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[54] **STOKER CONSTRUCTION AND DRIVE SYSTEM THEREFOR**
11 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **110/38**
[51] **Int. Cl.** **F23b 1/22**
[50] **Field of Search** 110/38; 91/6, 20

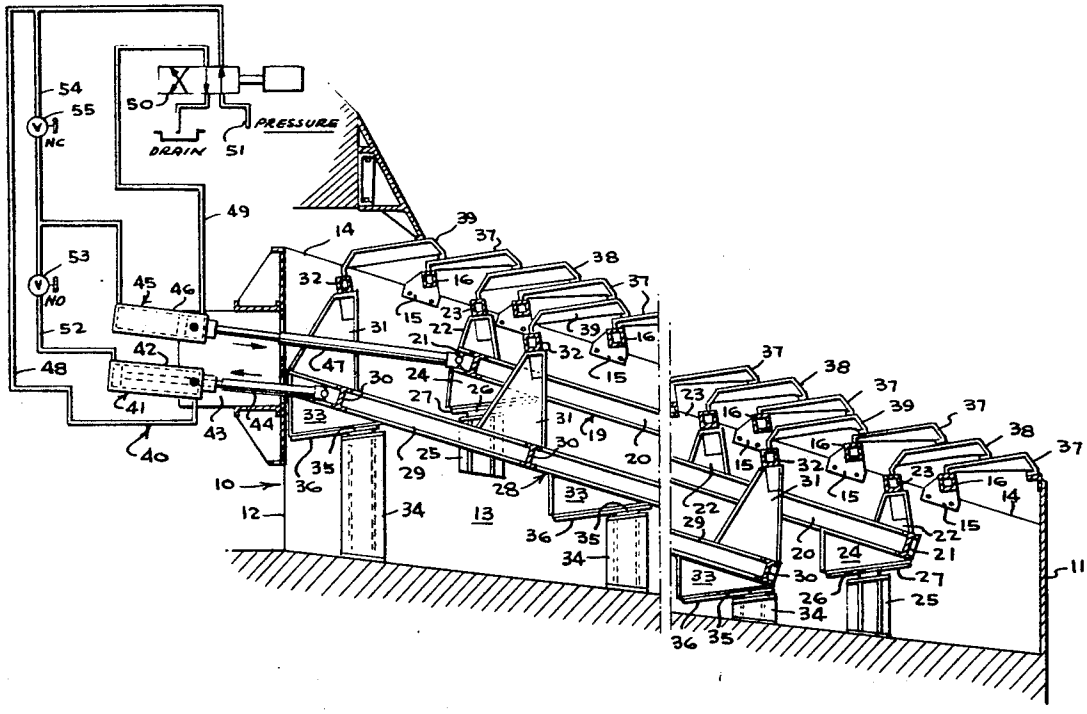
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ABSTRACT: A stoker for burning refuse in an incinerator including a support frame, a set of stationary grates mounted on the support frame, a first set of movable grates mounted on the support frame, a second set of movable grates mounted on the support frame and means for reciprocating the movable grates. The means for reciprocating the sets of movable grates comprises a pair of fluid cylinder assemblies operatively connected to the sets of movable grates, including means for assuring full strokes of the pistons of the fluid cylinder assemblies and, correspondingly, the sets of movable grates thereby providing an efficient stoking action.



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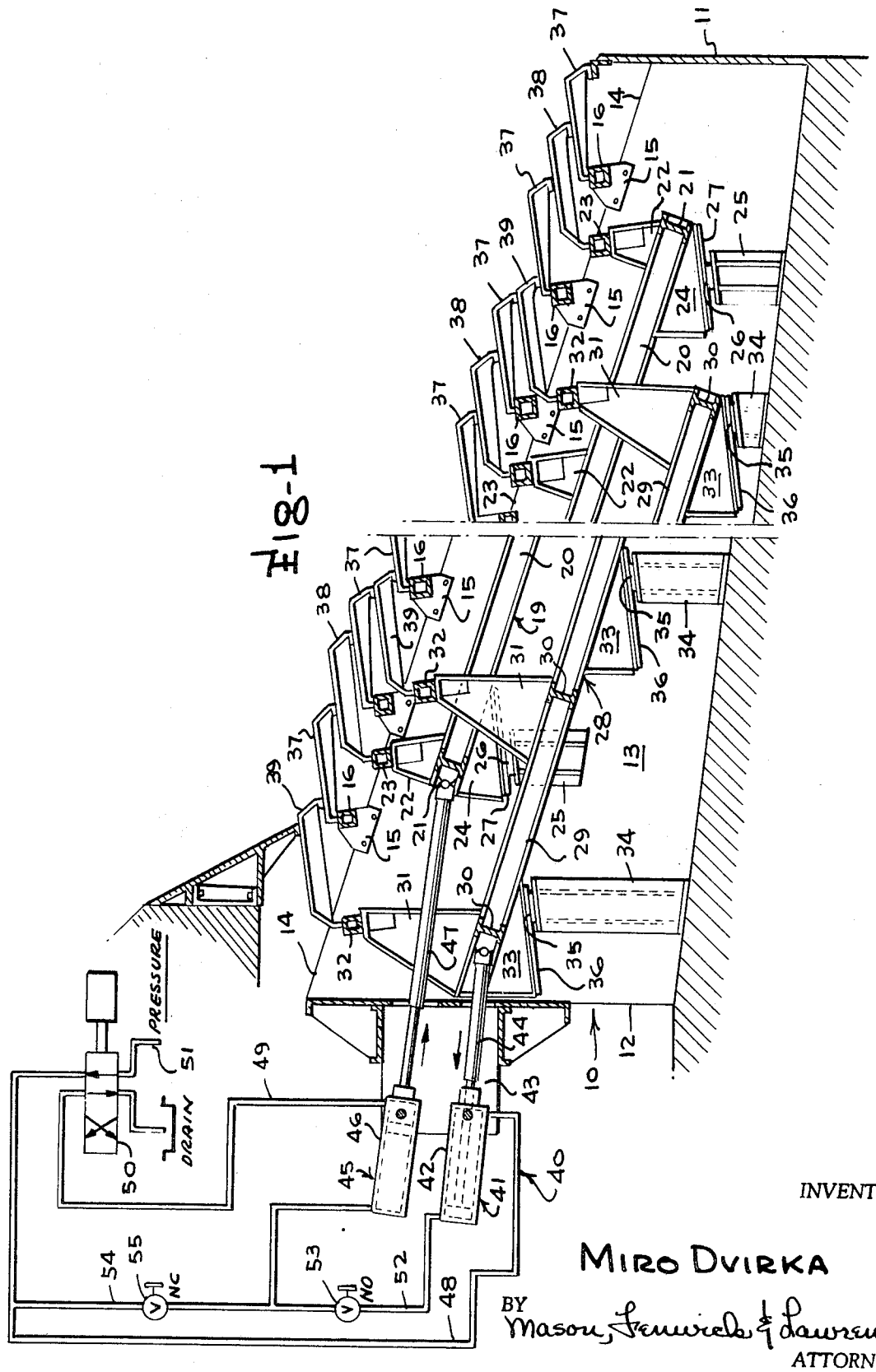


