

1,066,254.

G. B. CRAMP.
MECHANICAL STOKER.
APPLICATION FILED MAY 2, 1912.

Patented July 1, 1913.

4 SHEETS—SHEET 1.

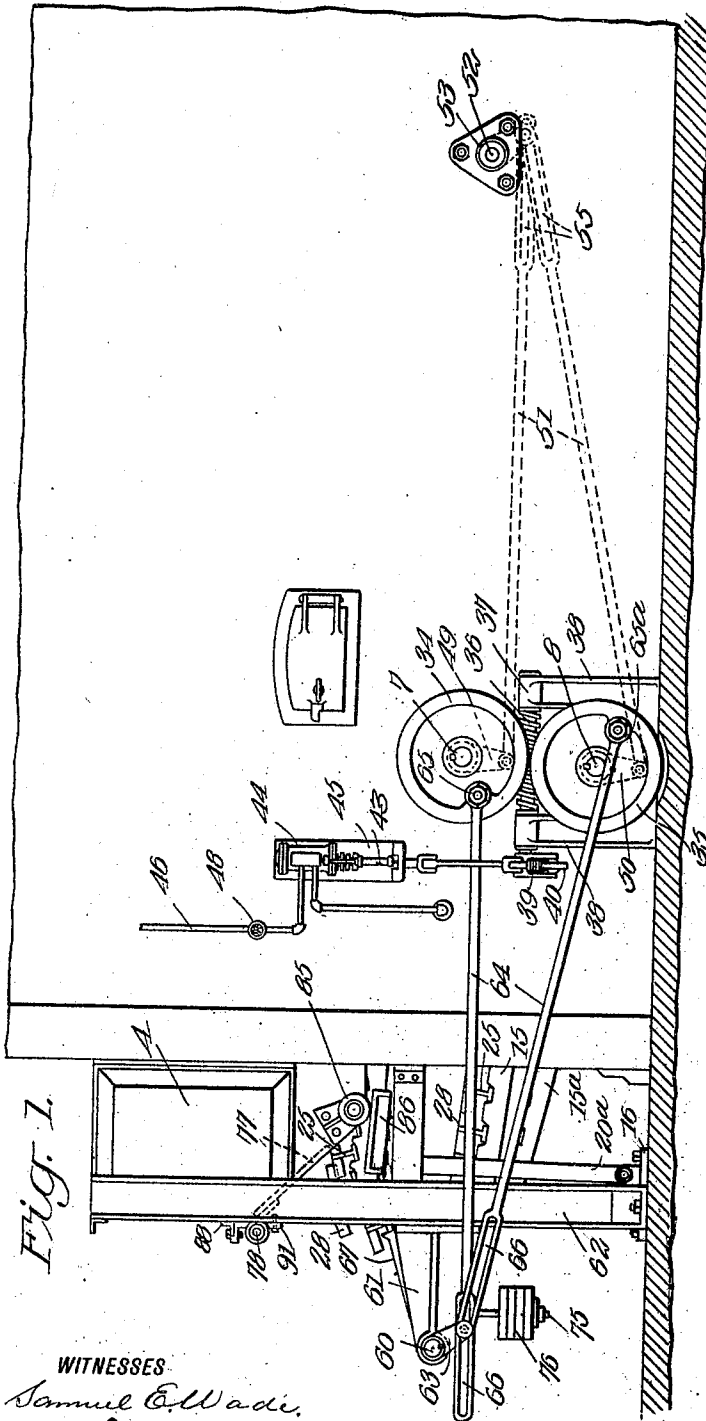


Fig. 1.

WITNESSES
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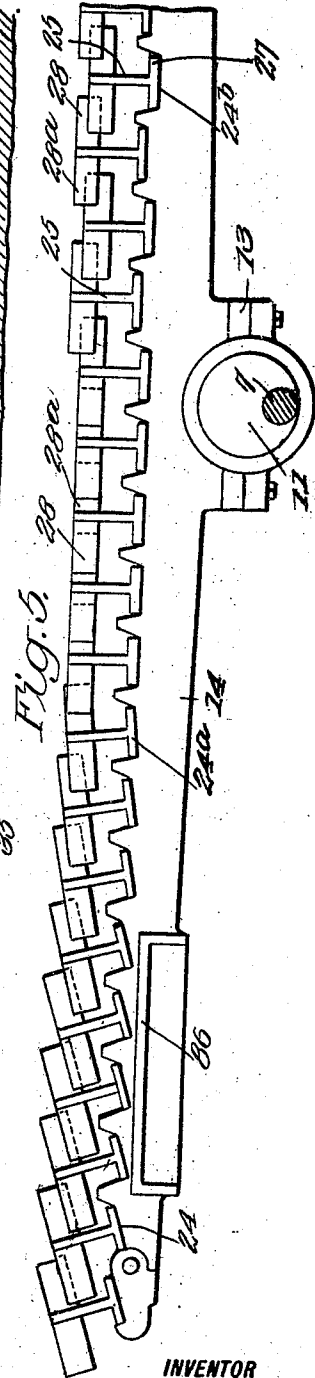


Fig. 5.

