March 13, 1945. R. A. SHERMAN 2,371,191

STOKER

Filed Feb. 10, 1941 3 Sheets-Sheet 1

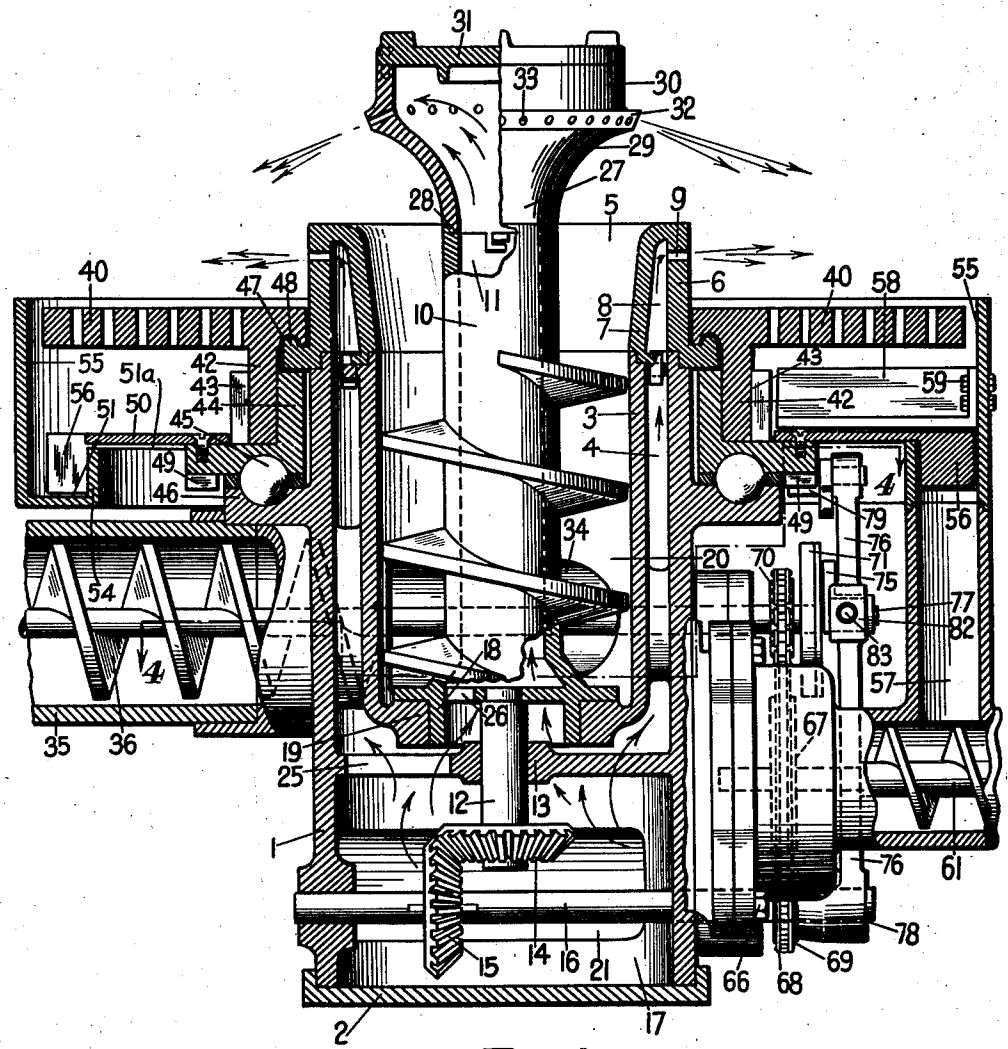


Fig. 1

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