FIG-1

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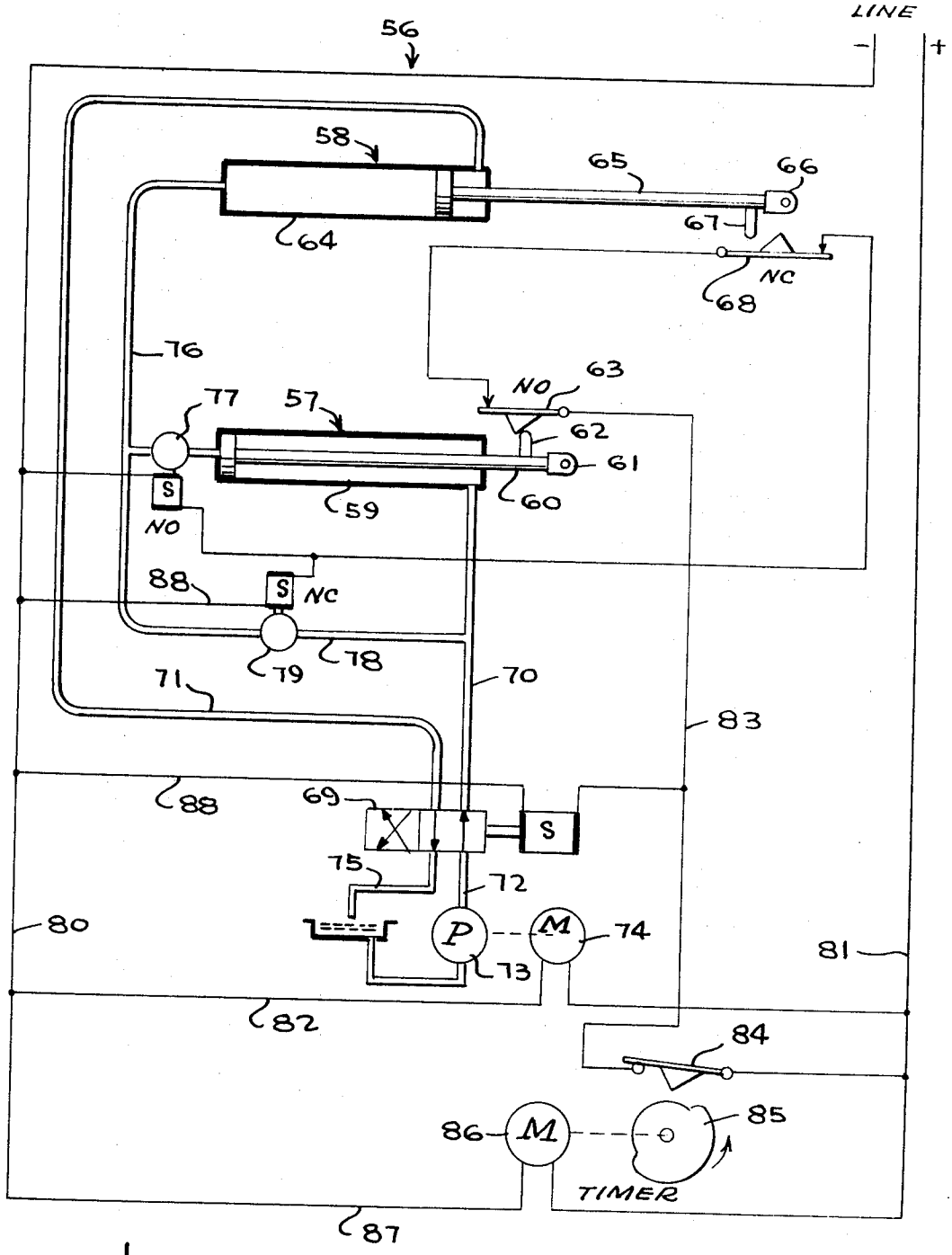


Fig-2

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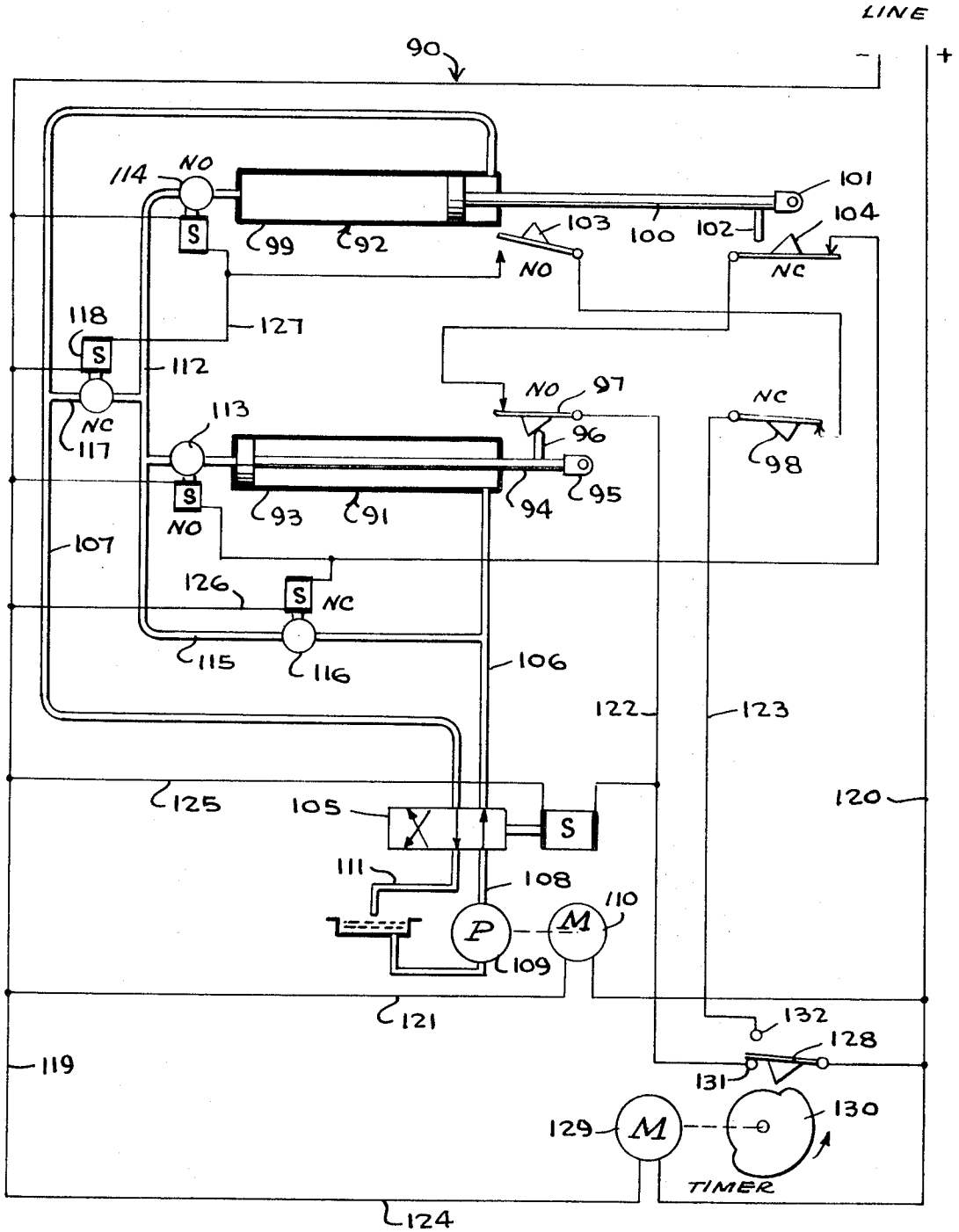