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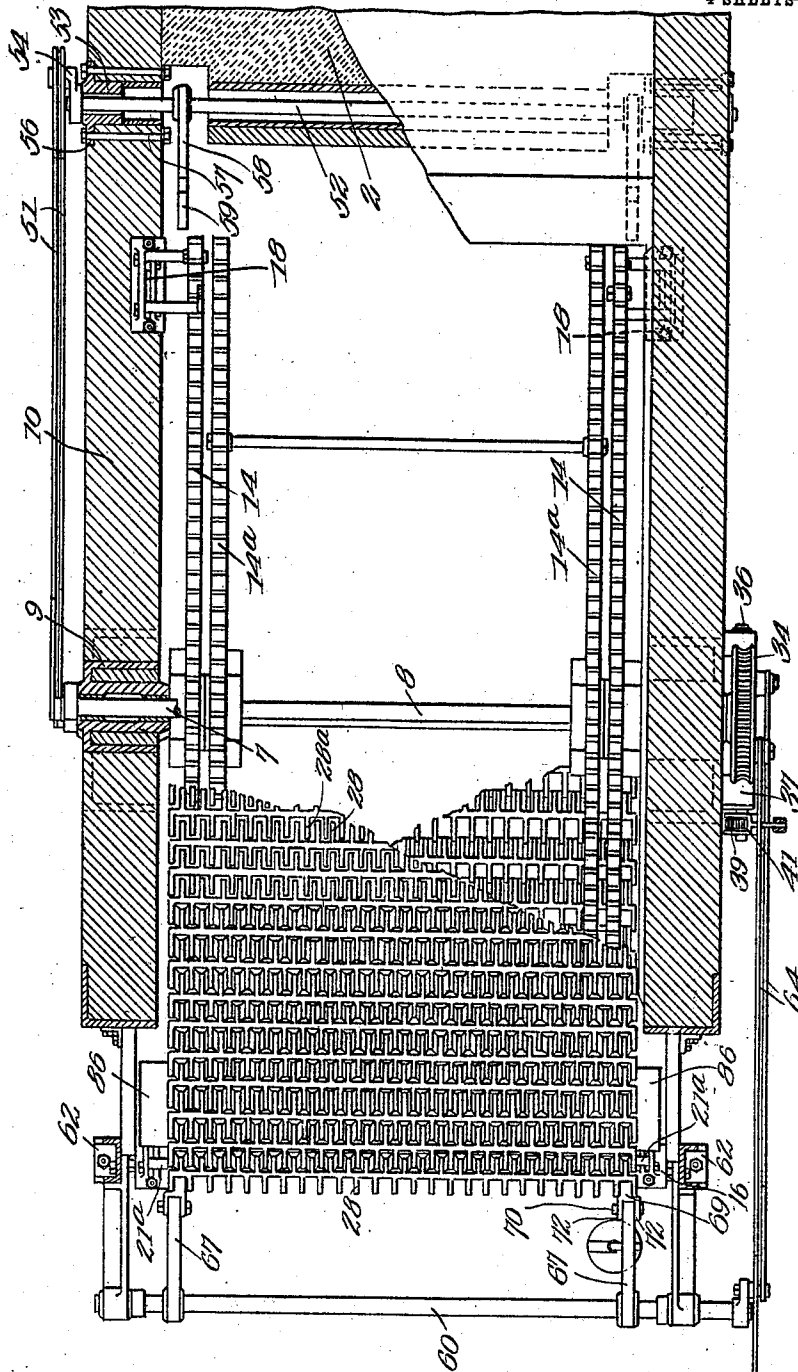
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4 SHEETS—SHEET 2.

Fig. 2.



WITNESSES

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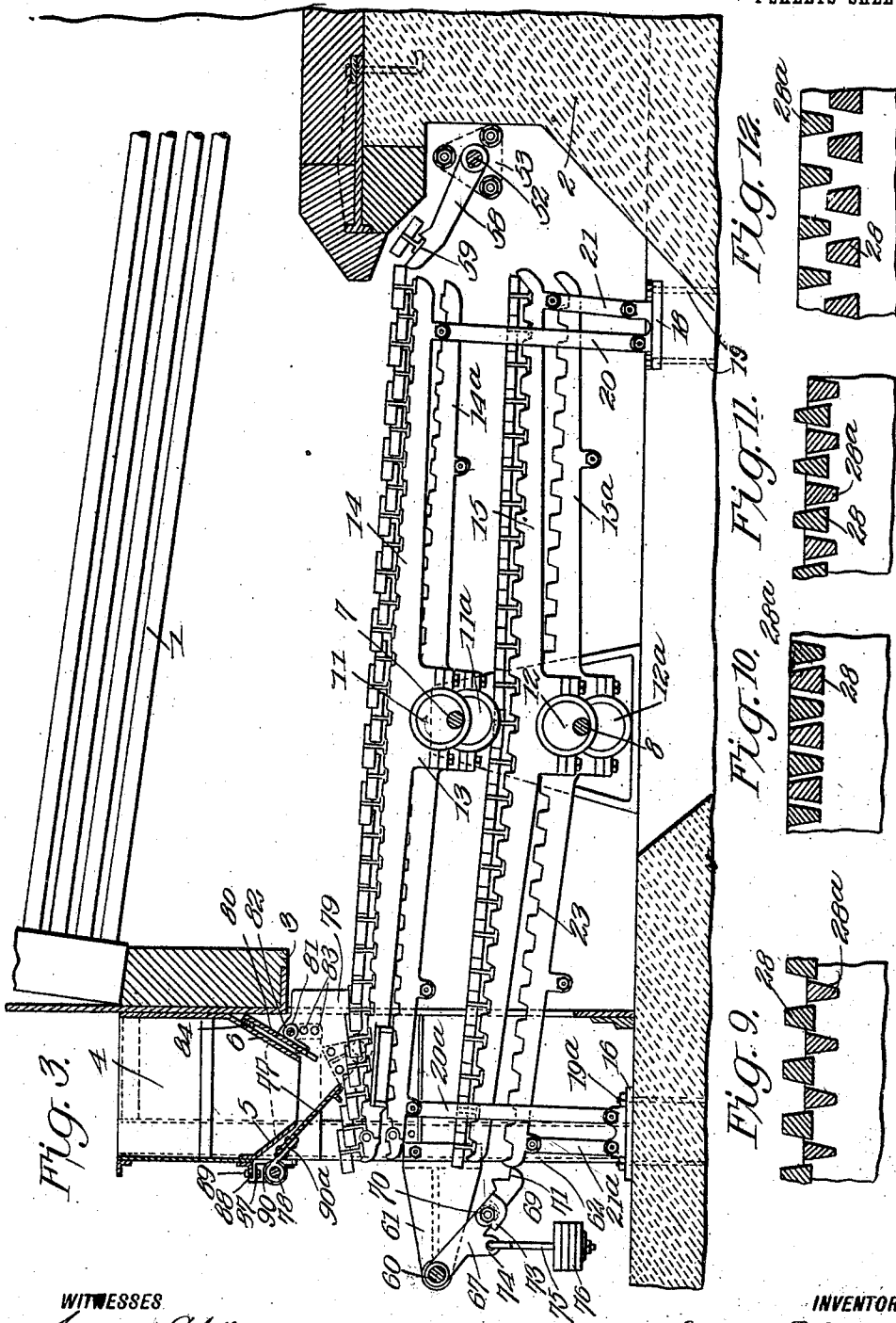
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4 SHEETS—SHEET 3.