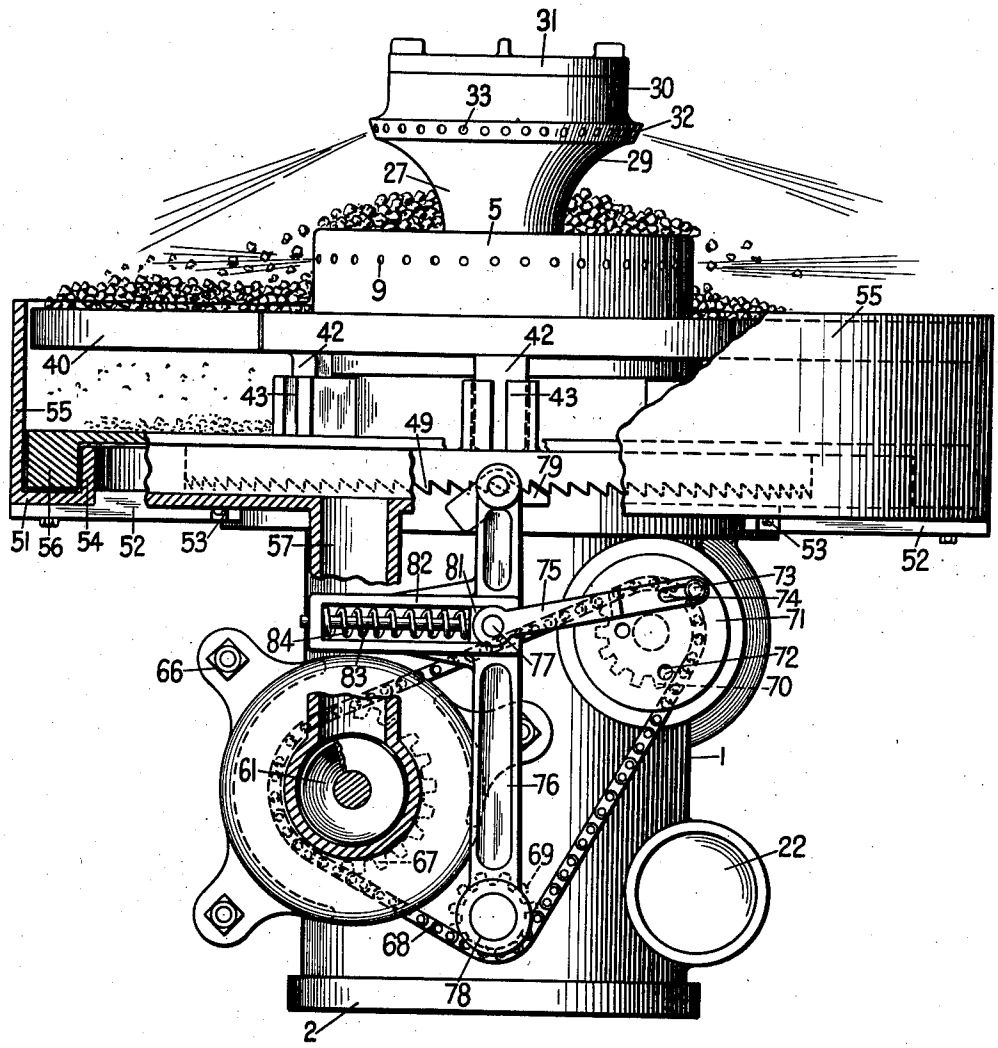


Fig. 2

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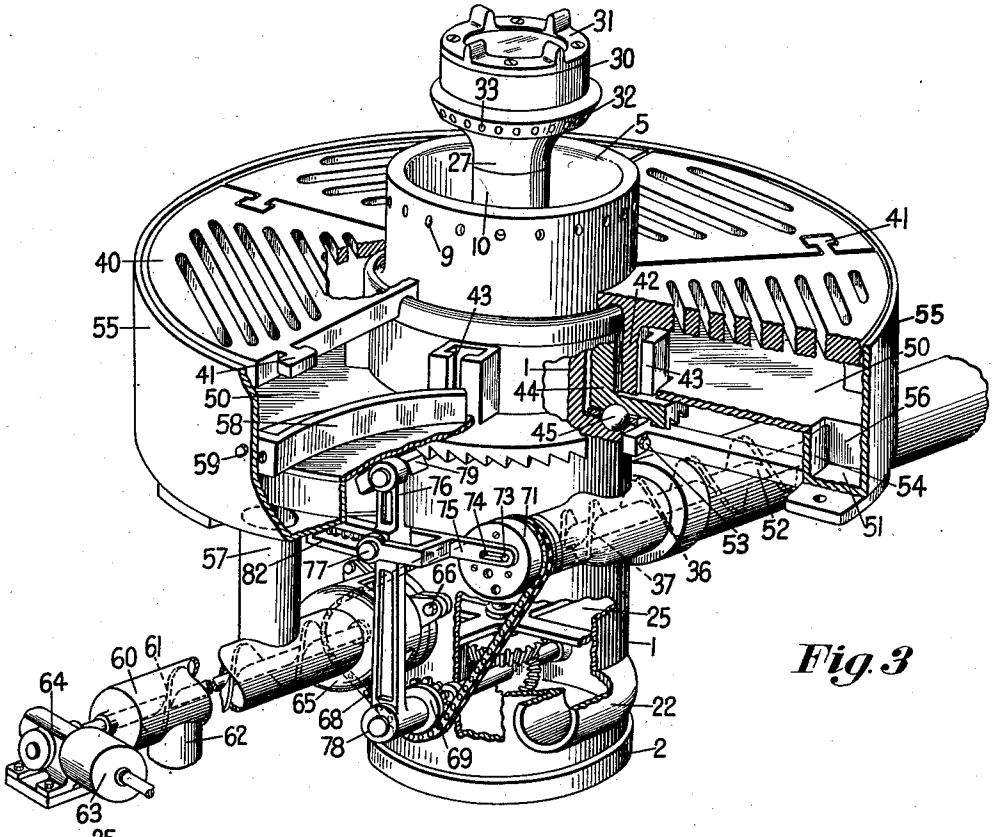


