slot 57 which constitutes a sliding support for this key.

From the construction so far described it will be apparent that the power shaft 41 is positively rocked back and forth throughout the operation of the furnace, but that this rocking movement of the power shaft will not be imparted to a particular arm 39 unless the key 55 associated with this arm is lowered into the slots 56 of the hub members. It therefore follows that the rocking movement of any particular arm 39 may be controlled as desired by raising and lowering its key 55. In the construction shown the position of each key 55 is controlled by a cam actuated

arm 58 one end of which is secured by a pivot pin 59 to a bracket 60 which is bolted to the front plate 44. Each cam actuated arm 58 projects outwardly from the front plate over the particular rocking arm 39 which it is to control and a connection extending from the arm 58 to the adjacent key 55 serves to control this key so that when the arm 58 is raised the key will be pulled upwardly to its inoperative position, and when the arm 58 is lowered the key will be inserted into the slots 56 to rock the arm 39. The means shown for raising and lowering the arm 58 consists of a cam 61 which is mounted upon and is keyed or otherwise secured to the rotating shaft 62. The arm 58 is provided with a roller 63 which rests upon the outer periphery of the cam and the construction is such that the arm 58 is held in its elevated position the major portion of the time, but is permitted to rock downwardly when the notch portion 64 of the cam passes under the roller 63. The shaft 62 upon which the cams 61 are mounted is journaled in bearings 65 mounted upon the brackets 43, and a step-by-step rotative movement is imparted to this shaft from the rocking power shaft 41. To this end the shaft 41 is provided with an arm 66 which is rigidly secured to this shaft and which projects upwardly therefrom, as will be apparent from Fig. 7. The upper end of the arm 66 is connected by a link 67 to the upper end of an arm 68 which is journaled upon the shaft 62 and the rocking arm 68 is provided with a dog 69 that is pivotally secured to this arm by the pivot pin 70 and the outer end of this dog engages a ratchet wheel 71 which in the construction shown has three notches 72 to correspond with the three different groups of stoker bars that are to be actuated. The arrangement just described is such that each complete rotation of the operating disk 46 will cause the dog 69 to rotate the shaft 62 through one-third of a complete circle, during which rotation one of the cams 61 will be positioned to lower its arm 58 whereupon the key 55 controlled by this lever will be moved to its active position. From the operation just described it will be seen that each complete rotation of the operating disk 46 will serve to operate one of the castings 31, 32, 33 to raise and lower one of the groups of stoker bars, and that the cams 61 may be secured to the shaft 62 so that these three groups of stoker bars may be operated in any desired order.

It is important that the operative connection between the cam actuated arm 58 and the key 55 which it controls be so constructed that the key 55 will not be moved to its inactive position until the arm 39 has completed its stroke, and to this end each key 55 is operatively connected to its cam arm 58 by a chain 73 which may pass around the pulleys 74 and 75 that are rotatably mounted upon

the arm 58. One end of the chain 73 is secured to the key 55 and the opposite end of this chain is provided with a weight 76. The arrangement is such that as long as power is being transmitted from the rocking shaft 41 to an operating rod 40 through a rocking arm 39 the key 55 will not be lifted by the elevation of the cam arm 58 since the pressure exerted upon a side face of the key 55 at this time will hold the same in the notches 56 and the elevation of the arm 58 will simply serve to raise the weight 76 to the upper position in which it is shown in Fig. 8. As soon as the arm 39 which is being actuated has completed its movement to the position in which it is shown in heavy lines in Fig. 8 (which is its grate lowered position) the gripping pressure upon the key 55 will be released, whereupon the key will be retracted by the pull which the weight 76 exerts upon the chain 73. It will be understood that when the arm 39 reaches its grate lowered position just mentioned the weight of the stoker bars 16 is no longer supported by the operating mechanism described since when these bars are lowered they are supported by the engagement of the lower ends of the flanges 17 of the stoker bars with the projections 77 formed upon the inclined beams 12.