WITNESSES
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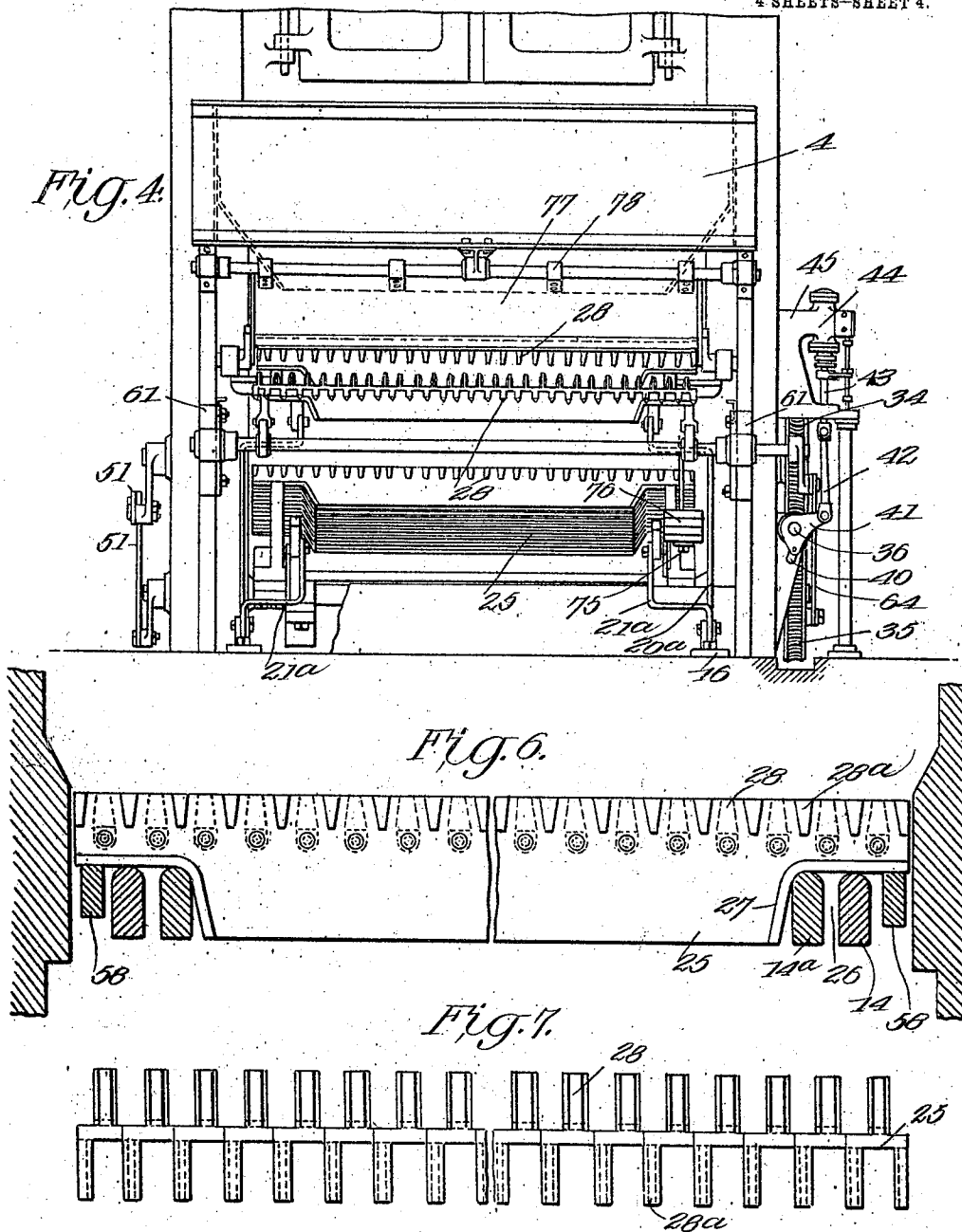
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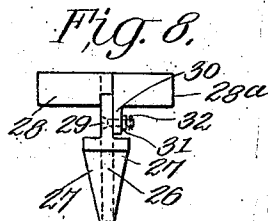
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4 SHEETS-SHEET 4.



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MECHANICAL STOKER.

1,066,254.

Specification of Letters Patent.

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Application filed May 2, 1912. Serial No. 694,656.

To all whom it may concern:

Be it known that I, GEORGE B. CRAMP, a citizen of the United States, and a resident of Harrisburg, in the county of Dauphin, State of Pennsylvania, have invented a new and useful Improvement in Mechanical Stokers, of which the following is a specification.

My invention is an improvement in mechanical stokers, and has for its object the provision of a device of the character specified wherein means is provided for passing the fuel through the furnace at a speed that will permit the fuel to be consumed, and wherein means is also provided in connection with the feeding means for breaking up and separating the burning fuel as it travels, in order to permit the greatest possible amount to be converted into heat, and to prevent the formation of clinkers and the adherence of the fuel and waste products to the grate bars.

A further object is to provide a stoker wherein the grate bars will be moved from the front of the furnace to the rear in one plane, and from the rear to the front in a lower plane, and wherein the said bars will be given a relative movement vertically as they move forwardly to thoroughly slice and break up the fuel, and wherein the fuel will be distributed uniformly and evenly on the grate and the fine coal will be held until it cokes and adheres to the larger size.

A further object is to provide a device wherein the grate bars may be renewed without the necessity of stopping the operation of the stoker, or slowing the operation thereof, and wherein the first cost will be relatively small and the operation economical, both as concerns the operating parts and the operation.

In the drawings: Figure 1 is a side view of a furnace provided with the improvement; Fig. 2 is a horizontal section; Fig. 3 is a longitudinal vertical section; Fig. 4 is a front view of the furnace; Fig. 5 is an enlarged partial side view of the grate; Figs. 6, 7 and 8 are front, plan and end views respectively of the grate bar; and Figs. 9 to 12 are diagrammatic sections of adjacent grate bars showing the different positions taken by the lugs as the grate bars travel from front to the rear of the grate.