Fig. 3

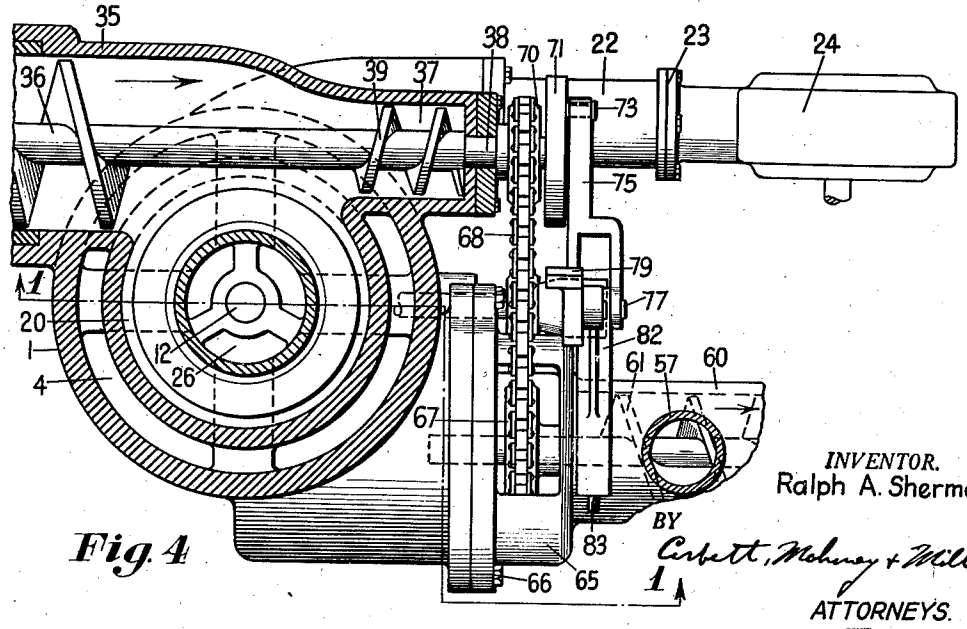


Fig. 4

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UNITED STATES PATENT OFFICE

2,371,191

STOKER

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Application February 10, 1941, Serial No. 378,298

7 Claims. (Cl. 110—45)

My invention relates to a stoker. It relates, more specifically, to a combustion apparatus or stoker which is adapted to feed solid fuel to a furnace, obtain efficient combustion of the fuel, and remove the ashes, without the disadvantages of the stokers now commonly in use.