The construction just described whereby the key 55 is permitted to remain in its arm-actuating position until the arm 39 has completed its stroke, is found to work very satisfactorily, but it may be desirable to provide means for insuring movement of the arm 39 to its grate lowered position in case the key 55 should be prematurely retracted, and to this end in the construction shown the hub members 54 are provided with the projecting ears 78 to which the bridge bar 79 is secured, and this bridge bar is provided with an adjustable bolt 80 the lower end of which is positioned to abut against the projection 81 formed upon the rocking arm 39. It will therefore be seen that should the key 55 fail to perform its intended function the bolt 80 will act upon the lug 81 to move the arm 39 to its grate lowered position.

It will be apparent from the foregoing description of the stoker operating mechanism that the power shaft 41 is positively rocked back and forth so that movement of the same throughout its stroke in either direction is assured, and it therefore follows that as long as a rocking arm 39 is operatively secured to this shaft by a key 55 positive movement of such arm back and forth is assured. When a key actuating arm 58 is no longer supported in its elevated position by a cam 61 it will move downwardly under the influence of its weight and that of the ball or weight 76. This will press the key 55 against the curved face of the hub members 54 and will force the key into the slot 56 when this slot is turned by the movement of the shaft 41 into align-

ment with the key. Should it be desired for any reason to stop stoking a particular section of the furnace grate, this may be accomplished by simply moving the proper key 55 by hand entirely out of its guide slot 57 to thereby render the arm 39 inoperative.

The form of operating means shown and described for selectively operating the arms 39, not only permits these arms to be operated in any desired order to stoke the furnace, but constitutes a strong, and durable construction, possessing but few parts which are not likely to get out of order, or to be rendered inoperative by the accumulation of the dirt and dust of the furnace room upon the operating parts.

It may be desirable to increase or decrease the distance to which the stoker bars 16 are elevated and this may be readily done, in accordance with the present invention, by providing an adjustable connection between the outer end of each operating bar 40 and the rocking arm 39 to which it is connected. In the construction shown the outer end of each bar 40 is provided with a slotted casting 82 in which is slidably mounted a block 83. This block is secured to the bifurcated end portion of the arm 39 by a pivot pin or bolt 84, the arrangement being such that the block 83 is pivotally secured to the arm 39 and is slidably mounted within the slot formed in the casting 82. At the outer end of the casting 82 is provided a bolt 85 having the hand wheel 86 adapted to rotate this bolt and the arrangement is such that if the bolt is rotated to advance the same lengthwise of the slot within the casting it will serve to clamp the block 83 at the lower end of this slot, in which case the full stroke imparted to the rocking arm 39 will be transmitted to the bar 40, but if the bolt 85 is backed off a desired distance from the clamping position just mentioned the block 83 will be permitted to travel some distance along its slot before it actuates the rod 40, thus reducing the movement imparted to this rod to lift the stoker bars.

Since the portion of the stoker bars which engages the fuel bed is subjected to a high temperature it is desirable to provide the bars 16 with the removable grate blocks or grate members 87. Various means might be provided for securing these blocks to the grate bars 16 and in the construction shown this is accomplished by providing each bar 16 with the block positioning lugs 88 arranged in pairs at the opposite sides of a bar 16, and these lugs are adapted to receive between them the fingers 89 which project downwardly from the lower face of a block 87. In order to prevent the blocks 87 from becoming accidentally disengaged from the bars 16 the securing pins 90 may be provided which extend transversely of the fingers 89, as will be apparent from Fig. 5. The construction

just described serves to secure the blocks 87 to the bars 16 so that an air space may be provided between each pair of blocks, as will be apparent from Fig. 4.

5 The construction of the blocks 87 is important because they are subjected to an extremely high temperature and unless provision is made for cooling them they will soon burn out. In order to give the blocks a maximum amount of cooling or radiating surface, they are given the hollow construction shown 10 having the air passages or slots 91 through which cooling currents of air pass to the fuel bed to promote combustion, and since the 15 blocks are supported out of contact with each other they are entirely surrounded by cooling currents of air. The cooling of these blocks is further promoted by giving them a substantial thickness from their upper to 20 their lower face. This increases the radiating surface and length of the passages 91, and the side walls of the blocks extend downwardly a sufficient distance to protect the inner structure of the blocks even when they 25 are elevated as shown in Fig. 13.