In the present embodiment of the invention the furnace may be of any usual construction, as may also the boiler 1, and the

stoking mechanism is arranged transversely of the furnace, extending forwardly from the bridge wall 2 through the feed opening 3 to a point beneath a suitable container 4 for fuel, which is arranged above the outer end of the stoker at the front of the boiler.

The container 4 may receive the fuel in any preferred manner, and from the container the fuel is fed through the bottom of the container. Inclined deflecting plates 5 and 6 are arranged in the bottom of the container, forming a species of hopper bottom, having an opening directly above the outer end of the stoker.

The stoker comprises a pair of shafts 7 and 8, journaled one above the other, in bearings stands 9 built in the side walls of the furnace. Each of the shafts 7 and 8 is provided with two pairs of eccentrics or cams 11 and 11^a and 12 and 12^a, respectively, the pairs of each shaft being oppositely arranged, and the members of each pair being at opposite ends of the shaft. As, for instance, the eccentrics 11 of shaft 7 have their point of greatest eccentricity directly opposite the point of greatest eccentricity of eccentrics 11^a, and one member of each pair is arranged at each end of the shaft. The same arrangement applies to the eccentrics 12 and 12^a of shaft 8.

A supporting frame or rack bar for holding the grate bars is operated by each eccentric, and four of the rack bars are provided for each shaft 7 and 8. Each rack bar has a sectional bearing 13 for engaging an eccentric, and each of the rack bars 14 and 15 for eccentrics 11 and 12 has its front end connected to a plate 18 secured to the furnace floor by bolts 19. The connection is by means of links 20 and 21 for the respective rack bars, each link being pivoted at one end to the rack bar and at the other to the plate.

Each of the rack bars 14^a and 15^a for the eccentrics 11^a and 12^a has its outer end similarly connected to a plate 16 secured to the furnace floor at the front thereof by bolts 19^a. Links 20^a connect the rack bars 14^a to the plate, and links 21^a connect the rack bars 15^a. On account of the above described connection, the rack bars 14 and 15 will be moved in the same manner, and the bars 14^a and 15^a will also be moved in the same manner, but in the opposite direction to bars 14 and 15.

It will be noticed from an inspection of

Fig. 4 that the ends of the links 20^a and 21^a are offset laterally from each other, and that the plates 16 to which they are secured are near the furnace wall, instead of being directly below the grate bars.

The rack bars 14, 14^a, 15 and 15^a are of similar construction, and each bar is provided in its upper edge with spaced notches or recesses. The notches or recesses are relatively wide as compared with their depth, and the bottom of each recess is straight or plane, and the side walls are inclined inwardly toward the bottom of the recess.

The bottoms of the notches or recesses of the lower rack bars 15 and 15^a are in approximate alignment, and the said notches or recesses are alike throughout the length of the rack bars. The distance from center to center of the said notches is exactly equal to the throw of the eccentrics. The notches of the upper rack bars 14 and 14^a are not alike, however, throughout the length of the bar, but are arranged in three series 24, 24^a and 24^b (Fig. 5).

The notches of series 24, which are at the outer or forward end of the rack bars, have their bottoms inclined downwardly toward their front ends, and the rear walls of the notches are of less depth than the front walls. The inclination of the said bottom wall decreases gradually toward the rear end of the series, until they merge gradually into the notches of series 24^a, in which the bottoms are horizontal and in approximate alignment.

The bottoms of the notches of series 24^b are also horizontal, but the alternate recesses are of less depth than the intermediate series. The grate bars 25 are notched or recessed at each end, at their lower edge, approximately half their width, as shown at 26, and the rack bars 14, 14^a, 15 and 15^a engage the grate bars in the notches.

The notches 26 are of a depth corresponding approximately to the width of the rack bars and at each of the said notches the grate bars are flanged laterally at both sides, at both the bottom and end of the notches, as shown at 27. Each grate bar is also provided at its upper edge with series 28 and 28^a of laterally extending lugs, the lugs 28 extending on one side of the bars and the lugs 28^a on the other side.

As shown in Fig. 7, the series 28 of lugs is staggered with respect to the series 28^a, and each of the lugs 28^a is detachably connected to the grate bar by means of bolts 29, which are passed through the bodies of the bars and through depending lugs 30 on the lugs 28^a. The bolts are engaged by nuts 31, and a cotter-pin 32 is passed through each bolt to hold the nut from turning.

The heads of the bolts are received in the countersunk ends of the openings through which they are passed, so that the said heads

are flush with the surface of the bars. When the grate bars are in place on the rack bars, the lugs 28^a of each bar fit between the lugs 28 of the adjacent bar, and the peculiar form of the notches 24, 24^a and 24^b provides for relative movement of the grate bars in a vertical direction.

The grate bars are arranged transversely of the furnace, and the said bars are of such length that their ends extend beyond the rack bars, in order that the said ends may be engaged by the transferring devices, to be described, at each end of the said rack bars. The upper edges of the rack bars are rounded, as shown in Fig. 6.

The shafts 7 and 8 are provided at one end with worm wheels 34 and 35, respectively, and the said wheels engage a common worm shaft 36 journaled between the wheels in bearings 37 on brackets 38. The shaft 36 is rotated by means of a ratchet wheel 39 secured to one end of the shaft and engaged by a pawl 40 on one arm of an elbow lever 41 pivoted on the shaft. The other arm of the elbow lever is pivoted to the lower end of a link 42, whose upper end is connected to the piston rod 43 of a piston (not shown) in a cylinder 44, held in a supporting frame 45 on the outer face of the furnace side wall. The cylinder is supplied with motive fluid from the boiler by means of pipes 46 and 47, the former having a valve 48 for controlling the same.

Each of the shafts 7 and 8 is provided with a crank arm 49 and 50, respectively, at its opposite end, and each of the said arms is connected by a link 51 with the transferring mechanism at the rear of the stoker for transferring the grate bars from the rack bars 14, 14^a to the rack bars 15, 15^a. The said mechanism comprises a shaft 52 journaled transversely of the stoker in bearings 53 in the furnace walls. A crank arm 54 is secured to one end of the shaft, and each of the links 51 is provided with a longitudinal slot 55 for engaging the outer end of the arm. The bearings 53 are integral with a triangular face plate 56 which is secured to the outer face of the wall by bolts 57 and the bearing extends into an opening in the wall.