Stokers now in use commonly at the present time are all of one similar design. In these prior art stokers, the fuel is fed upwardly through a retort on the inside of which near the top is placed a row or rows of tuyères through which air is supplied for the burning of the fuel. All bituminous coals coke to a greater or lesser extent in the retort and many coke so strongly that the coke is slow burning and may ultimately fill the firebox. Many of the bituminous coals of highest grade and highest heating value are unsuited to such stokers because of the coke which is formed therefrom during combustion in such stokers. Furthermore, because in such stokers the combustion occurs in a narrow annular ring, between the central coke formation and an outer ring of ash where the fuel cannot radiate to the heating surfaces of the boiler or furnace, excessively high temperatures result which fuse the ash into a clinker that cannot be removed automatically. Such stokers, therefore, require frequent manual attention. Another difficulty with prior art designs of stokers results from the heavy smoke which is produced when the stoker is stopped. This is caused by the coal below the surface of the hot fuel bed continuing to give off volatile gases, for burning of which no air is available through the tuyères.

An important object of my invention is to provide a stoker that will operate effectively with a wide variety of coals, including the strongly coking coals.

Another object of my invention is to provide a stoker which is of such a nature as to distribute the combustion over a wide area where heat can radiate to low-temperature surfaces so as to maintain such a low temperature in the fuel bed that the formation of clinker is prevented and automatic removal of the ash is made possible.

A further object of my invention is to provide a stoker wherein the supply of air for combustion is so distributed that high velocities are avoided and the carry-over of fly ash is prevented.

Still another object of my invention is to provide a stoker wherein air for combustion is introduced in such a way that air will be available for the combustion of volatile matter even after the stoker stops and, thus, the emission of dense smoke will be avoided.

Another object of my invention is to provide a stoker which is of such a nature that the fuel bed is maintained in such uniform condition at all times that efficient combustion with a minimum of excess air is obtained.

To accomplish the objects of my invention, I provide a stoker wherein the total air required for combustion is divided into two parts. At the point of entrance of the fuel to the furnace, enough air is admitted to burn the volatile gases released from the coal and the resulting heat is sufficient to convert the coal into coke. While the coal is being coked, it is subjected to forces which break the coal into small pieces and prevent agglomeration into large slow-burning masses. The small pieces of coke are then moved across a grate in a uniform layer, the remainder of the air necessary for their combustion being supplied through the grate. The uniformity of the pieces of coke and of the fuel bed assures complete combustion with a minimum of excess air.

In its preferred form, the stoker of this invention consists of a vertical, cylindrical fuel chamber, to the bottom of which coal is supplied by a suitable means, such as a screw conveyer, from a hopper or bin. The coal is lifted in this cylindrical chamber by means of a centrally located screw, the core or supporting shaft of which is hollow and through which air is passed from a plenum chamber, located below, to ports or tuyères at the periphery of a head which is disposed on the upper end of the lifting screw and rotates therewith. This head is spaced above the upper edge of the cylindrical fuel chamber. The walls of the fuel chamber are hollow and communicate with the same plenum chamber as the central screw so that air will be supplied to ports or tuyères at the top of the fuel chamber. The coal will pass upwardly and outwardly through a ring orifice, formed between the upper edge of the fuel chamber and the head, between two streams of air issuing from the ports or tuyères formed in the head and the wall of the fuel chamber. The air supplied at these two points is limited to that required to burn the volatile gases and thus supply the heat required for coking. While it is coking, the coal is in a plastic condition and, by the rotation of the head, is broken up into small pieces that are moved outwardly onto a grate which surrounds the fuel chamber. Combustion of the small pieces of coke is completed on the outer grate by air that may be supplied by either forced or natural draft. Because the burning is spread over a large area, provided

by the grate, which can radiate heat to the walls of the boiler or furnace, the temperature of the bed is relatively low and the ash remains in a finely divided condition. I provide means for intermittently rotating the grate so as to shake the ash from the burning coke and through the grate into a receptacle having means associated therewith for removing the ash automatically and discharging it into a suitable container.

The central rotating head, which is one of the important features of my invention, is always above the fuel bed. The ports formed therein are, therefore, never restricted by particles of coal or coke and, consequently, a considerable flow of air can occur through natural draft even when the fan on the stoker is not operating. In automatically controlled stokers, this is enough to burn most of the volatile matter that continues to be released from the coal just below the coke layer for some minutes after the stoker is stopped by the room thermostat control. In operation of my stoker, torch-like flames produced by air for combustion issuing from these ports into the streams of rich gas can be seen after the stoker is stopped. Because the air is distributed over a wide area and enters the furnace at all points at relatively low velocity, and because the ash is continuously shaken from the coke through the grate, with my stoker the fly ash is materially reduced from that obtained with stokers of conventional design.