The stoker bars 16 are made narrow in section as compared to the width of the blocks 87, this being highly desirable as it permits a large volume of air to pass freely 30 upwardly between the bars 16 to the blocks 87. By constructing the blocks 87 and the bars 16 in the manner just described the blocks are free from projections that are likely to be burnt off and the walls and inner 35 web structure of the blocks are sufficiently thin to cool readily, with the result that the entire construction is peculiarly well adapted to withstand the injurious action of high temperatures.

40 The furnace shown in Fig. 1 may be supplied with fuel from a hopper 92 of any well known or preferred construction and the fuel may be fed from this hopper through the passage 93 to the fuel bed by feeding 45 mechanism such as the feeding casting 94 which is mounted for sliding movement towards and from the fuel passage 93. The means shown for imparting reciprocatory movement to the casting 94 consists of the 50 power actuated shaft 95 which may extend transversely across the front of the furnace, and rocking movement is imparted to this shaft by a laterally extending arm 96 the 55 outer end of which is connected by a connecting rod 97 to a pin or bolt 98 which operatively secures the lower end of this rod to a disk 99 that may be fastened to the opposite end of the motor driven shaft 47.

60 The power shaft 95 is provided with the downwardly extending arms 100 each of which is bolted or otherwise rigidly secured to this shaft so that the rocking movement of the shaft 95 will be imparted to these arms. The number of arms 100 employed will correspond 65 with the number of fuel feeding cast-

ings 94 to be operated, and each arm 100 is provided at its lower end with a slotted head or casting 101 in which is slidably mounted a block 102 which may be similar to the block 83 above mentioned. Within the block 102 is 70 mounted a pivot rod 103 which extends parallel to the power shaft 95 and at the opposite ends of the rod 103 are provided the arms 104. These arms are journaled upon the shaft 95 75 for rocking movement, but are rigidly secured to the pivot rod 103 by bolts or the like 105.

It will be seen from the construction just described that when the power shaft 95 is 80 rocked the arms 100 which are rigidly secured to the shaft 95 will impart a swinging motion to the rods 103, and this swinging movement is imparted to the fuel feeding casting 94 by links 106 the inner ends of 85 which are connected to the castings 94 by a shaft, or pivot pins, 107. The length of stroke imparted to the fuel feeding casting 94 may be varied as desired by backing off the bolt provided with the hand-wheel 108, 90 the same as above described in connection with the hand wheel 86, and the bolt which is controlled by the hand-wheel 108 may be locked in the desired position of adjustment 95 by operating the locking nut or second hand-wheel 109. Since the side arms 104 are rigidly secured to the pivot rod 103, but are pivotally secured to the power shaft 95, these arms will hold each pivot rod 103 in parallel relation to the main shaft 95.

100 The stoking mechanism of the present invention works in an extremely satisfactory manner to keep the entire fuel bed loose and porous so that the air necessary to support combustion is freely supplied. It also serves 105 to gradually advance the fuel toward the rear end of the furnace. This advancing movement of the fuel is effected in part by the inclined lifting action of the stoker bars and in part by the tilting of the raised section 11 of the fuel bed rearwardly at an increased inclination. When the groups of stoker bars are raised and lowered in the order in which they are shown actuated in Figs. 11, 12 and 13, they produce successive waves traveling 11 from the rear to the front of the furnace and each wave is tilted rearwardly at an increased angle to the normal plane of the fuel bed as shown.

What is claimed is:—

1. Stoking mechanism, comprising in combination, stoker bars mounted side by side transversely of the furnace to form a fuel supporting grate that slopes downwardly toward the rear of the furnace, means for 1 supporting the bars for reciprocatory movement along straight paths in a direction at approximately right angles to the inclined plane of the grate, and means for simultaneously raising adjacent bars to different 1

heights to cause their fuel supporting surface to present a stepped support for the fuel while the bars are in the raised position.