An arm 58 provided with a bearing sleeve for engaging the shaft is arranged near each end thereof, and each bearing sleeve is keyed to the shaft (Fig. 3). Each arm is provided with a notch or recess 59 at its free end and on its upper face for receiving the end of the grate bar, as shown in the said Fig. 3. The shaft is oscillated to move the grate bars by means of the links 51. A similar transferring mechanism is arranged at the front ends of the frames or bars, the said mechanism comprising a shaft 60 journaled in bracket arms 61, extending outwardly from the front of the uprights 62, which

support the fuel container 4. The shaft 60 is provided with a crank arm 63 at one end, and links 64 connect the arm to wrist pins 65 and 65^a on the respective worm wheels 49 and 50 before mentioned.

Each link 64 is longitudinally slotted at its outer end, as shown at 66, for engaging the crank arm, and the said links 64 are slidably connected to the crank arm, as are also the links 51 to the crank arm 54. In both cases the slots engage and are slidable on a headed pin on the end of the crank arm. An arm 67 provided with a bearing sleeve for engaging the shaft is arranged near each end thereof, each sleeve being keyed to the shaft, as shown in Fig. 3.

The arms 67 differ somewhat from the arms 58, in that each arm 67 is sectional, having a movable portion 69 pivoted to the end of the arm, the said movable portion having the notch 71 for the grate bars corresponding to the notch 59 of the arms 58. Each portion 69 has a pair of ears or lugs 72 engaging opposite faces of the arm, and bolts 70 are passed through ears and arm 67 to pivotally connect the said portion and arm. The said portion 69 is provided with a finger 73 extending transversely of the main portion 67 of the arm beneath the same to limit the downward swinging of the portion 69 with respect to the said main portion to a position in alinement with the said main portion. One of the arms 67 is provided with a depending perforated lug 74 for receiving a link 75 which supports a plurality of weights 76.

The provision of the finger makes a rule joint between the sections of the arms, permitting the portions 69 to swing upwardly with respect to the portion 67 but preventing downward movement beyond alinement with the said portion 67. The weights 76 insure the return of the arms to their normal position when they have been moved by the operating mechanism.

The fuel container 4 is provided with a movable portion 79 at its lower end in the form of a frame encircling the said lower end. A plate or door 77 is arranged below the deflecting plate 5 in inclined position, and a shaft 78 connects the plate 77 and the movable portion 79 to the fuel container. The shaft is passed through bearings 90 on the container, and through bearings 90^a on the door.

A second plate or door 80 is arranged in inclined position below the rear deflecting plate 6, and the said plate or door is pivoted intermediate its ends and on a transverse axis to the frame, as shown in Fig. 3. The plate has bearings 82 at each end, and a shaft or rod 81 is passed through the bearings. The said plate is provided with a cross bar 84 at its upper end on the face adjacent to plate 6. The frame 79 is provided

at each side with a roller 85 (Fig. 1) and each of the rollers travels upon a trackway 86 secured to the outer face of the adjacent rack bar 14.

The free edge of the plate 77 is in position just above the grate bars as they begin to move rearwardly on the upper rack bars, and each time that the rack bars 14 move upwardly the rollers are lifted and also the movable portion of the container to insure the proper feeding of the fuel.

The shafts 7 and 8 are rotated by means of the cylinder. Every time the piston moves upwardly, the ratchet wheel is partially rotated. As the eccentrics turn, a four-feed movement is imparted to the grate bars, the feed closely resembling that of an ordinary sewing machine.

On the upper run of the conveyer comprising the rack bars 14 and 14^a the grate bars pass beneath the feed in inclined position on account of the shape of the notches in series 24. Each grate bar is inclined, the lugs at one side being at a lower level at their free ends than the lugs at the other side at their free ends. As the bars 14 move downward from the position of Fig. 3, the grate bars are lowered, until they meet rack bars 14^a which are moving upward. The grate bars are also moved rearwardly by the rack bars 14, so that they slowly travel rearwardly as they are passed from one pair of rack bars 14 to the other 14^a.

The position of the grate bars at the front of the stoker prevents the dropping of the fine coal through the bars and also assists in the even and uniform distribution of the coal over the bars. As the grate bars reach the series 24^a of notches they assume a vertical position, with the upper edges of the lugs 28 and 28^a in the same plane. Just in front of the eccentrics the notches of series 24^b commence.

The side faces of the lugs 28 and 28^a of the grate bars are beveled in opposite directions, the lugs 28 being wider at their bottoms than at their tops, while lugs 28^a are wider at their tops than at their bottoms (Figs. 9 to 12). From this construction results that when the grate bars are tilted or inclined forward, as at the front of the stoker, the wide tops of lugs 28^a are near the wide bottoms of lugs 28, and a close meshing of the lugs results (Fig. 9).

In series 24^a of notches the lugs are at the same level, Fig. 10, and more air may pass between the lugs. The small coal has begun or begins to coke at this point, and the fine coal is thus held to the coarse. When the grate bars reach the series 24^b of notches the lugs 28 and 28^a occupy the relative positions shown in Figs. 11 and 12, series 28 being first raised above the other series 28^a and then series 28^a above series 28. The fuel is thus continually stirred and sliced, and

broken up and apart, to insure complete and perfect combustion. When the grate bars reach the rear end of the rack bars, at the moment when the grate bar in the rearmost notch of the rack bar which extends nearest to shaft 52 is at the nearest point to the shaft, the arms 58 are lifted by links 51 and the notches of the said arms engage the said grate bar.

In operation, the shafts 7 and 8 are turned as above mentioned by the cylinder, and the worm turns them in opposite directions, so that the grate bars on the upper rack bars are moved rearwardly and the grate bars on the lower rack bars are moved forwardly. The grate bars are passed from rack bars 14 to rack bars 15 on the upper run of the conveyer, and on their passage from one pair of rack bars to the other the grate bars are moved rearwardly one notch. At the ends of the rack bars the grate bars are transferred from the upper bars to the lower bars by means of the arms 58 and 67-69. By the arrangement of the rack bars, that are pivoted at one end and free at the other and moved at a point intermediate their ends, a peculiar movement is imparted to the bars. That is, each bar is moved upwardly, rearwardly, downwardly and forwardly at each complete rotation of the eccentric connected therewith. The grate bars are also moved in this manner, but as they pass from one set of bars to the other the vertical movement is not so marked as that of the rack bars. The grate bars move rearwardly with one pair of rack bars and downwardly to a certain extent, and are then transferred to the other pair of bars which are moving upwardly, and are again moved rearwardly, while the first set of rack bars is moving forwardly.