The preferred embodiment of my invention is illustrated in the accompanying drawings wherein similar characters of reference designate corresponding parts and wherein:

Figure 1 is a vertical sectional view taken substantially along line 1—1 of Figure 4 through a stoker constructed according to my invention.

Figure 2 is a side elevation, partly broken away, of the stoker illustrated in Figure 1.

Figure 3 is a perspective view, partly broken away, of my stoker.

Figure 4 is a horizontal sectional view taken substantially along line 4—4 of Figure 1.

With reference to the drawings, I have illustrated the preferred form of my stoker as comprising a cylindrical vertically disposed retort member 1. This retort member 1 rests on a bottom plate 2 which is suitably secured thereto. The retort member 1 has an integral inner shell 3 disposed within the upper end thereof to form a vertically disposed annular air circulating space 4. The retort member 1 is capped by a tuyère ring 5 which has a substantially cylindrical outer shell 6 that interlocks with the outer wall of retort 1 and an outwardly flared inner wall 7 which rests on and interlocks with the upper edge of the inner shell 3 of the retort. Thus, the ring 5 is provided with an annular space 8 which is a continuation of the space 4. The walls 6 and 7 of the ring 5 are integrally joined at their upper edges. Adjacent the upper edge of the outer wall 6 a plurality of tuyères or ports 9 and formed at circumferentially spaced intervals.

Disposed centrally within the retort 1 is a vertical coal lifting screw 10. This screw 10 includes a central shaft or support having flights of helical form and fits within the inner shell 3. The shaft part of the screw 10 is of hollow construction forming an air passageway 11. On its lower end this screw 10 has a driving extension 12 which is rotatably mounted in a bearing carried at the center of a support 13. The lower end of this extension has a bevel pinion 14 keyed thereon. This pinion 14 meshes with a similar bevel pinion 15 which is keyed on a horizontally disposed drive shaft 16. The pinions 14 and 15 and the shaft 16 are disposed in a chamber 17 formed at the bottom of the retort member 1. The shaft 16 is rotatably mounted in bearings formed in the wall of this chamber. The shaft 16 extends through an opening in the wall of this chamber and is driven in a manner to be described later. The lower end of the main portion of the screw 10 is provided with a bearing portion 18 which fits within a bearing 19 formed on the lower end of the inner shell 3 of the retort 1. These portions 18 and 19 cooperate to close the lower end of the annular combustion chamber 20 formed within retort 1 and tuyère ring 5. Air is supplied to the lower chamber 17 through a large inlet 21 formed in the wall thereof. This inlet is connected to a tube 22 (Figure 4) which has its outer end connected, as at 23, to the outlet tube of a blower 24. As illustrated best in Figure 1, the air will enter the chamber 17 and will pass upwardly through openings 25 of support 13, into the annular chambers 4 and 8 and will leave the chamber 8 through the tuyères 9. Some of the air will also pass upwardly through bearing member 18 of the lifting screw 10 through ports 26 into the interior of the screw. Preferably, though not necessarily, the screw flights terminate at the lower edge of the tuyère ring 5. However, a tuyère head 27 is mounted on the upper end of the hollow shaft of the screw. This head 27 is of hollow construction and its lower edge interfits with the upper edge of the screw 10, as indicated at 28, so that it will rotate therewith. The head 27 has an outwardly flared lower portion 29 and a cylindrical enlarged upper portion 30. It is provided with a removable cap 31. At the bottom of the portion 30, an integral annular projecting shoulder 32 is formed. The wall of the head at this shoulder 32 has a plurality of circumferentially spaced tuyères or ports 33 formed therein. These ports are downwardly directed, as indicated best in Figure 1. Thus, air will pass from the hollow screw 10 upwardly into the head 27 and will be directed downwardly and outwardly by the ports 33. Furthermore, the head 27 will rotate with the screw 10.

