

Jan. 3, 1933.

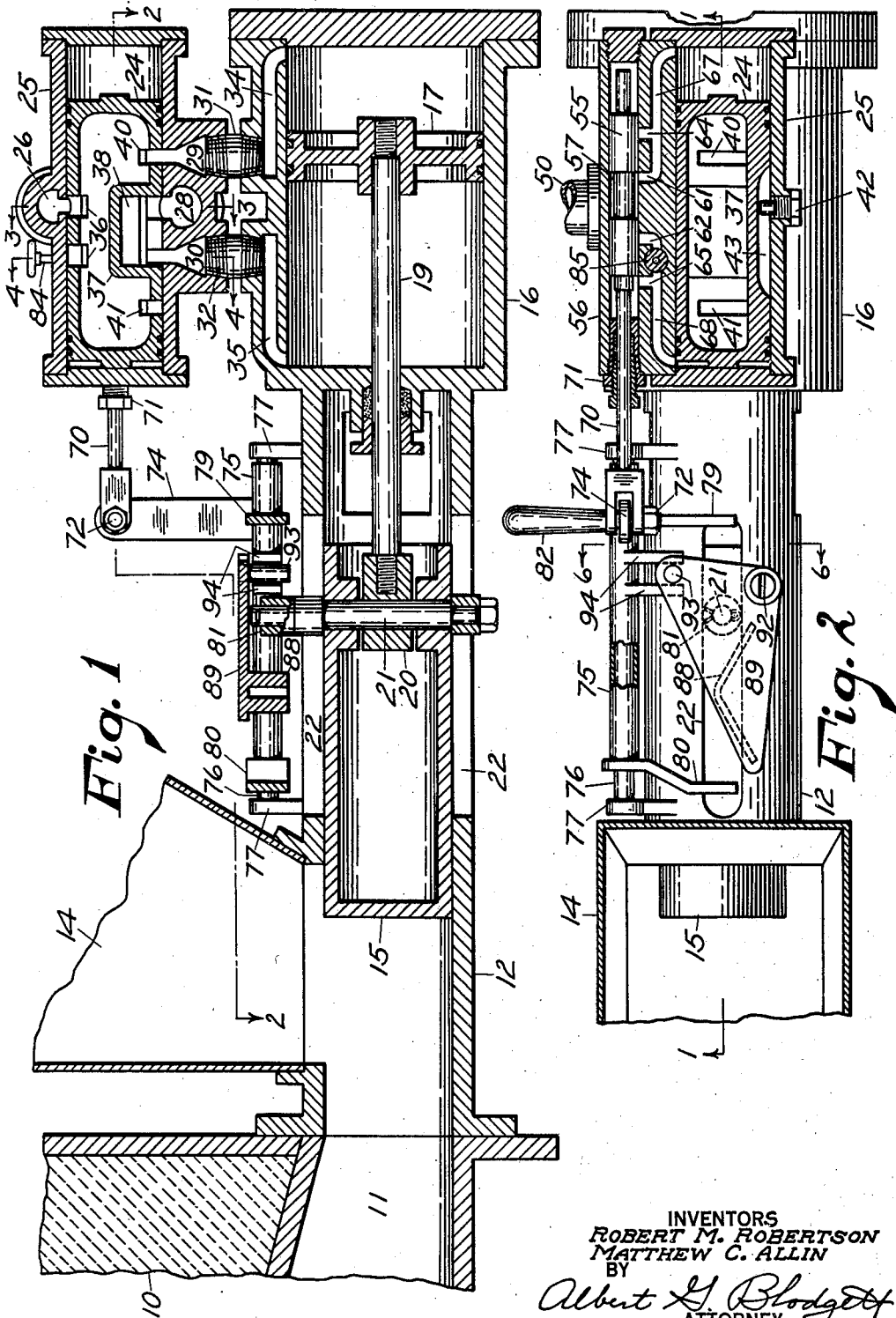
R. M. ROBERTSON ET AL

1,893,246

AUTOMATIC STOKER

Filed April 12, 1932

2 Sheets-Sheet 1



INVENTORS
ROBERT M. ROBERTSON
MATTHEW C. ALLIN
BY
Albert S. Blodgett
ATTORNEY

Jan. 3, 1933.