Fig-3

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Fig-4

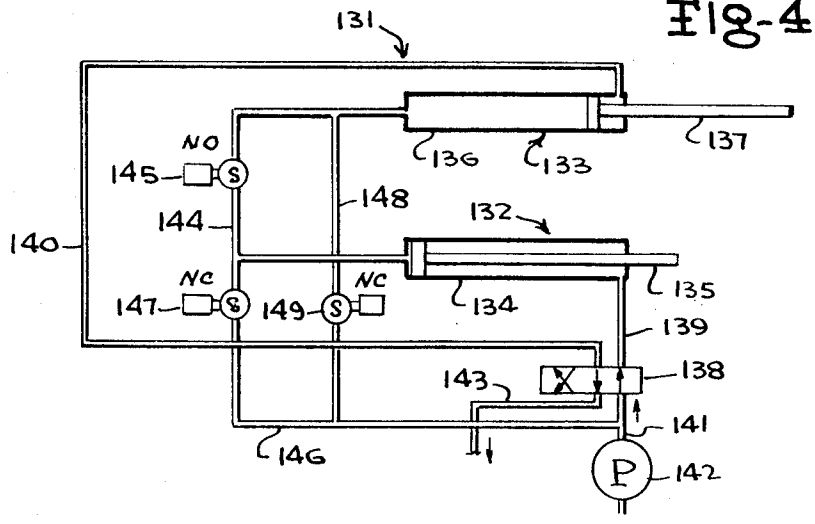


Fig-5

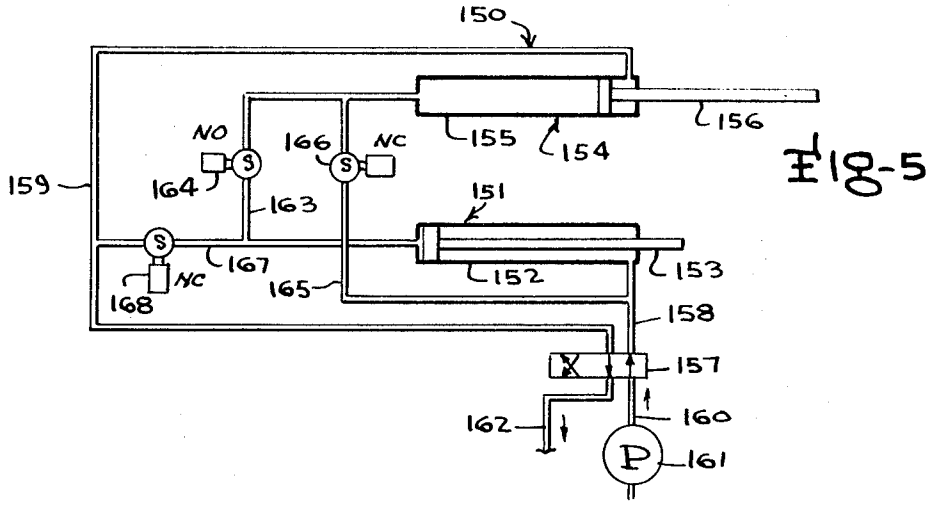
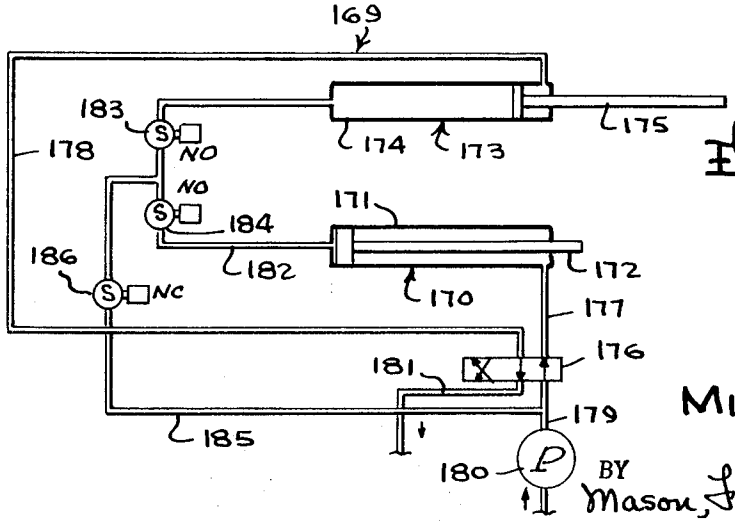


Fig-6



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STOKER CONSTRUCTION AND DRIVE SYSTEM THEREFOR

This invention relates to a stoker, and more particularly to a reciprocating type of stoker. This invention further contemplates a novel drive system particularly adapted for a reciprocating type of stoker.

In reciprocating type stokers utilizing fluid cylinder assemblies for reciprocating different sets of movable grates, it has been found that the stoking and advancing of the refuse along the length of the stoker is greatly impaired where the movable grates are not reciprocated between their maximum limits of travel. Often, over an extended period of service, the pistons of the fluid cylinder assemblies fail to extend or retract to their maximum limits when actuated, thereby limiting the length of travel of their associated movable grates. It thus has been found desirable to provide a reciprocating type of stoker in which the movable grates are caused to travel between their maximum limits during a normal stoking cycle.

Accordingly, it is the principal object of the present invention to provide a novel stoker.

Another object of the present invention is to provide a novel reciprocating type of stoker for burning refuse.

A further object of the present invention is to provide a novel reciprocating stoker suitable for use in incinerators for stoking and conveying large masses of refuse, which is effective in exposing and subjecting maximum areas of such refuse for burning.

A still further object of the present invention is to provide a novel reciprocating stoker for burning refuse which is effective in stoking compacted or interwoven masses of refuse.

Another object of the present invention is to provide a novel reciprocating stoker which is effective in tumbling refuse as the refuse is conveyed from the charging end to the discharge end of the stoker.

A further object of the invention is to provide a novel reciprocating stoker for burning refuse which is effective in exposing and subjecting a maximum area of refuse for maximum reduction by burning, thus eliminating or at least significantly reducing the amount of ash residue.

A still further object of the present invention is to provide a novel reciprocating stoker having an improved drive system.

Another object of the present invention is to provide a novel reciprocating stoker of the type having two or more sets of movable grates in which the movable grates are caused to reciprocate between their maximum limits of travel to provide an efficient stoking action.

