No. 789,273. PATENTED MAY 9, 1905.

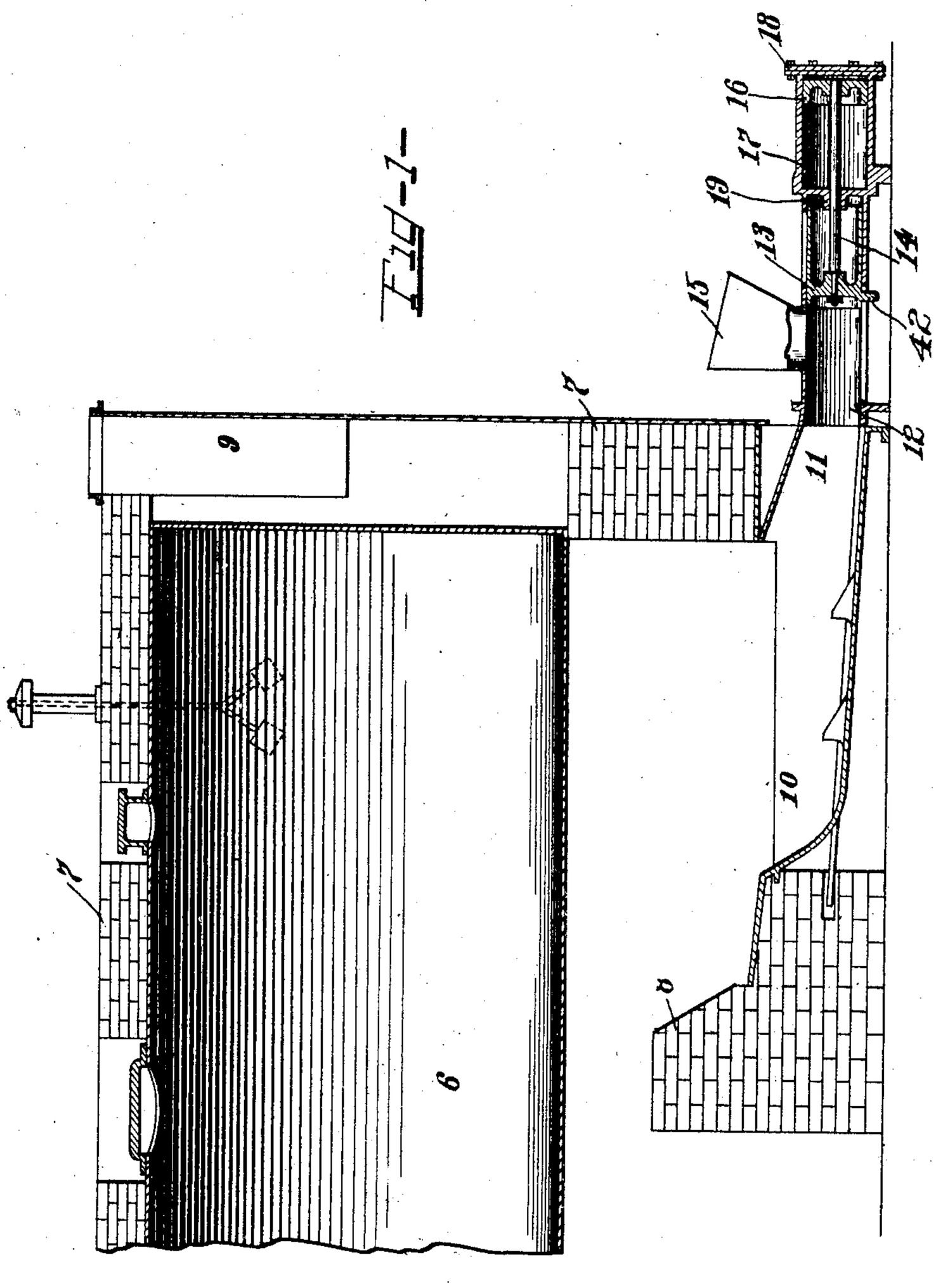
M. W. GREER.

CONTROLLING MECHANISM FOR STEAM CYLINDERS.