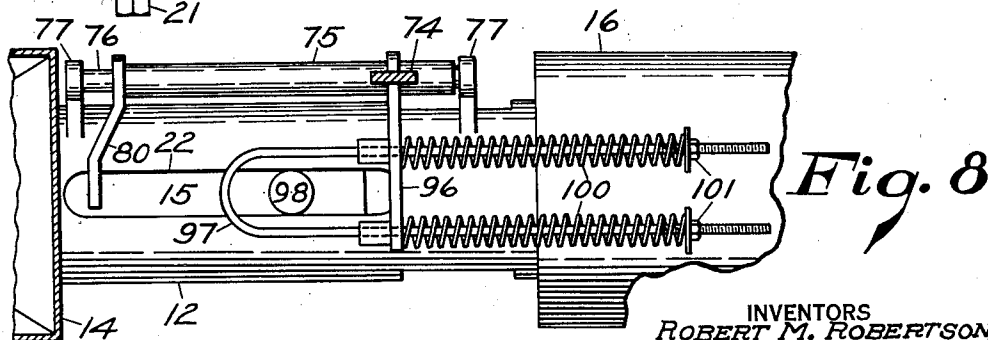
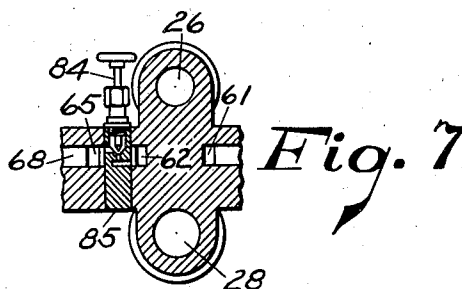
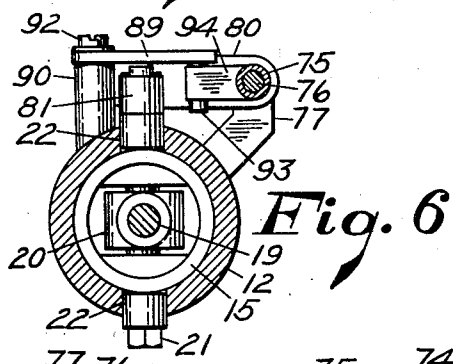
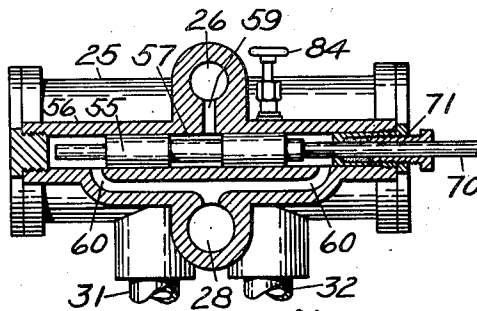
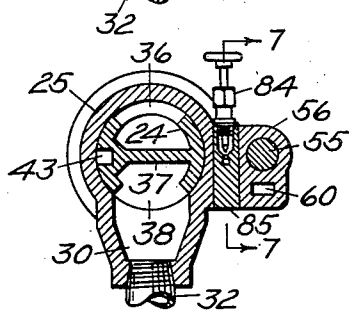
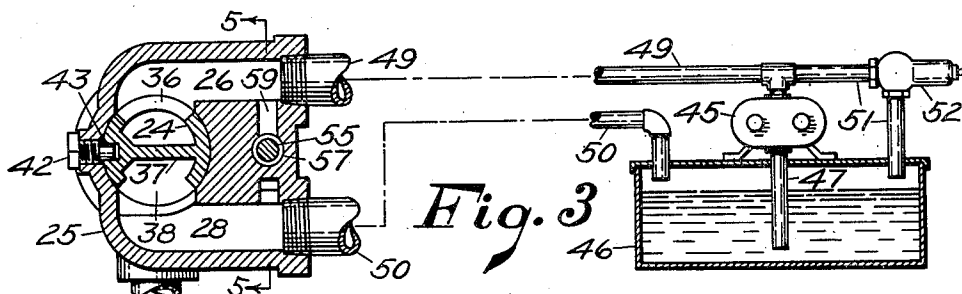
R. M. ROBERTSON ET AL

1,893,246

AUTOMATIC STOKER

Filed April 12, 1932

2 Sheets-Sheet 2



INVENTORS
ROBERT M. ROBERTSON
MATTHEW C. ALLIN

BY
Albert L. Bloodgett
ATTORNEY

UNITED STATES PATENT OFFICE

ROBERT M. ROBERTSON, OF TORONTO, ONTARIO, AND MATTHEW C. ALLIN, OF WESTON, ONTARIO, CANADA, ASSIGNORS TO RILEY STOKER CORPORATION, OF WORCESTER, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS

AUTOMATIC STOKER

Application filed April 12, 1932. Serial No. 604,750.

This invention relates to automatic stokers, and more particularly to stokers of the type having a reciprocable fuel feeding ram actuated by fluid pressure.