A further object of the present invention is to provide a novel drive system particularly adapted for use in a reciprocating stoker.

Another object of the present invention is to provide a novel reciprocating stoker utilizing fluid cylinder assemblies in which the maximum travel of the pistons thereof is assured.

Other objects and advantages of the invention will become more apparent to those persons skilled in the art, from the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a vertical cross-sectional view of an embodiment of the invention, having a portion thereof broken away and the drive system thereof illustrated diagrammatically;

FIG. 2 is a schematic-diagrammatic view of a modification of the drive system illustrated in FIG. 1;

FIG. 3 is a schematic-diagrammatic view of another modification of the drive system illustrated in FIG. 1; and

FIGS. 4, 5 and 6 illustrate diagrammatic views of additional modifications of the drive system illustrated in FIG. 1.

Referring to FIG. 1, there is illustrated an embodiment of the invention. This embodiment includes a support frame 10 situated in an incinerator, which includes a front wall 11, a rear wall 12, and spaced parallel sidewalls 13 having longitudinally inclined upper edges 14. Mounted on the upper edges of the side walls 13 are sets of transversely spaced brackets 15 on which there are rigidly mounted longitudinally spaced cross beams 16. As illustrated in FIG. 1, the cross beams 16 lie in a longitudinally inclined plane.

Disposed below the rigidly secured cross beams 16 and between the sidewalls 13 of the support frame, is a first carriage assembly 19. This assembly is disposed in a longitudinally inclined plane disposed substantially parallel to the plane in which the cross beams 16 lie, and includes a pair of longitudinally disposed beams 20 interconnected by means of a plurality of cross beams 21. Mounted on the longitudinally disposed beams 20 are longitudinally spaced, upstanding brackets 22 which support a plurality of longitudinally spaced cross beams 23. The cross beams 23 also lie in a longitudinally inclined plane disposed parallel to the plane in which the rigidly secured cross beams 16 lie.

The carriage assembly 19 also is provided with longitudinally spaced pairs of shoes 24 which are slidably mounted on pairs of support brackets 25 rigidly secured to the side walls 13 of the support frame. Each of the support brackets 25 is provided with an inclined support surface 26 on which a sliding planar surface 27 of a corresponding shoe 24 is seated. The support surfaces 26 are substantially parallel and lie in planes intersecting the longitudinally inclined plane in which the rigid cross beams 16 lie. It will be appreciated that upon applying a force along the longitudinal direction of the carriage assembly 19, the assembly will be caused to move as a unit along a line of travel substantially parallel to the support surfaces 26 of the support brackets 25.

Similarly disposed below the rigidly secured cross beams 16 and between the sidewalls 13 of the support frame is a second carriage assembly 28. This assembly is disposed in a longitudinally inclined plane substantially parallel to the planes in which the cross beams 16 and the first carriage assembly lie, and includes a pair of longitudinally disposed beams 29 interconnected by means of a plurality of cross beams 30. It further will be noted that the carriage assembly 28 is disposed below and lies within the lateral dimension of the carriage assembly 19. Mounted on the longitudinally disposed beams 29 are longitudinally spaced, upstanding brackets 31 which support a plurality of cross beams 32 on the upper ends thereof. The cross beams 32 also lie in a longitudinally inclined plane disposed parallel to the plane in which the rigidly secured cross beams 16 lie. In addition, the rigidly mounted cross beams 16 and movable cross beams 23 and 32 are disposed substantially parallel to each other.

Similar to the carriage assembly 19, the carriage assembly 28 is provided with longitudinally spaced pairs of shoes 33 which are slidably mounted on longitudinally spaced pairs of support brackets 34 rigidly secured to the side walls of the support frame. The support brackets 34 are provided with inclined support surfaces 35 on which sliding planar surfaces 36 of corresponding shoes 33 are seated. The support surfaces 35 are substantially parallel and lie in planes intersecting the longitudinally inclined plane in which the rigid cross beams 16 lie. The inclined surfaces 35 also are substantially parallel to the inclined surfaces 26 of support brackets 25. It will be noted that upon applying a force along the longitudinal direction of the carriage 28, the assembly will be caused to move as a unit along a line of travel substantially parallel to the support surfaces of the support brackets 34.

Mounted on each rigid cross beam 16 is a set of stationary grates 37. Each set of grates 37 consists of a plurality of grates which extend across the entire width of the stoker. Mounted on each of the movable cross beams 23 of the carriage assembly 19 is a set of movable grates 38. The sets of movable grates 38 are disposed in a first set of alternate spaces between the sets of stationary grates 37. Each set 38 consists of a plurality of grates which are disposed along the entire width of the stoker. Each grate of the set of movable grates 38 is interposed between grates of successive sets of stationary grates 37, is supported at the rearward end thereof on a cross beam member 23, and is supported at its forward end on a grate of a lower set of stationary grates 37.

A set of movable grates 39 similarly is mounted on each movable cross beam 32. The sets of movable grates 39 are disposed in a second set of alternate spaces between the sets of stationary grates 37, each consisting of a plurality of movable grates disposed across the entire width of the stoker. Each grate of the set of grates 39 is interposed between successive grates of the set of grates 37, is supported at the rearward end thereof on a movable cross beam member 32, and is supported at the forward end thereof on an adjacent grate of the set of stationary grates 37. As best illustrated in FIG. 1, the sets of stationary grates 37 are spaced along an inclined plane, the sets of movable grates 38 are disposed in a first set of alternate spaces in the sets of stationary grates 37, and the sets of movable grates 39 are disposed in a second set of alternate spaces in the sets of stationary grates 37.

The carriage assemblies 19 and 28 are adapted to be reciprocated by means of a drive system 40. The drive system includes a first fluid cylinder assembly 41 having a cylinder 42 pivotally mounted between laterally spaced brackets 43 rigidly secured to the rear wall 12 of the support frame, and a piston rod 44 which extends through an opening in the rear wall 12 of the support frame and is pivotally connected at the forward end thereof to the carriage assembly 29. The drive system also includes a fluid cylinder assembly 45 having a cylinder 46 pivotally secured to the spaced brackets 43, and a piston rod 47 which extends through an opening in the rear wall 12 of the support frame and is pivotally connected at its forward end to the carriage assembly 19. The front ends of the cylinders 42 and 46 are connected by means of fluid lines 48 and 49 to a valve 50 which is operable to selectively communicate the fluid lines 48 and 49 to a source of pressure 51. The rear ends of the cylinders 42 and 46 are interconnected by means of a fluid line 52 which includes a valve 53 normally in the open position to permit intercommunication of the fluid between the rear ends of the cylinders 42 and 46. The drive system further includes a fluid branch line 54 having a valve 55, which interconnects the fluid supply line 48 and the fluid line 52.