The arms 58 are operated by the links 51, one of which is connected to each shaft 7 and 8. The arms are lifted to receive each grate bar, first by one link and then by the other, and as soon as the grate bar is on the arms they are lowered or moved downward to shift the grate bar to the lower rack bars. The parts are so arranged that the rack bars of the lower set move upwardly and pick the grate bars from the arms. At each rotation of shaft 7 a grate bar is delivered at the rear of rack bars 14, and the rack bars 14^a also deliver a grate bar, so that for each complete rotation of the said shaft 7 two grate bars are delivered at the rear of the stoker. On this account the arms 58 must be operated twice during each rotation of shaft 7, and the shaft 52 is connected to shafts 7 and 8 in order that each shaft will operate the said shaft 52.

The links 51 are slidably connected to the crank arm of the shaft, so that when either link is operating the arm the other link will not be interfered with. It will be evident

that each of the grate bars may be inspected, at the front of the stoker, as it is lifted from the lower to the upper rack bars and defects may be at once remedied.

In operation of the stoker, the rack bars 14 and 14^a are, as before stated, moved upwardly, rearwardly, downwardly, and forwardly, the respective pairs of each shaft moving in opposite directions, and at each upward movement of a pair on the upper shaft 7, for instance, the bars 14, the grate bars on the upper run of the conveyer formed by the rack bars are engaged by the said pair 14 and are moved rearwardly by the said pair of bars a distance corresponding to the distance between two adjacent notches. The said pair of rack bars 14 at the end of their rearward movement begin to move downwardly and meet bars 14^a rising, and the said bars 14^a take the grate bars from bars 14 and move the said grate bars again rearwardly, the distance between the adjacent notches. This movement is continued until the grate bars reach the rear end of the stoker. As the pair of rack bars holding the rearward grate bar move downwardly, the arms 58 are lifted and lift the said rearward grate bar from the pair of rack bars, and immediately lower the said rearmost rack bar and deliver it to the rising pair of lower rack bars. As, for instance, when rack bars 14 in Fig. 2 begin to move downwardly, arms 58 move upward and lift the rearmost grate bar. The arms 58 then move downward, and rack bars 15 move forward, so that the ends of the arms may pass the rear ends of the grate bar without striking the same. As the bars 14 are completing their downward movement, and commencing their forward movement, rack bars 15^a are completing their rearward movement and are beginning to move upward, and the said pair of bars 15^a pick the grate bar from the arms 58 and move the said grate bar forward. As the rack bars 14^a move downward, the arms 58 are again lifted and pick the rearmost grate bar from the bars 14^a and deliver the said grate bar to arms 15 of the lowermost set of rack bars. The rack bars 15 and 15^a move the grate bars toward the front of the stoker in the same manner that the bars 14 and 14^a move them rearwardly and the said grate bars are delivered in turn to the front of the stoker. The rack bars 15 and 15^a move in the opposite direction to bars 14 and 14^a so that the grate bars are moved to the front instead of the rear of the stoker. As each grate bar reaches the front ends of rack bars 15, the arms 67 are lifted and the movable portions of the said arms engage the foremost grate bar and lift the said bar upwardly. At this moment rack bars 14^a are moving forwardly and upwardly, and the said rack bars lift the grate bar from arms 67. At any

67 again move downwardly and the movable portions 69 may swing upwardly, so that they will not interfere with the foremost grate bar on rack bars 15^a. As the arms 67 are moving downward, rack bars 15^a are rising, with a grate bar, and on that account the arms 67 must be constructed as shown, in order that the rising grate bar will not interfere with the said arms. The grate bars are thus moved in a stepwise manner from front to rear of the furnace and from rear to front. On the upper run of the stoker the grate bars at the front of the furnace are in their closest position, with the lugs arranged to make as nearly an imperforate holder as possible. As they move rearwardly they are separated to permit a larger quantity of air to pass, and as they near the center of the furnace the grate bars are so arranged as to break up and slice the burning fuel to insure complete combustion.

The feeding mechanism at the front of the furnace insures that the fuel will be evenly and uniformly distributed over the grate bars, and that the fuel will be fed continuously and not by jerks, first a large amount, and then a small amount or none at all. A defective grate bar may be removed at the front of the stoker without stopping or slowing the movement of the stoker.

I claim:

1. A mechanical stoker comprising a progressive feed grate composed of upper and lower sets of rack bars, each set comprising a plurality of pairs, the members of the pairs being arranged in spaced relation, a plate arranged adjacent to each end of each of the pairs, links connecting the front ends of one pair of upper rack bars and one pair of lower rack bars to the plates at the front of the grate, links connecting the rear ends of the other pairs to the plates at the rear of the grate, upper and lower shafts journaled transversely of the grate intermediate the ends of the rack bars, an eccentric for each upper rack bar secured to the upper shaft, an eccentric for each lower rack bar secured to the lower shaft, a bearing intermediate the ends of each rack bar, each bearing engaging an eccentric, the eccentrics of the rack bars connected at their front ends being oppositely arranged to the eccentrics of the rack bars connected at their rear ends, means for intermittently rotating the shafts at the same speed in opposite directions, a plurality of grate bars, each grate bar having oppositely extending flanges at its lower edge for engaging the rack bars, each of the said rack bars having its upper edge provided with spaced notches for engagement by the said ends, the notches of the lower rack bars having their bottoms in approximate alinement, and the notches of the upper rack bars being arranged in three

series, the members of the series at the front ends of the said bars having their bottoms inclined downwardly toward the front ends thereof, the notches of the second series having their bottoms in alinement, and the alternate notches of the third series being of lesser depth than the intermediate notches, each of the said grate bars having oppositely extending series of lugs at each side thereof, the lugs of one series being staggered with respect to the lugs of the other series, and the side edges of the lugs of one series being beveled in the opposite direction to the side edges of the other series, and means at each end of the rack bars for transferring the grate bars from one set of rack bars to the other set.