5 Reciprocable rams are frequently utilized for the purpose of delivering fuel into the retorts of underfeed stokers. It is desirable that such a ram should move with comparative rapidity during the rearward or fuel
10 feeding stroke, since the burning fuel bed is thus broken up and maintained in a porous condition which is favorable to efficient combustion. It is furthermore desirable that the ram move with similar rapidity during the
15 forward stroke and that its direction of movement be reversed immediately at the end of the forward stroke, so that the ram may remain stationary at its rearmost position whenever it is not actually engaged in delivering
20 fuel to the retort. This has the advantage of sealing the retort throat and thus preventing the escape of gas from the furnace into the room. While these facts have been recognized heretofore, prior constructions
25 have been in general complicated, expensive, and difficult to adjust and operate.

It is accordingly one object of the invention to provide a fluid pressure actuated driving mechanism for the reciprocable ram of
30 an automatic stoker which will be comparatively simple and inexpensive to manufacture, and which will serve to move the ram with rapid strokes in both directions and with little if any pause at the end of the forward
35 stroke.

It is a further object of the invention to provide a fluid pressure actuated driving mechanism having a simple and accessible adjusting means whereby the rate of fuel feed
40 may be controlled, preferably by varying the time interval during which the ram remains stationary at the end of each fuel feeding stroke.

In the actual operation of stokers of this
45 type, blocks of foreign material, such as wood or iron, frequently enter the fuel hopper with the fuel. This often results in the blocking of the ram, which will remain stalled until the operator happens to notice the situation
50 and removes the obstruction. In the mean-

time, the forced draft fan has continued to operate, and the fuel bed within the furnace may have become consumed to such an extent as to expose parts of the stoker to the intense heat and thus cause their rapid de- 55 struction.

It is accordingly one object of the invention to overcome these difficulties and to provide an automatic stoker which will continue to feed a certain amount of fuel to the furnace in spite of accidental blocking of the ram, and which will tend to correct the abnormal condition by removing the obstruction automatically from the path of the ram.

It is a further object of the invention to 65 provide a fluid pressure actuated automatic stoker which will be of simple and compact construction, and which will serve to deliver fuel to a furnace at a desired rate and with a minimum of attention on the part of the 70 operator.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered 75 by the claims appended hereto.

In accordance with our invention, we provide an automatic stoker having a ram which is arranged to reciprocate in a ram casing beneath a fuel hopper, and which serves to deliver fuel from the hopper into a furnace. The ram is actuated by fluid under pressure, and its movements are controlled by a main valve which is also operated by fluid pressure under control of a pilot valve, the 85 pilot valve being reversed automatically at each stroke of the ram. The flow of fluid serving to move the main valve at the end of the fuel feeding stroke of the ram is restricted, preferably by means of an adjustable valve, so that the ram may remain stationary for a predetermined period after delivering a charge of fuel to the furnace. By adjusting the valve and thus varying the length of this period, the rate of fuel feed 95 may be altered as desired. The pilot valve is preferably reversed automatically before the ram has reached the end of its fuel feeding stroke, so that in case the ram meets an obstruction and becomes stalled, it will 100

nevertheless continue to reciprocate throughout a reduced length of stroke, thereby either crushing the obstruction or forcing it through into the retort. The movements of the main valve in response to this pilot valve reversal during the fuel feeding stroke are retarded by a suitable means, such as the adjustable valve already mentioned, so that the ram will make full strokes in normal operation.

Referring to the drawings illustrating one embodiment of the invention, and in which like reference numerals indicate like parts,

Fig. 1 is a vertical longitudinal section through an automatic stoker, the section being taken on the line 1—1 of Fig. 2;

Fig. 2 is a plan view, partly in section on the line 2—2 of Fig. 1;

Fig. 3 is a section on the line 3—3 of Fig. 1, showing in addition, at a reduced scale, a pump and associated parts for supplying liquid under pressure for operating the stoker;

Fig. 4 is a section on the line 4—4 of Fig. 1;

Fig. 5 is a section on the line 5—5 of Fig. 3;

Fig. 6 is a section on the line 6—6 of Fig. 2;

Fig. 7 is a partial section on the line 7—7 of Fig. 4; and

Fig. 8 is a plan view showing a modified form of the invention.

The embodiment illustrated comprises a furnace wall 10 having an opening 11 there-through leading to an underfeed retort (not shown). A horizontal cylindrical ram casing 12 extends forwardly from the wall 10, with its rear end communicating with the opening 11. A fuel hopper 14 is mounted above the ram casing to deliver fuel thereto, and a reciprocable fuel feeding ram 15 is mounted within the ram casing beneath the hopper.