2. Stoking mechanism, comprising in combination, stoker bars mounted side by side transversely of the furnace to form a fuel supporting grate that slopes downwardly toward the rear of the furnace, means for supporting the bars for reciprocatory movement along straight paths in a direction at approximately right angles to the inclined plane of the grate, and means for simultaneously raising several adjacent bars forming a local group different heights to produce a stepped formation adapted to lift and thrust rearwardly the portion of the fuel bed resting upon the raised bars.

3. Stoking mechanism, comprising in combination, stoker bars mounted side by side transversely of the furnace to form a fuel supporting grate that slopes downwardly toward the rear of the furnace, means for supporting the bars for reciprocatory movement along straight paths in a direction at approximately right angles to the inclined plane of the grate, and means for raising adjacent bars forming a section of the grate simultaneously to different heights so that one bar is forced upwardly into the fuel bed a greater distance than the raised bar next to it to tilt rearwardly at an increased angle the portion of the fuel bed upon the raised bars.

4. Stoker mechanism, comprising in combination, stoker bars mounted side by side transversely of the furnace to form a fuel supporting grate that slopes downwardly toward the rear of the furnace, means for supporting the grate bars for reciprocatory movement along straight paths in a direction at approximately right angles to the inclined plane of the grate and so that they may be shifted in groups and one group may be raised while the adjacent groups remain in their lowermost position, and means for raising the adjacent bars forming a group simultaneously but to different heights so that the raised bars will present a stepped fuel supporting surface to the fuel bed to tilt that portion of the fuel bed rearwardly at an increased angle.

5. Stoking mechanism, comprising in combination, stoker bars mounted side by side transversely of the furnace to form a fuel supporting grate that slopes downwardly toward the rear of the furnace, means for supporting the grate bars for reciprocatory movement along straight paths in a direction at approximately right angles to the inclined plane of the grate and so that they may be shifted in groups and one group may be raised while the adjacent groups remain in their lowered position, and means for raising the adjacent bars forming a group simultaneously to thrust the portion of the

fuel bed resting thereupon rearwardly and to tilt it at an increased fuel advancing slope.

6. Stoker mechanism, comprising in combination, stoker bars mounted side by side transversely of the furnace to form a fuel supporting grate and arranged to be operated in different groups, said groups being disposed in successive relation lengthwise of the grate and each group consisting of several adjacent grate bars, means for supporting the bars for reciprocatory movement along straight paths to and from elevated positions, and means for raising simultaneously the several adjacent bars of one group and then the several adjacent bars of the next group to impart to the fuel bed successive waves or ripples that travel lengthwise of the fuel bed.

7. Stoking mechanism, comprising in combination, a plurality of stoker bars supported side by side to form a fuel grate the stoker bars of which are adapted to be operated in groups, means for supporting the bars for sliding movement along straight paths in a direction at approximately right angles to the plane of the grate, and means for raising the adjacent bars of a group simultaneously to different heights, including an operating bar movable in the direction of its length, and separate rocking levers provided with different length arms connected to the stoker bars, and means connecting said operating bar and rocking levers to transmit the movement of the operating bar to the different stoker bars.

8. Stoking mechanism, comprising in combination, stoker bars mounted side by side transversely of the furnace to form a fuel supporting grate that slopes downwardly toward the rear of the furnace, the stoker bars being adapted to be raised and lowered in independent groups, means for supporting the bars for movement along straight paths to and from elevated positions at substantially right angles to the plane of the inclined grate, and means for raising simultaneously but to different heights the adjacent bars forming one group and then similarly actuating the bars forming an adjacent group including rocking levers provided with different length actuating arms connected to the different stoker bars of a group, and means for simultaneously rocking the several levers for actuating a group of bars.

9. A furnace grate, comprising in combination a plurality of stoker bars supported side by side transversely of the furnace for movement toward and from a raised position, bearings for supporting the bars for sliding movement along straight paths at an inclination to a vertical plane and positioned well below the fuel supporting surface of the grate, bearing surfaces projecting downwardly from the ends of said bars to slide in said supporting bearings and located well below the plane of the upper surface of the grate out of the range of the hot fuel bed,

and means for raising one group of adjacent bars and then another group of adjacent bars.