To operate the embodiment illustrated in FIG. 1, the selector valve 50 is positioned as illustrated to apply pressure to the fluid supply line 48 and cause the piston 44 to retract. As the piston 44 retracts, the carriage assembly 28 is moved rearwardly, correspondingly causing the sets of movable grates 39 to be retracted to their rearmost positions. The rearward movement of the piston 44 also causes fluid to flow through fluid line 52 into cylinder 46, causing the piston rod 47 to extend. The extension of the piston rod 47 correspondingly causes the carriage assembly 19 to move forwardly and the sets of grates 38 to move toward their forwardmost positions.

In the event the piston rod 47 is not extended to its maximum extended position, due to possible malfunctioning of the cylinder assembly 45, the valve 53 is closed to block intercommunication between the rear ends of the cylinders 42 and 46, and the valve 55 is opened to connect the rear end of the cylinder 46 with pressurized fluid supply line 48. The additional pressure thus applied to the cylinder 46 will cause the piston rod 47 to extend to its maximum extended position, thus causing the sets of movable grates 38 to extend to their forwardmost limits of travel. When the piston rod 47 has been extended to its maximum extended position, the valve 55 is closed and valve 53 is opened to reset the drive system for the normal stoking cycle.

To move the carriage assemblies 19 and 28 and the corresponding sets of grates 38 and 39 in the opposite directions to complete the stoking cycle, the selector valve 50 is moved to the right to connect the fluid supply line 29 to the pressure source and connect the fluid supply line 48 to the drain line. Under such conditions, fluid under pressure will be supplied to the front end of the cylinder 46, driving the piston rod 47 rearwardly, and fluid will flow from the rear end of the cylinder 46, through the fluid line 52, to the rear end of cylinder 42 to extend the piston rod 44. Such action will retract the carriage assembly 19 and extend the carriage assembly 28, thus causing the sets of movable grates 38 to retract and the sets of movable grates 39 to extend.

Referring to FIG. 2, there is illustrated a modification of the drive system shown in FIG. 1. The modification includes a drive system 56 including a first fluid cylinder assembly 57 and a second fluid cylinder assembly 58. The fluid cylinder assembly 57 includes a cylinder 59 and a piston 60 having a coupling element 61 on the forward end thereof for pivotally connecting the piston to the rear end of the carriage assembly 28, and an actuating element 62 which is operative to engage and close a limit switch 63 when the piston 60 is in its maximum retracted position, as illustrated in FIG. 2.

The fluid cylinder assembly 58 includes a fluid cylinder 64 and a piston 65 having a coupling element 66 on the forward end thereof for pivotally connecting the piston 65 to the rear end of the carriage assembly 19, and an actuating element 67 which is adapted to engage and open a limit switch 68 when the piston 65 is in its maximum extended position.

The front ends of the cylinders 59 and 64 are connected to a solenoid operated selector valve 69 by means of fluid supply lines 70 and 71. The selector valve 69 is adapted to communicate either of the fluid supply lines 70 and 71 with a fluid line 72 including a pump 73 driven by an electric motor 74. The valve 69 also is adapted to connect one of the fluid supply lines 70 and 71 with a return line 75, while the other fluid supply line is connected to the source of fluid under pressure. The rear ends of the cylinders 59 and 64 are interconnected with a fluid line 76 which includes a solenoid operated valve 77 normally in the open position. A fluid line 78 having a solenoid operated valve 79 normally in the closed position, interconnects the fluid supply line 70 and the fluid line 76 between the rear end of the cylinder 64 and the valve 77.

The electrical control system for the fluid circuit including the fluid cylinder assemblies 57 and 58 includes lines 80 and 81 connected to an electrical supply source and to ground. The electrical system is provided with a branch circuit 82 for operating the motor 74 and a branch circuit 83 including a cam operated switch 84, limit switches 63 and 68, and the solenoid operated valve 77. The switch 84 normally is in the closed position and is adapted to be opened periodically by a timer including a cam 85 driven by a motor 86 provided with a supply circuit 87. The limit switch 63 normally is in the open position and is adapted to be closed by the actuating element 62 as previously described, to close the branch circuit 83. The limit switch 68 normally is in the closed position and is adapted to be opened by the actuating element 67 to break the circuit 83. The selector valve 63 is operated by a branch circuit 88 which interconnects the branch circuit 83 and the line 80. Similarly, the valve 79 is energized by means of a branch circuit 89 interconnecting the branch circuit 83 and the line 80.

In the operation of the drive system illustrated in FIG. 2, when a voltage is applied to lines 80 and 81, and switch 84 is in the closed position, the selector valve 69 will be energized to move the valve in the position as illustrated. Under such conditions, fluid under pressure will be supplied to the front end of cylinder 59 to retract the piston 60 and thus cause fluid to flow through fluid line 76 to the rear end of cylinder 64. The admission of fluid into the rear end of cylinder 64 will cause the piston 65 to extend and fluid in the front end of the cylinder 64 will be drained through fluid lines 71 and valve 69 to return line 75.

In the event the piston 60 is moved to its maximum retracted position and piston 65 fails to move to its maximum extended position, limit switch 63 will be closed and limit switch 68 will remain closed to apply a voltage to branch circuit 83. Under such conditions valve 77 will be actuated to close and valve 79 will be opened to block intercommunication between the rear ends of the cylinders 59 and 64 and connect the rear end of the cylinder 64 to pressure line 70. The connection of the rear end of cylinder 64 to the pressure line will cause the piston 65 to be moved forwardly to its maximum extended position, thus causing the actuating element 67 to

engage and open the limit switch 68. The opening of the limit switch 68 will break the circuit 83, thus causing valve 79 to close and valve 77 to open.

Periodic opening of the switch 84 by the cam member 85 will deenergize the selector valve 69, thus causing the valve to move to the right under the action of a spring element, to connect the front end of the cylinder 64 to the pressure line 72 and simultaneously connect the front end of the cylinder 59 to the return line 75. Under such conditions, the pistons 60 and 65 will be caused to move in opposite directions to complete a stoking cycle.

The modification illustrated in FIG. 3 provides a drive system which will assure the maximum extensions of the pistons of both fluid cylinder assemblies. This modification includes a drive system 90 including a first fluid cylinder assembly 91 and a second fluid cylinder assembly 92. The fluid cylinder assembly 91 is provided with a cylinder 93 and a piston 94 having a coupling element 95 on the front end thereof for pivotally connecting the piston 94 to the rear end of the carriage assembly 28, and an actuating element 96 which is adapted to engage and close a limit switch 97 when the piston 94 is in its maximum retracted position, and engage and open a limit switch 98 when the piston is in its maximum extended position. Similarly, the fluid cylinder assembly 92 is provided with a cylinder 99 and a piston 100 having a coupling element 101 adapted to be pivotally connected to the rear end of the carriage assembly 19, and an actuating element 102 adapted to engage and close a limit switch 103 when the piston is in its maximum retracted position, and engage and open a normally closed limit switch 104 when the piston is in its maximum extended position.

The front ends of the cylinders 93 and 99 are connected to a solenoid operated selector valve 105 by means of fluid supply lines 106 and 107. The selector valve 105 is operable to selectively communicate the fluid supply lines 106 and 107 with a pressure line 108 including a pump 109 driven by a motor 110, and a return line 111.