The ram 15 is arranged to be actuated by fluid under pressure, and for this purpose we have illustrated one suitable mechanism comprising a cylinder 16 with closed ends and a piston 17 slidable therein. The cylinder 16 is mounted in front of and coaxial with the ram casing. The piston is connected to the ram by means of a piston rod 19 having an enlarged head 20 at the rear end thereof, and a bolt or pin 21 extending vertically through the ram and the head 20. The ends of the bolt 21 project through longitudinal slots 22 in the top and bottom walls of the ram casing 12.

In order to control the movements of the piston 17 and the ram 15 actuated thereby, we provide a valve mechanism comprising a main valve 24 shaped as a hollow cylinder with closed ends. The valve 24 is slidably mounted within a cylinder 25, which is likewise closed at each end. This cylinder 25 is preferably mounted above the cylinder 16

with its axis parallel to the axis of the latter cylinder. The cylinder 25 is provided with an inlet port 26 in its upper wall, an exhaust or outlet port 28 in its lower wall, and ports 29 and 30 located respectively in front of and in the rear of the exhaust port 28. The ports 29 and 30 are connected by pipe nipples 31 and 32 to passages 34 and 35 leading respectively to the front and rear ends of the cylinder 16. The nipples 31 and 32 provide a convenient means for supporting the cylinder 25. The valve 24 is provided with a pair of inlet ports 36 in its upper wall, an inverted U-shaped partition 37 enclosing a recess 38 in its lower wall, and ports 40 and 41 located respectively in front of and in the rear of the partition 37. Rotation of the valve 24 about its axis is prevented by a screw 42 extending through the wall of the cylinder 25 and into a longitudinal groove 43 in the valve.

The inlet port 26 is supplied with fluid under pressure by any suitable means. We prefer to use oil as the operating fluid, and we have accordingly illustrated a pump 45 (Fig. 3) driven by a suitable source of power, such as an electric motor (not shown), and arranged to draw oil from a reservoir or tank 46 through a pipe 47 and deliver it under pressure to the inlet port 26 through a pipe 49. Oil discharged through the exhaust port 28 may be returned to the tank 46 through a pipe 50. A by-pass pipe 51 provided with a suitable pressure relief valve 52 connects the discharge side of the pump with the oil tank, so that the pressure delivered by the pump cannot exceed a predetermined maximum value. The pump is preferably of the positive displacement type operated at a constant speed.

The valve mechanism is so constructed and arranged that when the main valve 24 is in its rearmost position, as shown in Fig. 1, oil is free to flow from inlet port 26 through ports 36, 40, 29, nipple 31 and passage 34 to the front end of cylinder 16. At the same time the oil in the rear of the piston 17 is free to flow through passage 35, nipple 32, port 30 and recess 38 to the exhaust port 28. The piston 17 and the ram 15 will move toward the rear and a charge of fuel will be delivered from the hopper 14 through the opening 11. If the main valve 24 is moved to its extreme forward position, port 41 will register with port 30, and recess 38 will connect port 29 with the exhaust port 28. This will cause the ram and piston to reverse their movement and travel in a forward direction.

The main valve 24 is arranged to be actuated by fluid pressure under the control of a pilot valve 55. This pilot valve may be of any suitable construction, and is illustrated as cylindrical in shape and slidably mounted within a cylinder 56 integral with and parallel to the main valve cylinder 25. The

valve 55 is reduced in diameter at the center to provide an annular recess 57, which is always in communication with the inlet port 26 through a passage 59 (Fig. 5). The ends of the pilot valve cylinder 56 are always in communication with the exhaust port 28 through passages 60. Referring now to Fig. 2, we have shown a front inlet port 61 and a rear inlet port 62 in the wall of the pilot valve cylinder 56, with an exhaust port 64 in front of the port 61, and an exhaust port 65 in the rear of the port 62. The ports 61 and 64 are connected to the front end of the main valve cylinder 25 by a passage 67, and the ports 62 and 65 are connected to the rear end of the cylinder 25 by a passage 68.

The pilot valve mechanism is so constructed and arranged that when the valve 55 is in its forward position, as shown in Fig. 2, oil may flow from the port 26 through passage 59, recess 57, port 61 and passage 67 to the front end of the main valve cylinder 25, while oil in the rear end of the cylinder may flow to the exhaust port 28 through passage 68, port 65 and passage 60. The main valve 24 will therefore be forced to the rear. If the pilot valve is moved rearwardly, oil will enter the rear end of the main valve cylinder through port 62, and oil will exhaust from the front end of the main valve cylinder through port 64. This will force the main valve to its forward position.