APPLICATION FILED NOV. 13, 1902.

4 SHEETS—SHEET 1.

Fig. 1.



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4 SHEETS—SHEET 2.

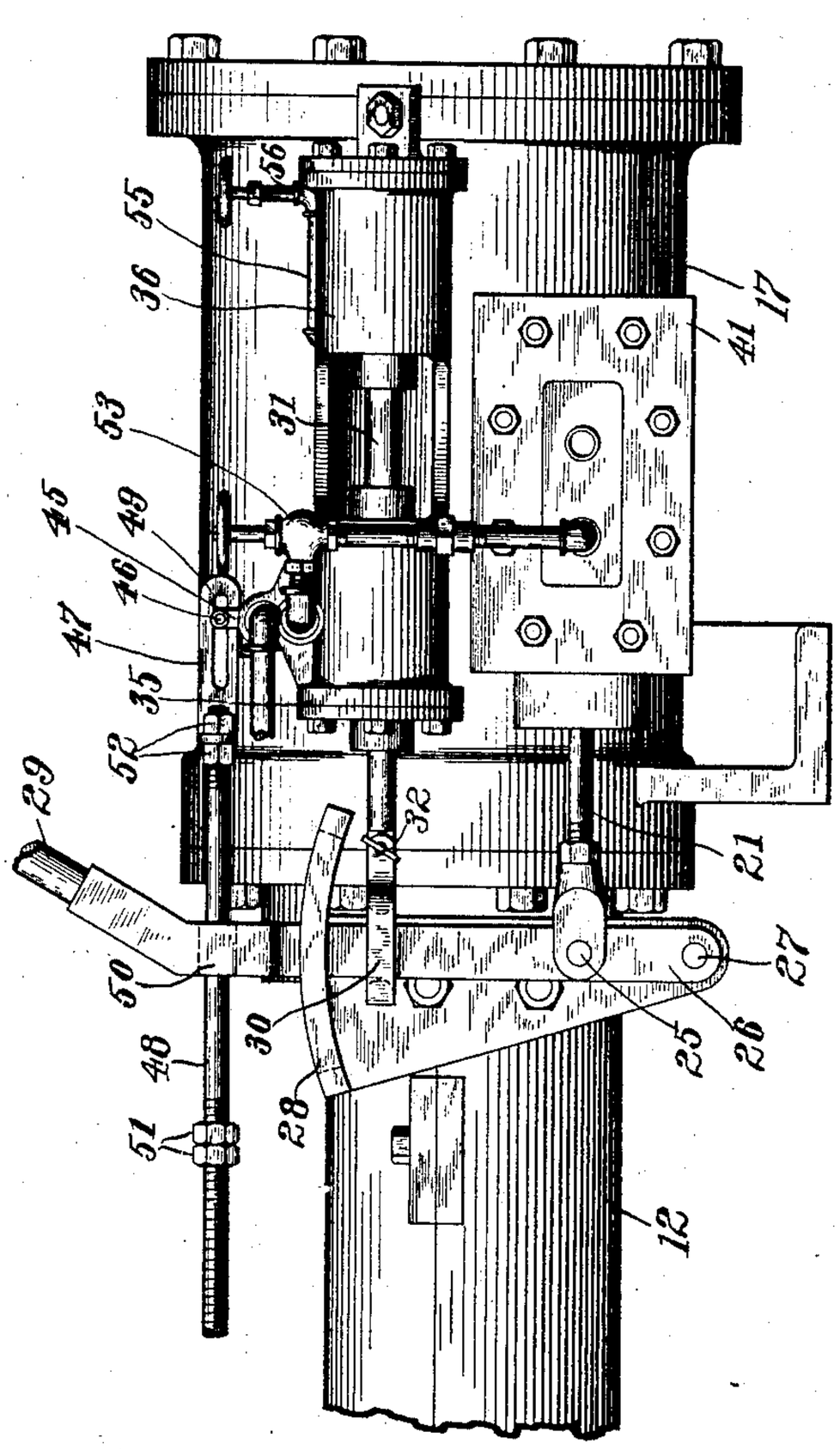

Fig. 2.