The rear ends of the cylinders 93 and 99 are interconnected by means of a fluid line 112 having a pair of solenoid operated valves 113 and 114 which normally are open. The portion of the fluid line 112 between the valves 113 and 114 is connected to the fluid supply line 106 by a fluid line 115 having a solenoid operated valve 116, normally closed, and is connected to fluid supply line 107 by a fluid line 117 having a solenoid operated valve 118 which normally is closed.

The electrical control system for the modification illustrated in FIG. 3 includes lines 119 and 120 connected to an electrical supply source, primary branch lines 121, 122, 123 and 124, and secondary branch lines 125, 126 and 127. The primary branch line 122 interconnects the lines 119 and 120 and includes a selector switch 128, limit switch 97 which is normally in the open position, limit switch 104 which is normally in the closed position, and valve 113. The secondary circuit 125 interconnects the line 119 and primary circuit 122, and includes the selector valve 105. The secondary circuit 126 interconnects the primary circuit 122 and the supply line 119, and includes the valve 116.

The primary circuit 123 interconnects lines 119 and 120, and includes the selector switch 128, the limit switch 98 which normally is in the closed position, limit switch 103 which normally is in the open position, and the valve 114. The secondary circuit 127 includes the valve 117 and interconnects the line 119 and the primary circuit 123, in parallel with the circuit for the valve 114.

The primary circuit 121 interconnects lines 119 and 120 and is connected to the motor 110 for the pump 109. Similarly, the primary circuit 124 connects a motor 129 with the lines 119 and 120. The motor is part of a timer mechanism including a cam 130 driven by the motor 129, which engages the selector switch 128 to cause the switch to selectively contact elements 131 and 132 to selectively apply a voltage to primary circuits 122 and 123.

In the operation of the drive system illustrated in FIG. 3, when a voltage is applied to lines 119 and 120, and the selector switch 28 is in the position as illustrated, the solenoid of the selector valve 108 will be energized to move the valve in the position as illustrated. Simultaneously, the motors 110 and 129 will be energized to operate the pump 109 and drive the timing cam 130. Under such conditions, fluid supply line 106 will be connected to the pressure line 108, and fluid supply line 107 will be connected to return line 111, so that fluid under pressure will be supplied to the front end of the cylinder 93 and fluid will be drained from the front end of the cylinder 99. As the piston 94 is retracted, fluid will flow from the rear end of cylinder 93 through fluid line 112 into the rear end of cylinder 99.

Under circumstances where the piston 94 is moved to its maximum retracted position and the piston 100 is moved to its maximum extended position, the actuating element 96 will close limit switch 97 and actuating element 102 will engage and open limit switch 104 to maintain the primary circuit 122 in a deenergized condition. However, in the event the piston 94 is moved to its maximum retracted position so that the actuating element 96 engages and closes limit switch 97, and piston 100 fails to move to its maximum extended position so that the actuating element 102 does not engage and open limit switch 104, the primary circuit 122 will be closed, thus causing valve 113 to close and valve 116 to open. The effect of valve 113 closing and valve 116 opening is to block communication between the rear ends of the cylinders 93 and 99 and connect the rear end of cylinder 99 to fluid supply line 106. Under such conditions, fluid under pressure will be supplied to the rear end of cylinder 99, causing the piston 110 to move to its maximum extended position. As the piston 100 is moved into its maximum extended position, the actuating element 102 will engage and open limit switch 104, thus breaking primary branch circuit 122 and deenergizing valves 113 and 116. The deenergization of valves 113 and 116 will cause valve 116 to close and valve 113 to open, thereby again intercommunicating the rear ends of the cylinders 93 and 99.

The rotation of the cam 130 periodically will cause the switch 128 to break contact with the element 131 and make contact with the element 132, thus applying a voltage to primary branch circuit 123. Upon deenergization of the solenoid of selector valve 105, the valve will be moved to the right by a spring to communicate the supply line 107 with the pressure line 108 and the supply line 106 with the return line 111. Under such conditions, fluid under pressure will be supplied through fluid supply line 107 to the front end of the cylinder 99 to retract the piston 100, and fluid will be drained from the front end of the cylinder 93 through fluid supply line 106. The retraction of the piston 100 will cause fluid to flow from the rear end of the cylinder 99 through the fluid line 112 into the rear end of cylinder 93 to extend the piston 94.

Under circumstances where the piston 100 is moved to its maximum retracted position and the piston 94 is moved to its maximum extended position, the actuating element 102 will engage and close limit switch 103 and actuating element 96 will engage and open limit switch 98, thus maintaining the primary branch circuit 123 in the deenergized condition. However, in the event the piston 100 moves to its maximum retracted position so that actuating element 102 engages and closes limit switch 103, and piston 94 fails to move to its maximum extended position so that actuating element 96 does not engage and open limit switch 108, primary branch circuit 123 will be closed to energize valves 114 and 118. Under such circumstances, the valve 114 will close to block communication between the rear ends of the cylinders 93 and 99, and valve 118 will open to communicate the rear end of the cylinder 93 with the fluid supply line 107 communicating with the pressure line 108. Fluid under pressure will then be supplied to the cylinder 93 to move the piston 94 to its maximum extended position.

As the piston 94 is moved to its maximum extended position, the actuating element 96 will engage and open limit

switch 98, thus breaking primary branch circuit 123 and deenergizing the solenoids of valves 114 and 118. Valve 114 will then reopen and valve 118 will reclose, the to permit intercommunication between the rear ends of the cylinders 93 and 99. The cycle as described, is repeated to reciprocate the carriage assemblies 19 and 28 and move the movable sets of grates 38 and 39 to provide a stoking action. It will be appreciated that the means provided for assuring the full strokes of the pistons of the fluid cylinder assemblies assures reciprocating movement of the sets of movable grates 38 and 39 between their maximum limits of travel.

The modifications illustrated in FIGS. 4, 5 and 6 consist of alternate drive systems which may be utilized in the embodiment illustrated in FIG. 1. FIG. 4 illustrates a drive system 131 including a first cylinder assembly 132 and a second fluid cylinder assembly 133. The fluid cylinder assembly 132 is provided with a cylinder 134 and a cooperating piston 135 adapted to be connected at its outer end to the carriage assembly 28. Similarly, the fluid cylinder assembly 133 is provided with a cylinder 136 and a cooperating piston 137 which is operatively connected to the carriage assembly 19. The front ends of the cylinders 134 and 136 are connected to a selector valve 138 by means of fluid supply lines 139 and 140. The selector valve 138 is adapted to communicate the fluid supply lines 139 and 140 selectively with a pressure line 141 including a pump 142 and a return line 143. The rear ends of the cylinders 134 and 136 are interconnected by a fluid line 144 having an electrically operated valve 145 which normally is open.

The system further is provided with a fluid line 146 having an electrically operated valve 147 which normally is closed, and a fluid line 148 having an electrically operated valve 149 which normally is closed. The fluid line 146 interconnects the fluid line 144 between the rear end of the cylinder 134 and the valve 145, and the pressure line 141. The fluid line 148 interconnects the fluid line 144 between the rear end of the cylinder 136 and the valve 145, and the fluid line 146.