The pilot valve 55 is arranged to be actuated by a suitable mechanism in accordance with the movements of the ram 15. For this purpose we have illustrated a valve stem 70 extending rearwardly from the valve 55 through a stuffing box 71. The rear end of the valve stem 70 is fastened by means of a bolt 72 to the upper end of a vertical arm 74. The lower end of the arm 74 is welded or otherwise rigidly attached to a hollow cylindrical sleeve 75 slidable axially on a rod 76. This rod 76 is rigidly supported from the ram casing 12 by means of brackets 77, the axis of the rod being parallel to the axis of the ram casing. A lost motion connection is provided between the ram and the sleeve 75, comprising an arm 79 rigidly attached to the sleeve 75 near its front end, and an arm 80 rigidly attached to the sleeve near its rear end. Both of these arms project horizontally above the ram casing and lie in the path of an abutment 81 mounted on the upper end of the bolt 21, which travels with the ram. This abutment is preferably formed as a roller, free to rotate upon the bolt, for a purpose which will be explained hereinafter. A handle 82 may be provided on the bolt 72 (Fig. 2), so that the pilot valve 55 can be operated manually if desired.

With the construction as so far described, the ram 15 will be reciprocated continuously at a rate determined principally by the fluid discharge capacity of the pump 45. At the

end of each stroke, the roller 81 will strike one of the arms 79 and 80, thus sliding the sleeve 75 along the rod 76 and reversing the position of the pilot valve 55. This will in turn reverse the main valve 24 and cause the piston 17 to take a stroke in the opposite direction.

In order to control the rate of fuel feed while still maintaining a comparatively high ram speed, we provide means to stop the ram for a predetermined but variable period at the end of each fuel feeding stroke. This may be accomplished by controlling the time required to reverse the main valve 24 after each fuel charge has been delivered to the furnace. Variation in this time interval should preferably have no effect upon the time required to reverse the main valve at the end of each forward stroke of the ram, since it is desirable that the ram be stationary only in its rearmost position where it will prevent the escape of gas through the opening 11.

In the preferred construction illustrated, we have provided a valve 84 arranged to control the flow through the inlet port 62 without affecting the flow through the exhaust port 65. This valve is shown as of the well known needle valve type, adapted for manual adjustment, and comprising a cylindrical body portion 85 having the necessary flow passages formed therein. The cylindrical body 85 is preferably made a tight press fit within the surrounding metal. It will be apparent that various other types of valves, either manually or automatically operable, may be utilized within the scope of our invention, and that the valve may be arranged to restrict the flow through the exhaust port 64 instead of the inlet port 62, since either construction will serve to control the forward speed of the main valve 24 without affecting its rearward speed.

It will be clear that after the ram 15 has completed a fuel feeding stroke and the pilot valve 55 has been moved rearwardly, oil will flow into the rear end of main valve cylinder 25 through the valve 84. By adjusting this valve, the main valve 24 can be made to move forwardly as slowly as desired, and the ram 15 will remain stationary for a predetermined but variable period. Since the valve 84 does not control the flow through the exhaust port 65, the main valve will reverse quickly at the end of each forward ram stroke, and the ram will start at once on its fuel feeding stroke.

In the actual operation of a stoker of this type, blocks of foreign material such as wood, iron, etc. frequently find their way into the hopper 14 with the fuel. With the construction as so far described, if the ram becomes obstructed during its fuel feeding stroke by such a foreign body, the stoker will remain stalled indefinitely, or until the operator discovers the situation and reverses the ram

manually by means of the handle 82. This delay is liable to cause serious damage to the furnace parts of the stoker, because the fuel bed within the furnace may become too thin to form a protecting covering.

In order to overcome this difficulty, we provide means to reverse the pilot valve 55 automatically before the ram has reached a point in its stroke where it is likely to become blocked. It is very seldom indeed that the ram will be stalled by an obstruction before it has completed a substantial part of its fuel feeding stroke. If the pilot valve has already been reversed when the ram becomes stalled, the main valve will be reversed and the ram withdrawn. This will usually allow the obstruction to drop to the bottom of the ram casing, so that the next stroke of the ram will force it into the furnace. In normal operation, the ram will make full strokes in spite of the early reversal of the pilot valve, since the flow through the inlet port 62 is restricted and the forward movement of the main valve 24 will be slow enough to allow completion of each fuel feeding stroke.

The preferred construction comprises a member connected to reverse the pilot valve during the rearward ram stroke and located in the path of an abutment movable with the ram. The member is arranged to yield so that it will not interfere with the movement of the abutment, since the abutment will in normal operation move considerably beyond the point necessary to effect the desired valve reversal. One suitable construction comprises a cam 88 located in the path of the roller 81 and formed for convenience integral with a horizontal plate 89. This plate is pivoted to a vertical post 90 (Fig. 6) on the ram casing 12 by means of a screw 92. The plate 89 carries a downwardly projecting pin 93, which fits between two fingers 94 extending laterally from the sleeve 75. These parts are so arranged that when the ram has partially completed its fuel feeding stroke, the roller 81 will contact with the cam 88 and swing the plate 89 about its pivot 92, thus sliding the sleeve 75 rearwardly and reversing the pilot valve. The purpose of using a roller is to reduce friction and wear.