2. A mechanical stoker comprising a progressive feed grate composed of upper and lower sets of rack bars, each set comprising a plurality of pairs, the members of the pairs being arranged in spaced relation, a plate arranged adjacent to each end of each of the pairs, links connecting the front ends of one pair of upper rack bars and one pair of lower rack bars to the plates at the front of the grate, links connecting the rear ends of the other pairs to the plates at the rear of the grate, upper and lower shafts journaled transversely of the grate intermediate the ends of the rack bars, an eccentric for each upper rack bar secured to the upper shaft, an eccentric for each lower rack bar secured to the lower shaft, a bearing intermediate the ends of each rack bar, each bearing engaging an eccentric, the eccentrics of the rack bars connected at their front ends being oppositely arranged to the eccentrics of the rack bars connected at their rear ends, means for intermittently rotating the shafts at the same speed in opposite directions, a plurality of grate bars, each grate bar having oppositely extending flanges at its lower edge for engaging the rack bars, each of the said rack bars having its upper edge provided with spaced notches for engagement by the said ends, and means at each end of the grate for transferring the grate bars from one set of rack bars to the other set.

3. A mechanical stoker comprising a progressive feed grate composed of upper and lower sets of rack bars, each set consisting of a plurality of pairs, the members of the pairs being approximately parallel and arranged at opposite sides of the grate, a plate at each end of the rack bars at each side of the grate, a link connecting the front ends of one pair of upper rack bars and one pair of lower rack bars to the plates at the front of the grate, links connecting the rear ends of the other pairs to the plates at the rear of the grate, upper and lower shafts journaled transversely of the grate intermediate the ends of the rack bars, an eccentric on

the upper shaft for each upper rack bar, an eccentric on the lower shaft for each lower rack bar, a bearing on each rack bar for engaging an eccentric, the eccentrics of the first named pairs of rack bars being oppositely arranged to the eccentrics of the last named pairs of frame bars, means for intermittently rotating the shafts at the same speed in opposite directions, a plurality of grate bars, the rack bars having notches for receiving the ends of the grate bars, and means at each end of the rack bars for transferring the grate bars from one set of rack bars to the other set.

4. A mechanical stoker comprising a progressive feed grate composed of upper and lower sets of rack bars, each set consisting of a plurality of pairs, the members of the pairs being arranged in spaced relation, a link pivotally connecting the front ends of one pair of upper rack bars and one pair of lower rack bars to the bottom of the furnace, links connecting the rear ends of the other pairs of rack bars to the bottom of the furnace, means for imparting a vertically oscillating and endwise reciprocating movement to all of the rack bars and for causing the first named pairs of bars to move in the opposite direction to the last named pairs, a plurality of grate bars each having oppositely extending flanges at its ends, each of the rack bars having its upper face provided with spaced notches for engagement by the said ends of the grate bars, and means at each end of the grate for transferring the grate bars from one set of rack bars to the other set.

5. A mechanical stoker comprising a progressive feed grate composed of a plurality of grate bars arranged transversely of the grate, upper and lower sets of frame bars, each having a notched upper surface for engagement by the grate bars, the rack bars of each set being arranged in pairs, a shaft journaled transversely of each set of rack bars intermediate the ends thereof, means on each shaft for simultaneously imparting a vertically oscillating and endwise reciprocating movement to the rack bars and for constraining one pair of each set to move in the opposite direction to the other pair of the set, means for rotating the shafts in opposite directions and at equal speed, and means at each end of the grate for transferring the grate bars from one set to the other, said means comprising a shaft arranged transversely of the grate at each end thereof, each shaft having arms extending toward the rack bars, a connection between each of the first named shafts and each of the last named shafts for oscillating the said last named shafts once during each rotation of the first named shafts, the arms on the shaft at the front of the grate being sectional, and the sections being hinged to-

gether for swinging movement upwardly with respect to each other.

6. A mechanical stoker comprising a progressive feed grate composed of a plurality of grate bars arranged transversely of the grate, upper and lower sets of rack bars each having a notched upper surface for receiving the grate bars, the rack bars of each set being arranged in pairs, means for simultaneously imparting a vertically oscillating and endwise reciprocating movement to each set of rack bars and for constraining one pair of each set to move in the opposite direction to the other pair of the set, means for intermittently operating the said means in opposite directions, and means at each end of the rack bars for transferring the grate bars from one set of rack bars to the other set.

7. A mechanical stoker comprising a progressive feed grate composed of a plurality of grate bars arranged transversely of the grate, fuel feeding means at the front of the grate, each of the said grate bars having oppositely arranged series of laterally projecting spaced lugs at its upper edge, the lugs of one series being staggered with respect to the lugs of the other series, the lugs of each series having their side edges beveled, the side edges of the lugs of one series being beveled in the opposite direction to the side edges of the lugs of the other series, means for moving the said grate bars in spaced relation from the front to the rear of the grate and with the lugs of each bar extending between the lugs of the adjacent bars, said moving means having means for supporting the grate bars with the lugs inclining downwardly at the front of the grate bar as the said grate bars pass below the feeding means and for supporting the grate bars with the lugs at approximately the same level as the grate bars enter the furnace and for supporting the alternate grate bars at a higher level than the intermediate grate bars for the remainder of their travel to the rear of the grate, means below the first named means for moving the said bars in spaced relation from the rear to the front of the grate, and means at each end of the said moving means for transferring the grate bars from one of the said moving means to the other of the said moving means.

8. A mechanical stoker comprising a progressive feed grate composed of a plurality of grate bars arranged transversely of the grate, fuel feeding means at the front of the grate, each of the said grate bars having oppositely arranged series of laterally projecting spaced lugs at its upper edge, the lugs of one series being staggered with respect to the lugs of the other series, means for moving the said grate bars in spaced relation from the front to the rear of the grate

and with the lugs of each bar extending between the lugs of the adjacent bars, said moving means having means for supporting the grate bars with the lugs inclining downwardly at the front of the grate bar as the said grate bars pass below the feeding means and for supporting the grate bars with the lugs at approximately the same level as the grate bars enter the furnace and for supporting the alternate grate bars at a higher level than the intermediate grate bars for the remainder of their travel to the rear of the grate, means below the first named means for moving the said bars in spaced relation from the rear to the front of the grate, and means at each end of the said moving means for transferring the grate bars from one of the said moving means to the other of the said moving means.