10. A furnace grate, comprising in combination a plurality of stoker bars supported side by side transversely of the furnace for sliding movement toward and from a raised position, bearings for supporting the bars for sliding movement along straight paths at an inclination to a vertical plane and positioned well below the fuel supporting surface of the grate, and each stoker bar having downwardly extending projections at its opposite ends that extend downwardly a substantial distance from the bar to fit slidably in said bearings so that the supporting bearings are located well below the plane of the upper surface of the grate, and means for simultaneously raising several adjacent bars.

11. Stoking mechanism, comprising in combination, stoker bars supported side by side to form a fuel grate that slopes downwardly toward the rear of the furnace, means for supporting the stoker bars for sliding movement along straight paths at substantially right angles to the inclined plane of the grate and so that they may be shifted in independent groups to raise and thrust rearwardly the portion of the fuel bed upon each group, a separate actuator for each group of grate bars, means for shifting one actuator while the others are still, and connections between each actuator and the grate bars of the group controlled thereby for simultaneously shifting the bars of a group.

12. Stoking mechanism comprising in combination, a group of stoker bars consisting of comparatively wide, thin bars extending transversely of the furnace and supported side by side but in spaced relation to each other for sliding movement along straight paths at an inclination to a vertical plane and at approximately a right angle to the plane of the fuel bed to thrust the portion of the bed resting thereon upwardly and rearwardly, relatively wide hollow grate blocks mounted upon said bars to conduct air upwardly through the blocks at the opposite sides of the bars and provided with deep side walls that lie in close proximity to the side walls of the adjacent grate blocks to overlap the latter throughout their sliding movement, means located at the ends of the grate bars and below the grate blocks for supporting the bars for sliding movement, and means for shifting the grate bars to stoke the fuel bed.

13. Stoking mechanism, comprising in combination, a series of grate bars extending transversely of the furnace and arranged side by side to form a fuel supporting grate that slopes downwardly towards the rear of the furnace, means for supporting the grate bars for reciprocatory movement in a straight line at an inclination to a vertical plane to raise and lower portions of the fuel bed, means connecting the bars for operation in

groups each consisting of three adjacent bars, and mechanism for raising the three adjacent bars of a group simultaneously but to successively increasing heights so that the raised bars of a group form a series of steps adapted to tilt the fuel bed resting thereupon to an increased inclination.

14. Stoking mechanism comprising in combination, a series of grate bars extending transversely of the furnace and arranged side by side to form a fuel supporting grate that slopes downwardly towards the rear of the furnace, means for supporting the grate bars for reciprocatory movement in a straight line at an inclination to a vertical plane to raise and lower portions of the fuel bed, means connecting the bars for operation in groups each consisting of several adjacent bars, and mechanism for positively raising and lowering the bars of a group and operable to raise the bars of a group simultaneously but to successively increasing heights so that the raised bars form steps adapted to tilt the fuel bed resting thereupon at an increased inclination.

15. A mechanical stoker having a grate that is inclined downwardly toward the rear of the furnace, and comprising in combination a series of grate bars mounted side by side transverse of the furnace to form a fuel supporting grate the bars of which are movable in groups, means for supporting the bars for reciprocatory movement along straight paths in a direction at substantially right angles to the plane of the inclined grate, mechanism for raising the adjacent bars of a group simultaneously but to successively increasing heights to form adjacent steps which tilt the fuel bed resting thereupon at an increased angle, and means for periodically actuating one group of bars and then another to impart to the fuel bed successive waves or ripples that travel down the grate.

16. Stoking mechanism comprising in combination, a series of grate bars extending transversely of the furnace and arranged side by side to form a fuel supporting grate, means for supporting the grate bars for reciprocatory movement along straight paths at an inclinate to a vertical plane to force the portion of the fuel bed resting thereupon upward and rearward, mechanism for operating one group of adjacent bars and then another group to stoke the fuel bed and adapted to raise the successive bars of a group increasing distances, and adjustable means for varying the length of movement imparted to the grate bars.

In testimony whereof, I have signed my name to this specification.

GEORGE H. THACHER, JR.