In Fig. 8 we have illustrated a modification which comprises an arm 96 rigidly attached to the sleeve 75 near the front end thereof and projecting horizontally above the ram casing. This arm 96 slidably supports a U-shaped member 97, which lies with its curved portion at the rear and in the path of an abutment 98 carried by the ram. The arm 96 is also in the path of this abutment. A pair of coil springs 100 are mounted upon the straight portions of the member 97 in front of the arm 96. These springs are held in place by nuts 101. The springs 100 are of sufficient strength to slide the sleeve 75 rearwardly and reverse the pilot valve when the

abutment 98 strikes the curved portion of the member 97. The springs will then yield and allow the member 97 to slide relative to the arm 96 as the ram 15 completes its rearward stroke.

The operation of the invention will now be apparent from the above disclosure. The hopper 14 is kept filled with fuel, and the pump 45 is operated at a constant speed and delivers oil under pressure to the inlet port 26. With the main valve 24 in its rearmost position as shown in Fig. 1, oil will flow to the front end of cylinder 16, forcing the piston 17 and ram 15 rearwardly, and causing the ram to feed a charge of fuel through the opening 11 into the furnace. The oil pressure during this stroke will depend upon the resistance offered to the ram movement by the fuel, and in normal operation will be considerably lower than that required to open the relief valve 52. As the ram moves rearwardly, the pilot valve 55 will be reversed, either by the roller 81 and the cam 88, or by the mechanism shown in Fig. 8. This will allow oil to flow to the rear end of the main valve cylinder through port 62 and valve 84, moving the main valve 24 forwardly. This movement will be comparatively slow, however, because of the restriction provided by the valve and also because of the low oil pressure. The ram will therefore complete its rearward stroke before the main valve has moved sufficiently to close port 29. The adjusting valve 84 is preferably so restricted even when fully open, that the ram will make complete fuel feeding strokes in normal operation.

As the piston reaches the rear end of the cylinder 16, it will stall, and the oil pressure will immediately increase, usually to a point sufficient to open the relief valve 52 and allow oil to by-pass. The ram will remain stationary for a predetermined period dependent upon the adjustment of valve 84, which thus serves to control the rate of fuel feed. When sufficient oil has flowed past this valve 84 to move the main valve 24 to its forward position, oil will be admitted to the rear end of cylinder 16 through port 30, and the ram and piston will move forwardly. At the end of the forward stroke the roller 81 will strike the arm 79, or in Fig. 8 the abutment 98 will strike the arm 96, thus returning the pilot valve to its original position and admitting oil through port 61 into the forward end of main valve cylinder 16. Since neither port 61 nor port 65 is restricted, the main valve 24 will move quickly to the rear, and a second fuel feeding stroke will begin without appreciable delay.

If the ram becomes blocked by a foreign body during the fuel feeding stroke and after the pilot valve has been reversed by the cam 88, or by the mechanism shown in Fig. 8, it will remain stalled only during the time re-

quired for the oil to reverse the main valve 24. The ram will then move forwardly and the foreign body will usually drop to the bottom of the ram casing and be forced into the furnace when the ram makes its next fuel feeding stroke. Even though the obstruction remains in place, the ram will nevertheless continue to make short strokes and deliver a certain amount of fuel to the furnace. This continuous short stroking will submit the obstruction to a pounding which will often either dislodge it or break it into smaller pieces.

It will thus be seen that we have provided a simple and compact automatic stoker which can be adjusted easily to vary the fuel feeding rate as desired. The ram moves with comparative rapidity regardless of the feeding rate, so that the fuel bed is well broken up and maintained in a porous condition conducive to high efficiency and high capacity. Since the ram pauses only at the end of its rearward stroke, there is practically no opportunity for gas to escape through the opening 11 and hopper 14 to the room. The stoker is so constructed that it will clear itself of obstructions automatically and continue to deliver fuel to the furnace without attention on the part of the operator. The mechanism is simple and positive, and there is nothing which is likely to get out of order or cause difficulty in operation.

Having thus described our invention, what we claim and desire to secure by Letters Patent is:

1. An automatic stoker comprising a reciprocable fuel feeding ram actuated by fluid pressure, a main valve actuated by fluid pressure and arranged to control the movements of the ram, a pilot valve to control the movements of the main valve, connections whereby the pilot valve is reversed automatically at each stroke of the ram, and means to restrict the flow of fluid serving to move the main valve at the end of the fuel feeding stroke of the ram, said restricting means being so arranged as to have no effect upon the movement of the main valve in the opposite direction.