9. A mechanical stoker comprising a progressive feed grate composed of a plurality of grate bars arranged transversely of the grate, fuel feeding means at the front of the grate, each of the said grate bars having oppositely arranged series of laterally projecting spaced lugs, the lugs of one series being staggered with respect to the lugs of the other series, means for moving the said grate bars in spaced relation from the front to the rear of the grate, said moving means having means for supporting the grate bars with the lugs of the adjacent bars intermeshing, and with the lugs inclining downwardly at the front of the grate bar as the said grate bars pass below the feeding means, and for supporting the alternate grate bars at a higher level than the intermediate grate bars as they move toward the rear of the grate, means below the first named means for moving the said bars in spaced relation from the rear to the front of the grate, and means at each end of the said moving means for transferring the grate bars from one of the said moving means to the other of the said moving means.

10. A mechanical stoker comprising a progressive feed grate composed of a plurality of grate bars arranged transversely of the grate, fuel feeding means at the front of the grate, each of the said grate bars having oppositely arranged series of laterally extending lugs, means for moving the said grate bars in spaced relation from the front to the rear of the grate and for supporting the said bars with the lugs of the adjacent bars intermeshing, and with the said lugs inclining downwardly at the front of the grate bars as the said grate bars pass below the feeding means, and for supporting the alternate grate bars at a higher level than the intermediate grate bars as they move toward the rear of the grate, means below the first named means for moving the said bars in spaced relation from the rear to the front

of the grate, and means at each end of the grate for transferring the grate bars from one of the said moving means to the other of the said moving means.

11. In a mechanical stoker, a progressive feed grate composed of a plurality of grate bars arranged transversely of the grate, fuel feeding means at the front of the grate, each of the said grate bars having oppositely arranged series of laterally projecting spaced lugs at its upper edge, the lugs of one series being staggered with respect to the lugs of the other series, the lugs of each series having their side edges beveled, the side edges of the lugs of one series being beveled in the opposite direction to the side edges of the lugs of the other series, means for moving the said grate bars from the front to the rear of the grate and with the lugs of each bar extending between the lugs of the adjacent bars, said moving means having means at the front thereof for holding the grate bars with the lugs inclined downwardly toward the front of the grate and having means at the rear thereof for supporting the alternate grate bars at a higher level than the intermediate grate bars, and means for returning the said grate bars to the front of the grate.

12. In a mechanical stoker, a progressive feed grate composed of grate bars arranged transversely of the grate, each of the said grate bars having oppositely arranged series of laterally projecting spaced lugs at its upper edge, the lugs of one series being staggered with respect to the lugs of the other series, the lugs of each series having their side edges beveled, the side edges of the lugs of one series being beveled in the opposite direction to the side edges of the lugs of the other series, means for moving the said grate bars in spaced relation from the front to the rear of the grate and with the lugs of each bar extending between the lugs of the adjacent bars, the said moving means having means for holding the grate bars with the lugs inclining downwardly at the front of the grate bars at the front of the grate and for holding the alternate grate bars at a higher level than the intermediate grate bars at the rear of the grate, and means for returning the grate bars to the front of the grate.

13. In a mechanical stoker, a progressive feed grate composed of a plurality of grate bars arranged transversely of the grate, each of the said grate bars having oppositely arranged series of laterally projecting spaced lugs, means for moving the said grate bars from the front to the rear of the grate with the lugs of each bar extending between the lugs of the adjacent bars, the moving means having means for holding the grate bars with the front series of lugs at a lower level than the rear series at the front

of the grate, and for holding the alternate grate bars at a higher level than the intermediate grate bars at the rear of the grate, and means for returning the grate bars to the front of the grate.

14. In a mechanical stoker, a progressive feed grate composed of independent and detached grate bars arranged transversely of the grate; each bar having oppositely arranged series of lateral spaced lugs, means disconnected from the grate bars and engaging beneath the same for lifting and moving them from the front to the rear of the grate with the lugs of the adjacent bars intermeshing, the moving means having means for imparting vertical movement of the grate bars with respect to each other as they move rearwardly, and means for returning the said grate bars to the front of the grate.

15. In a mechanical stoker, a progressive feed grate composed of grate bars arranged transversely of the grate, a plurality of pairs of rack bars for supporting the grate bars, said rack bars having notched upper edges for engagement by the grate bars, means for imparting a vertically oscillating and endwise reciprocating movement to the rack bars and for constraining one pair of bars to move in the opposite direction to the other pair, fuel feeding means at the front of the grate, and means operated by the movement of the rack bars for actuating the feeding means.

16. In a mechanical stoker comprising a progressive feed grate composed of independent and detached grate bars arranged transversely of the grate, each bar having oppositely arranged series of laterally projecting spaced lugs, means disconnected from the grate bars and engaging beneath the same for lifting and moving them intermittently from the front to the rear of the

furnace in spaced relation, the moving means having means for imparting relative vertical movement to the grate bars, fuel feeding means at the front of the grate, and means operated by the movement of the moving means for the grate bars for actuating the feeding means.

17. In a mechanical stoker comprising a progressive feed grate composed of independent and detached grate bars arranged transversely of the grate, each bar having oppositely arranged series of laterally projecting spaced lugs, means disconnected from the grate bars and engaging beneath the same for lifting and moving them intermittently from the front to the rear of the furnace in spaced relation, the moving means having means for imparting relative vertical movement to the grate bars.

18. In a mechanical stoker, a progressive feed grate composed of disconnected grate bars arranged transversely of the grate in upper and lower runs, means below the upper run for engaging beneath the bars of the said run, for lifting the bars and moving them from the front to the rear of the grate, means below the lower run for engaging and lifting the bars of the said run and moving them from the rear to the front of the grate, means at the rear of the grate for receiving the bars from the upper run and delivering them to the lower run, means at the front of the grate for receiving the bars from the lower run and delivering them to the upper run, the moving means of the upper run having means for imparting relative vertical movement to the alternate pairs of the said run as they are moved rearwardly.

GEORGE BERKLEY CRAMP.

Witnesses:

B. L. ZIMMERMAN,
S. E. PATTERSON.