In the operation of drive system 131, when the selector valve 138 is in the position as illustrated, fluid under pressure will be supplied to the front end of cylinder 134 to retract the piston 135 and fluid will be drained from the front end of cylinder 133, through fluid supply line 140. The rearward movement of the piston 135 will cause fluid to flow from the rear end of the cylinder 134 through fluid line 144 into the rear end of cylinder 136, causing the piston 137 to extend. Assuming the piston 135 will be moved to its maximum retracted position and piston 137 will be moved to its maximum extended position, no compensating action is initiated. However, under conditions where the piston 135 is in its maximum extended position and piston 137 fails to move to its maximum extended position, such conditions will activate an electrical control system to close valve 145 and open valve 149. Communication between the rear ends of the cylinders 134 and 136 will then be blocked and the rear end of the cylinder 136 will communicate with the pressure line 141. The additional fluid under pressure supplied to the rear end of the cylinder 136 will cause the piston 137 to extend to its maximum extended position, thereby deactivating the electrical control system which operates to open valve 145 and close valve 149.

To continue the stoking cycle, the selector valve 138 is moved to the right to communicate the fluid supply line 140 with the pressure line 141 and to communicate the fluid supply line 139 with the return line 143. Under such conditions, fluid under pressure will be supplied to the front end of cylinder 136, causing the piston 137 to retract and force fluid through fluid line 144 to the rear end of cylinder 134. The admission of fluid into the rear end of cylinder 134 will cause the piston 135 to extend and fluid in the front end thereof to drain through fluid supply line 139. Again assuming the piston 135 will be moved to its maximum extended position and piston 137 will be moved to its maximum retracted position, the electrical control system will not be activated to provide a compensating action. However, if the piston 137 is moved to its maximum retracted position and piston 135 is not moved to its maximum extended position, such conditions will activate the electrical control system to close valve 145 and open valve 147. Under such circumstances, the communication between the rear ends of the cylinders 134 and 136 will be blocked and fluid under pressure will be supplied through line 146 to the rear end of cylinder 134. The admission of fluid under pressure into the rear end of cylinder 134 will cause the piston 135 to move to its maximum extended position. Such movement will have the effect of deactivating the electrical control system, thereby closing valve 147 and opening valve 145. The drive system will then be in a position to repeat the aforementioned stoking cycle.

FIG. 5 illustrates a drive system 150 which is similar in construction and operation to drive system 131. The system includes a first fluid cylinder assembly 151 having a cylinder 152 and a cooperating piston 153, and a second fluid cylinder assembly 154 having a cylinder 155 and a cooperating piston 156. The front ends of the cylinders 152 and 155 are connected to a selector valve 157 by means of fluid supply lines 158 and 159. These lines are selectively communicated with a pressure line 160 provided with a pump 161 and a return line 162. A fluid line 163 having an electrically operated valve 164, normally open, interconnects the rear ends of the cylinders 152 and 155. A fluid line 165 having an electrically operated valve 166, normally closed, interconnects the rear end of the cylinder 155 with fluid supply line 158. Similarly, a fluid line 167 having an electrically operated valve 168, normally closed, interconnects the rear end of the cylinder 152 with the fluid supply line 159.

The operation of the drive system 150 is similar to the operation of the drive system 131. In providing a supplemental force to move the piston 156 to its maximum extended position, the valve 164 is closed and the valve 166 is opened to supply fluid under pressure to the rear end of the cylinder 155. To provide a supplemental force to move the piston 153 to its maximum extended position, valve 164 is closed and valve 168 is opened to supply fluid under pressure to the rear end of cylinder 152.

The drive system 169 illustrated in FIG. 6 is provided with a first fluid cylinder assembly 170 having a cylinder 171 and a cooperating piston 172, and a second fluid cylinder assembly 173 having a cylinder 174 and a cooperating piston 175. The front ends of the cylinders 171 and 174 are connected to a selector valve 176 by means of fluid supply lines 177 and 178. The selector valve selectively communicates the fluid supply lines 177 and 178 with a pressure line 179 having a pump 180, and a return line 181.

The rear ends of the cylinders 171 and 174 are interconnected by a fluid line 182 having a pair of electrically operated valves 183 and 184 which normally are open. An additional fluid supply line 185 having an electrically operated valve 186, normally closed, interconnects a portion of fluid line 182 between valves 183 and 184, and the pressure line 179.

In the operation of drive system 169, when the selector valve 176 is in the position as illustrated in FIG. 6, fluid under pressure is supplied to the front end of cylinder 171 to retract the piston 172 and cause fluid to flow from the rear end of the cylinder 171 to the rear end of cylinder 174. The admission of fluid into cylinder 174 causes the piston 175 to extend and fluid to drain from the front end of cylinder 174. Assuming piston 172 is moved to its maximum retracted position and piston 175 is moved to its maximum extended position, the electrical control system will remain deactivated. However, in the event piston 172 assumes its maximum retracted position and piston 175 fails to move to its maximum extended position, the electrical control system will be activated to close valve 184 and open valve 186. Under such circumstances, fluid under pressure will be supplied to the rear end of cylinder 174 to move the piston 175 to its maximum extended position. When this is achieved, the control system is deactivated to close valve 186 and open valve 184.

To continue the stoking cycle of the system, the selector valve 176 is moved to the right to supply fluid under pressure to the front end of cylinder 174 and to drain fluid from the front end of cylinder 171. Correspondingly, the piston 175 will be retracted and piston 172 will be extended. Assuming the piston 175 is moved to its maximum retracted position and piston 172 is moved to its maximum extended position, the electrical control circuit will remain deactivated. However, assuming piston 175 is moved to its maximum retracted position and piston 172 fails to move to its maximum extended position, such condition will activate the electrical control system, causing valve 183 to close and valve 186 to open. Under such circumstances, fluid under pressure will be supplied to the rear end of the cylinder 171, causing it to move to its maximum extended position. When this occurs, the control system will be deactivated, causing valve 186 to close and valve 183 to open. The system is then in condition to repeat the aforementioned stoking cycle.

It will be appreciated that slight modifications to the electrical control circuit illustrated in FIG. 3 would be required in the modifications illustrated in FIGS. 4 through 6. In addition, it will be noted that various other means can be employed for sensing the positions of the pistons of the fluid cylinder assemblies.

I claim:

1. A stoker construction comprising a support frame, a plurality of spaced stationary grates mounted on said support frame, a first plurality of movable grates spaced along said support frame and disposed between a first set of alternate spaces between said stationary grates, a second plurality of movable grates spaced along said support frame and disposed between a second set of alternate spaces between said stationary grates, wherein movable grates are disposed on each side of each stationary grate, and means for reciprocating said movable grates including a first cylinder assembly having a piston operatively connected to said first plurality of movable grates, a second fluid cylinder assembly having a piston operatively connected to said second plurality of movable grates, first means for supplying fluid under pressure to the front end of said first fluid cylinder assembly, second fluid supply means for supplying fluid to the front end of said second fluid cylinder assembly, said first and second fluid supply means being communicable with a source of fluid under pressure, means for selectively communicating said first and second fluid supply means with said source of fluid under pressure, means intercommunicating the rear ends of said fluid cylinder assemblies, and means communicable with said source of fluid under pressure for selectively supplying fluid under pressure to the rear end of said first fluid cylinder assembly while closing said means intercommunicating the rear ends of said fluid cylinder assemblies.