2. An automatic stoker comprising a reciprocable fuel feeding ram actuated by fluid pressure, a main valve actuated by fluid pressure and arranged to control the movements of the ram, a pilot valve to control the movements of the main valve, connections whereby the pilot valve is reversed automatically at each stroke of the ram, and an adjustable valve to restrict the flow of fluid serving to move the main valve at the end of the fuel feeding stroke of the ram, said adjustable valve being so arranged as to have no effect upon the movement of the main valve in the opposite direction.

3. An automatic stoker comprising a reciprocable fuel feeding ram actuated by fluid

pressure, a main valve actuated by fluid pressure and arranged to control the movements of the ram, a pilot valve to control the movements of the main valve, mechanism to reverse the pilot valve automatically at each stroke of the ram, means providing an inlet port through which fluid may flow to move the main valve in one direction and an exhaust port through which fluid may flow as the main valve moves in the opposite direction, and an adjustable valve arranged to restrict the flow through one of said ports and thereby retard the movement of the main valve at the end of the fuel feeding stroke of the ram, said parts being so constructed and arranged that the ram will remain stationary for a predetermined but variable period at the end of each fuel feeding stroke.

4. An automatic stoker comprising a reciprocable fuel feeding ram actuated by fluid pressure, a main valve actuated by fluid pressure and arranged to control the movements of the ram, a pilot valve to control the movements of the main valve, mechanism to reverse the pilot valve automatically at each stroke of the ram, means providing an inlet port through which fluid may flow to move the main valve in one direction at the end of the fuel feeding stroke of the ram, an adjustable valve to restrict the flow through the inlet port and thus retard the movement of the main valve, and means providing a separate exhaust passage through which fluid may flow as the main valve moves in the opposite direction, the flow through the exhaust passage being unrestricted by said adjustable valve, said parts being so constructed and arranged that the ram will remain stationary for a predetermined but variable period at the end of each fuel feeding stroke.

5. An automatic stoker comprising a reciprocable fuel feeding ram actuated by fluid pressure, a main valve cylinder, a main valve actuated by fluid pressure and slidable therein, said main valve being arranged to control the movements of the ram, said cylinder having both an inlet port and an exhaust port connected to one end thereof, a pilot valve arranged to control the flow through the ports and to reciprocate the main valve, mechanism to reverse the pilot valve automatically at each stroke of the ram, and an adjustable valve arranged to restrict the flow through one of said ports and thereby retard the movement of the main valve in one direction, said parts being so constructed and arranged that the ram will remain stationary for a predetermined but variable period at the end of each fuel feeding stroke.

6. An automatic stoker comprising a reciprocable fuel feeding ram actuated by fluid pressure, a main valve cylinder having ports connected to each end thereof, there being both an inlet port and an exhaust port connected to one end, a main valve actuated by

fluid pressure and slidable within the cylinder, said main valve being arranged to control the movements of the ram, a pilot valve arranged to control the flow through the ports and to reciprocate the main valve, mechanism to reverse the pilot valve automatically at each stroke of the ram, and an adjustable valve arranged to restrict the flow through said inlet port and thereby retard the movement of the valve in one direction, said parts being so constructed and arranged that the ram will remain stationary for a predetermined but variable period at the end of each fuel feeding stroke.

7. An automatic stoker comprising a reciprocable ram actuated by fluid pressure and arranged to feed a charge of fuel to a furnace at each rearward stroke, a main valve actuated by fluid pressure and arranged to control the movements of the ram, a pilot valve to control the movements of the main valve, means to reverse the pilot valve automatically during each rearward stroke of the ram and before the ram reaches its rearmost position, and means to retard the movement of the main valve in response to the pilot valve reversal during the rearward ram stroke, whereby the ram will make complete strokes in normal operation, and shorter strokes if its rearward movement is obstructed.

8. An automatic stoker comprising a reciprocable ram actuated by fluid pressure and arranged to feed a charge of fuel to a furnace at each rearward stroke, a main valve actuated by fluid pressure and arranged to control the movements of the ram, a pilot valve to control the movements of the main valve, means to reverse the pilot valve automatically at the end of each forward stroke of the ram, means to reverse the pilot valve automatically during each rearward stroke of the ram and before the ram reaches its rearmost position, and means to restrict the flow of fluid serving to move the main valve in response to the pilot valve reversal during the rearward ram stroke, whereby the ram will make complete strokes in normal operation, and shorter strokes if its rearward movement is obstructed.