For feeding coal into the base of the combustion chamber 20, a tangentially disposed coal inlet port 34 is provided in the wall of the retort at a point spaced above air inlet 21. This inlet 34 is connected, as indicated in Figure 4, to a coal feed tube 35. This coal feed tube 35 has a coal-feeding screw 36 rotatably mounted therein. The tube 35 is located at the same side of the retort as the air tube 22 but extends in an opposite direction and at a higher level. It may extend to a suitable bin or hopper. The tube 35 has its inner end extending beyond the inlet 34 to form a small cylindrical chamber 37. The end of the screw is rotatably mounted in the end wall of this chamber, as at 38, and extends through this wall. Dust will tend to collect in the chamber 37 and, therefore, in this chamber the screw is provided with a reversely threaded portion 39 to force the dust rearwardly back into the opening 34. The screw 36 is driven in a manner to be explained later.

Surrounding the tuyère ring 5 is a grate 40 which is made up of a plurality of segmental sections that interlock with each other, as indicated at 41 in Figure 3. These grate sections are horizontally disposed and each is provided at its inner end with a depending leg 42 which fits into a socket 43 formed on a grate-supporting ring 44. The ring 44 surrounds the retort 1 and is

supported by means of ball bearings 45 (Figures 1 and 3) on an annular flange 46 formed on the outer wall of the retort 1. Each of the grate sections is provided with an annular groove 47 on its lower surface at its inner end which cooperates with an annular integral ring 48 formed on the tuyère ring 5 at the lower edge thereof. However, due to the fact that the legs 42 of the grate section contact with the bottom of the sockets 43, the weight of the grate section will not be supported on the ring 48. This will permit free rotary movement of the grate section relative to the ring 48. Adjacent its outer periphery and on its lower surface, the ring 44 has ratchet teeth 49 formed thereon by means of which it may be rotated.

The ashes which fall through the grate 40 will fall onto an ash plate 50 which is horizontally supported by the ring 44 for rotation therewith. An ash trough 51 of annular form is supported at the periphery of the plate 50 by means of radially extending arms 52 which have their inner ends secured, as at 53, to the stationary flange 46. This ash trough 51 has an inner wall 54 which terminates just below the plate 50 and an outer wall 55 which terminates at the level of the grate. The plate 50 has a plurality of plow members 56 which extend down into the trough 51. These plow members 56 serve to move the ash through the trough, upon rotation of ring 44, until they drop through an ash outlet 57. For causing the ash to pass from the plate 50 into the trough 51, I provide plows 58 which are disposed directly above plate 50 but which are secured to the outer wall 55 of the trough, as at 59. These plows 58 will serve to sweep the ash off plate 50 into the trough upon rotation of the ring 44 and the plate 50 relative to the trough 51 and members 58.

The ash passes downwardly through the outlet 57 into an ash removal tube 60. This tube 60 has an ash removal screw 61 disposed for rotation therewithin. This screw 61 will feed the ash through an outlet 62 into a suitable container for receiving it.

Power to drive all parts of the stoker is transmitted from a motor 63. Blower 24 may be driven from motor 63 in any suitable manner. Motor 63 is connected to the outer end of the ash removal screw 61 through the medium of speed reducing gear unit 64. The inner end of the screw 61 is rotatably carried in a bearing housing 65 which is bolted, as at 66, to the outer wall of the retort member 1. As shown best in Figures 2 and 4, the inner end of screw 61 has a sprocket 67 keyed thereon. This sprocket drives a sprocket chain 68. This chain 68 passes around a sprocket wheel 69 keyed on the outer portion of shaft 16 which drives the coal-lifting screw 10. The chain 68 also passes around a sprocket wheel 70 which is keyed on the end of the coal-feeding screw 36. Also on the end of the coal-feeding screw 36 is keyed a disk 71. This disk 71 is provided with a plurality of openings 72 any of which may receive a pin 73. The pin 73 will extend into a slot 74, formed in the outer end of a link 75. The opposite end of this link 75 is bifurcated and straddles the upper end of the grate moving arm 76 to which it is pivotally connected, as at 77. The arm 76 has its lower end pivoted on the extreme outer end of shaft 16, as at 78.