2. A stoker construction according to claim 1, wherein said means for selectively supplying fluid under pressure to the rear end of said first fluid cylinder assembly is operable responsive to a predetermined condition of the piston of said first fluid cylinder assembly.

3. A stoker construction according to claim 1, including a first means for sensing a predetermined position of the piston of the first fluid cylinder assembly and second means for sensing a predetermined position of the piston of said second fluid cylinder assembly, and wherein said means for selectively communicating the rear end of said first fluid cylinder assembly with said source of fluid under pressure is operative responsive to said first and second sensing means.

4. A stoker construction comprising a support frame, a plurality of stationary grates spaced on said support frame, a first plurality of spaced movable grates mounted on said support frame and disposed between a first set of alternate spaces between said stationary grates, a second plurality of spaced movable grates mounted on said support frame and disposed between a second set of alternate spaces between said stationary grates, wherein movable grates are disposed on opposite sides of each stationary grate, and means for reciprocating said movable grates including a first fluid cylinder assembly having a piston operatively connected to said first plurality of movable grates, a second fluid cylinder assembly having a piston operatively connected to said second plurality of movable grates, a first fluid supply line communicating with the front end of said first fluid cylinder assembly, a second fluid supply line communicating with the front end of said second fluid cylinder assembly, a third fluid supply line intercommunicating the rear ends of said fluid cylinder assemblies, said first and second fluid supply lines being communicable with a source of fluid under pressure, a valve for selectively communicating said first and second fluid supply lines with said source of fluid under pressure, a valve disposed in said third fluid line intercommunicating the rear ends of said fluid cylinder assemblies, a fourth line communicable with said source of fluid under pressure and the rear end of said first fluid cylinder assembly, and a valve disposed in said fourth fluid line.

5. A stoker construction according to claim 4, including a first means for sensing a predetermined position of the piston of said first fluid cylinder assembly, and a second means for sensing a predetermined position of the piston of said second fluid cylinder assembly, and wherein said valve in said third fluid line is normally in the open position and is operable to close responsive to said first and second sensing means, and said valve in said fourth fluid line is normally in the closed position and is operable to open responsive to said first and second sensing means.

6. A stoker construction comprising a support frame, a plurality of spaced stationary grates mounted on said support frame, a first plurality of spaced movable grates mounted on said support frame and disposed between a first set of alternate spaces between said stationary grates, a second plurality of spaced movable grates mounted on said support frame and disposed between a second set of alternate spaces between said stationary grates, wherein movable grates are disposed on opposite sides of each stationary grate, and means for reciprocating said movable grates including a first fluid cylinder assembly having a piston operatively connected to said first plurality of movable grates, a second fluid cylinder assembly having a piston operatively connected to said second plurality of movable grates, first means for supplying fluid under pressure to the front end of said first fluid assembly, second fluid means for supplying fluid to the front end of said second fluid cylinder assembly, said first and second fluid supply means being communicable with a source of fluid under pressure, means for selectively communicating said first and second fluid supply means with said source of fluid under pressure, means intercommunicating the rear ends of said fluid cylinder assemblies, and means for selectively supplying fluid under pressure to the rear ends of said fluid cylinder assemblies while closing said means intercommunicating the rear ends of said fluid cylinder assemblies.

7. A stoker construction according to claim 6, wherein said means for selectively supplying fluid under pressure to the rear ends of said fluid cylinder assemblies is operative responsive to a predetermined condition of the piston of one of said fluid cylinder assemblies.

8. A stoker construction according to claim 6, including a first means for sensing first predetermined positions of the pistons of said fluid cylinder assemblies and second means for sensing second predetermined positions of the pistons of said fluid cylinder assemblies and wherein said means for selectively communicating the rear ends of said fluid cylinder assemblies with said source of fluid under pressure is operative responsive to said first and second sensing means.

9. A stoker construction comprising a support frame, a plurality of spaced stationary grates mounted on said support frame, a first plurality of spaced movable grates mounted on said support frame and disposed between a first set of alternate spaces between said stationary grates, a second plurality of spaced movable grates mounted on said support frame and disposed between a second set of alternate spaces

between said stationary grates, wherein movable grates are disposed on opposite sides of each stationary grate, and means for reciprocating said movable grates including a first fluid cylinder assembly having a piston operatively connected to said first plurality of movable grates, a second fluid cylinder assembly having a piston operatively connected to said first plurality of movable grates, a first fluid supply line communicating with the front end of said first fluid cylinder assembly, a second fluid supply line communicating with the front end of said second fluid cylinder assembly, a third fluid supply line intercommunicating the rear ends of said fluid cylinder assemblies, said first and second fluid supply lines being communicable with a source of fluid under pressure, a valve for selectively communicating said first and second fluid supply lines with said source of fluid under pressure, first and second valves disposed in said third fluid line intercommunicating the rear ends of said fluid cylinder assemblies, a fourth fluid line including a valve intercommunicating said first fluid supply line and said third fluid line between said first and second valves in said third fluid line, and a fifth fluid line including a valve intercommunicating said second fluid supply line and said third fluid line between said first and second valves in said third fluid line.

10. A stoker construction according to claim 9, including first means for sensing a first set of predetermined positions of the pistons of said fluid cylinder assemblies and second means for sensing a second set of predetermined positions of the pistons of said fluid cylinder assemblies, and wherein said first valve of said third line normally is open and adapted to close

and said valve in said fourth line normally is closed and adapted to open responsive to said first sensing means and said second valve of said third fluid line normally is open and adapted to close and said valve of said fifth fluid line normally is closed and adapted to open responsive to said second sensing means.

11. A stoker construction according to claim 9, wherein said valves in said third fluid line normally are open and are electrically operable to close, said valves in said fourth and fifth fluid lines are normally closed and are electrically operable to open, said first valve of said third fluid line and said valve in said fourth fluid line are provided with a first electrical circuit, said second valve of said third fluid line and said valve of said fifth fluid line are provided with a second electrical circuit and wherein said first electrical supply circuit includes a first limit switch normally in the closed position adapted to be opened responsive to the maximum forward travel of the piston of said second cylinder assembly and a second limit switch normally in the open position adapted to close responsive to the maximum rearward travel of the piston of said first fluid cylinder assembly and said second electrical circuit having a first limit switch normally in the open position adapted to be closed responsive to the maximum rearward travel of the piston of said second fluid cylinder assembly and a second limit switch normally in the closed position adapted to be opened responsive to the maximum forward travel of the piston of said first fluid cylinder assembly.