9. An automatic stoker comprising a reciprocable ram actuated by fluid pressure and arranged to feed a charge of fuel to a furnace at each rearward stroke, a main valve actuated by fluid pressure and arranged to control the movements of the ram, a pilot valve to control the movements of the main valve, an abutment movable with the ram, means providing a lost motion connection between the abutment and the pilot valve which is arranged to reverse the pilot valve at the end of each forward stroke of the ram and also during each rearward stroke of the ram before the ram reaches its rearmost position, and means to retard the movement of the main valve in response to the pilot valve re-

versal during the rearward ram stroke, whereby the ram will make complete strokes in normal operation and shorter strokes if its rearward movement is obstructed.

10. An automatic stoker comprising a reciprocable ram actuated by fluid pressure and arranged to feed a charge of fuel to a furnace at each rearward stroke, a main valve actuated by fluid pressure and arranged to control the movements of the ram, a pilot valve to control the movements of the main valve, an abutment movable with the ram, connections between the abutment and the pilot valve including a member which lies in the path of the abutment during the rearward ram stroke and which serves to reverse the pilot valve before the ram reaches its rearmost position, said member being arranged to yield and allow the abutment to continue its movement with the ram beyond the point necessary to effect pilot valve reversal, and means to retard the movement of the main valve in response to the pilot valve reversal during the rearward ram stroke, whereby the ram will make complete strokes in normal operation and shorter strokes if its rearward movement is obstructed.

11. An automatic stoker comprising a reciprocable ram actuated by fluid pressure and arranged to feed a charge of fuel to a furnace at each rearward stroke, a main valve actuated by fluid pressure and arranged to control the movements of the ram, a pilot valve to control the movements of the main valve, an abutment movable with the ram, a cam device connected to the pilot valve and located in the path of the abutment during the rearward ram stroke, said cam device serving to reverse the pilot valve before the ram reaches its rearmost position, means to reverse the pilot valve at the end of each forward ram stroke, and means to retard the movement of the main valve in response to the pilot valve reversal during the rearward ram stroke, whereby the ram will make complete strokes in normal operation and shorter strokes if its rearward movement is obstructed.

12. An automatic stoker comprising a reciprocable ram actuated by fluid pressure and arranged to feed a charge of fuel to a furnace at each rearward stroke, a main valve actuated by fluid pressure and arranged to control the movements of the ram, a pilot valve to control the movements of the main valve, an abutment movable with the ram, a pivotally mounted cam member connected to the pilot valve and mounted in the path of the abutment during the rearward ram stroke, said cam member serving to reverse the pilot valve before the ram reaches its rearmost position, a member connected to the pilot valve and mounted in the path of the abutment during the forward ram stroke, said member serving to reverse the pilot valve as the ram com-

pletes its forward stroke, and means to retard the movement of the main valve in response to the pilot valve reversal during the rearward ram stroke, whereby the ram will
5 make complete strokes in normal operation and shorter strokes if its rearward movement is obstructed.

13. An automatic stoker comprising a reciprocable ram actuated by fluid pressure and
10 arranged to feed a charge of fuel to a furnace at each rearward stroke, a main valve actuated by fluid pressure and arranged to control the movements of the ram, a pilot valve to control the movements of the main valve,
15 an abutment movable with the ram, a member located in the path of the abutment during the rearward ram stroke, connections between the member and the pilot valve including a spring, said member serving to reverse
20 the pilot valve before the ram reaches its rearmost position, and the spring being arranged to yield after pilot valve reversal to allow the abutment to continue its movement with the ram, means to reverse the pilot valve
25 at the end of each forward ram stroke, and means to retard the movement of the main valve in response to the pilot valve reversal during the rearward ram stroke, whereby the ram will make complete strokes in normal
30 operation and shorter strokes if its rearward movement is obstructed.

14. An automatic stoker comprising a reciprocable ram actuated by fluid pressure and arranged to feed a charge of fuel to a furnace
35 at each rearward stroke, a main valve actuated by fluid pressure and arranged to control the movements of the ram, a pilot valve to control the movements of the main valve, an abutment movable with the ram, a member
40 located in the path of the abutment during the rearward ram stroke, connections between the member and the pilot valve including a spring, said member serving to reverse the pilot valve before the ram reaches its
45 rearmost position, and the spring being arranged to yield after pilot valve reversal to allow the abutment to continue its movement with the ram, a member mounted in the path of the abutment during the forward ram
50 stroke and connected to the pilot valve to reverse the valve as the ram completes its forward stroke, and means to retard the movement of the main valve in response to the pilot valve reversal during the rearward ram
55 stroke, whereby the ram will make complete strokes in normal operation and shorter strokes if its rearward movement is obstructed.

Signed at Toronto, Ontario, Canada, this
60 6th day of April, 1932.

ROBERT M. ROBERTSON.
MATTHEW C. ALLIN.