It will be apparent that rotation of the disk 71 will swing the arm 76. The extent of this swinging movement may be changed by changing the pin 73 from one opening 72 to another. The arm 76 has a ratchet member 79 pivoted to the upper end thereof and which is normally in engagement with the ratchet teeth 49 of grate supporting ring 44. It will be apparent from Figure 2, that when the arm 76 is swung to the right, the ring 44 will not be rotated. However, when the arm 76 is swung to the left, the ring 44 will be rotated to a predetermined extent. Rotation of disk 71 will oscillate the arm 76. To prevent stripping of the teeth 49, in case the ring 44 fails to move, the pivot 77 is of special construction. A block 81 is supported for sliding movement in a guide member 82. A spring 84 surrounds a pin 83 and normally forces the block 81 to the right hand end of member 82, as shown in Figure 2. When the link 75 pushes on arm 76 and it fails to move to the left, the block 81 will be moved to the left in member 82 against the force of spring 84. Thus, stripping of the teeth 49 is prevented.

In the operation of my apparatus, coal from a bin or hopper is moved through the coal feed tube 35 into the bottom of the chamber 20. It is lifted upwardly through this chamber by means of the rotating screw 10. The coal is fed upwardly through the tuyère ring 5 and outwardly over the upper edge of this ring between such edge and the rotating head 27. The air supplied by blower 24 will issue through the tuyère ports 9 in ring 5 and tuyère ports 33 in head 27. This will burn the volatile matter of the coal thus supplying heat for the coking of the coal. In this manner a fuel plasticizing temperature zone is maintained within and immediately above the tuyère ring 5 of the retort causing the fuel particles to coalesce or agglomerate. Thus the upper end of the fuel column emerging from the ring 5 will be more or less self-sustaining so that radial pressure internally exerted thereon by the outwardly flaring wall 29 of the head 27 will break up such agglomerations into particles of smaller size to be distributed outwardly over the fuel bed in the intermittent rotation of the grate 40.

It will be noted that the upper end of the ring or egress section 5 of the retort and the upper end of the head wall 29 are of such relative diameters that the large pieces of plasticized fuel forced outwardly therebetween will be subjected to a severe crushing force which very effectively breaks down the plasticized fuel mass into comparatively small coke pieces of substantially uniform size.

By terminating the feed screw flights at the upper end of the body section of the retort the fuel is not agitated within the top section 5 so that the individual fuel particles will readily plasticize or agglomerate therein, while possible coking of the fuel on the screw flights is avoided. The small pieces of coke form a thin fuel bed of substantially uniform thickness which is burned with a minimum excess of air which may be supplied either by forced or natural draft beneath the grate 40. A draft chamber (not shown) will be provided with a casing enclosing the lower part of the stoker. Draft from this chamber will reach the grate 40 through the space between plate 50 and the upper edge of the inner wall 54 of trough 51.

The large area of the fuel bed on the grate, radiating to low-temperature heat-receiving surfaces, insures that excessive temperatures are not attained in the fuel bed. The ash is not fused together into clinker and removal through

the perforated grate into a receiver below and then by automatic means outside the furnace, is made possible. During operating periods of the stoker the emission of high pressure air from the tuyères 33 produces a circularly moving flame sheet directed downwardly from the rotating head 27, which constantly drives off the products of combustion emanating from the fuel bed and directs the same outwardly and upwardly into contact with the walls or other heat transfer surfaces of the furnace. Thus the development of high ash fusing temperatures in the thin fuel bed is obviated while a substantially uniformly incandescent condition thereof is quickly established and maintained. During "off" periods of the stoker this flame sheet is subdued, the supply of air to the tuyères 33 by natural draft being only sufficient to ignite the volatiles rising from the fuel chamber of the retort.

The features described make possible the use of a wide variety of coals including heavily coking coals without difficulty. Thin, uniform fuel beds are formed on the grate and clinker formation is prevented. Air is supplied by natural draft at the point needed to reduce or eliminate smoke from the volatile gases released during the "off" periods of intermittently operated stokers. The division of the air supply into two parts insures low velocities and elimination of difficulties from fly ash. Other advantages in economy, flexibility, and convenience of operation and maintenance may be secured by means of this invention.

Various other advantages will be apparent from the preceding description, the drawings and the following claims.

Having thus described my invention, what I claim is:

1. A coal-feeding and combustion device comprising a combustion chamber, a vertically disposed retort associated therewith, a grate surrounding said retort, said retort having a series of outwardly discharging air supply tuyères around the upper periphery thereof, coal feeding means in the retort including a centrally disposed vertical support spaced from the retort wall to form therewith a vertical fuel passageway, a tuyère head carried by the upper end of said support, said head being flared upwardly and outwardly to form an exit passageway above the retort having an axis substantially at right angles to the axis of the vertical passageway, said head also having a series of outwardly and downwardly discharging air supply tuyères for cooperation with the air supply tuyères of the retort to supply a portion of the air required for the combustion of the fuel, and means for supplying air to the tuyères in said retort and said head.

2. A coal feeding and combustion device comprising a combustion chamber, a retort associated therewith, a grate surrounding said retort, coal feeding means including a support disposed in the retort cooperating with the retort wall to form a vertical passageway, said retort having a series of outwardly discharging air supply tuyères around the upper periphery thereof, a tuyère head carried by the upper end of said support, said head being flared upwardly and outwardly in such a manner that said head extends outwardly at least substantially vertically above the upper edge of said retort, the vertical clearance between said head and the upper edge of said retort being substantially as small as the horizontal dimension of said passageway at the upper edge of said retort, said head also having a series of outwardly and downwardly discharging air supply tuyères for cooperation with the air supply tuyères of the retort to supply a portion of the air required for the combustion of the fuel, and means for supplying air to the tuyères in said retort and said head.

3. A coal feeding and combustion device comprising in combination a combustion chamber, a vertically disposed retort associated therewith having a series of outwardly discharging air supply tuyères around the upper periphery thereof, a horizontal grate surrounding said retort adjacent to said air supply tuyères, means for feeding coal upwardly through said retort including a rotatable part, a tuyère head supported by said part and spaced a short distance above the upper edge of said retort and being flared upwardly and outwardly to deflect the coal outwardly over the upper edge of said retort at substantially right angles to the axis of the retort, said head also having a series of outwardly and downwardly discharging air supply tuyères for cooperation with the air supply tuyères of the retort, and means for supplying air to the tuyères in said retort and said head.

4. A coal feeding and combustion device comprising a combustion chamber, a vertically disposed stationary retort of tubular form associated therewith, means for feeding coal into the lower end of said retort, an elevating screw rotatably mounted in said retort for lifting the coal and causing it to be discharged over the upper edge of said retort, said elevating screw being centrally disposed within the retort to form between the shaft of the screw and the retort an annular vertical passageway, said screw carrying a tuyère head on its upper end which is flared upwardly and outwardly in such a manner that said head extends outwardly at least substantially vertically above the upper edge of said retort, the vertical clearance between said head and the upper edge of said retort being substantially as small as the horizontal distance between the upper edge of said retort and said head, said head having downwardly and outwardly directed air supply tuyère openings formed in the periphery thereof, said retort having outwardly directed air supply tuyère openings formed in the periphery thereof adjacent to the upper edge for cooperation with the air supply tuyère openings of the head, means for supplying air to said tuyère openings, means for rotating said screw and head, and a grate provided around the retort adjacent to the air supply tuyère openings therein.

5. An under-feeding furnace stoker, comprising, in combination with the furnace grate, a vertical retort having an upper end section extending above the furnace grate and forming a fuel plasticizing chamber, means for feeding fuel into the lower end of the retort, a vertical feed screw rotatably mounted in the retort and having flights terminating at the lower end of said upper section thereof to feed the fuel upwardly into said plasticizing chamber, said feed screw including a hollow central shaft, and a rotating head on the upper end of said shaft having a part spaced above the retort and provided with a series of outwardly and downwardly discharging air supply tuyères communicating with said hollow shaft, said head, between said tuyères and the screw shaft, having an arcuately curved wall cooperating with the upper end of the retort wall to resist the passage of the plasticized fuel therebetween under feeding pressure and subject

the same to crushing forces dividing said plasticized fuel into particles of substantially uniform size.

6. The combination defined in claim 5, in which said upper end section of the retort is provided with a series of outwardly discharging air supply tuyères to cooperate with the tuyères of said rotating head and maintain a fuel plasticizing temperature adjacent to the retort and above the grate, and means is provided for directing air to the retort tuyères.

7. The combination defined in claim 5 in which means is provided to detachably interlock said rotating head with the upper end of the screw shaft.

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