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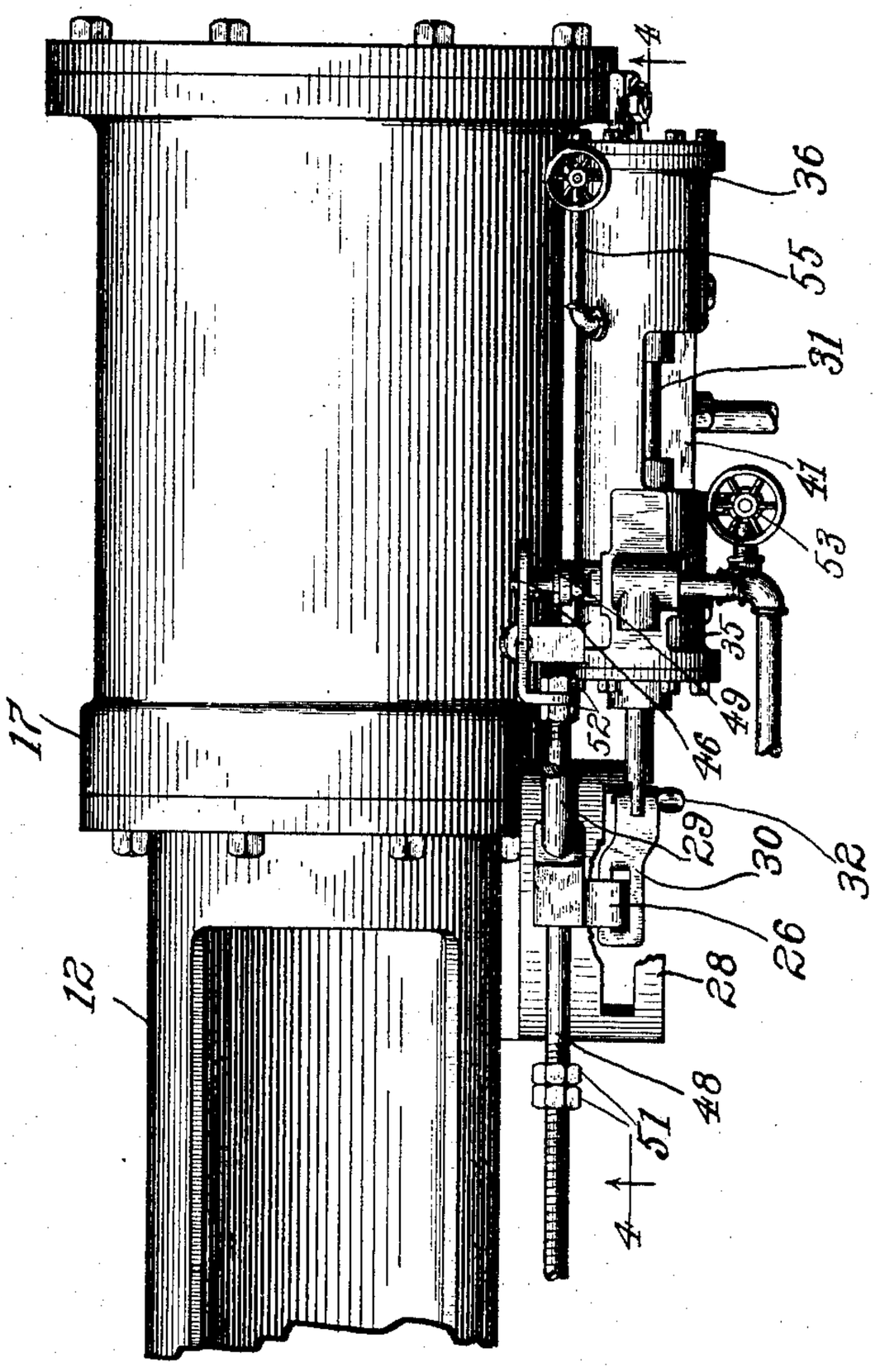
4 SHEETS—SHEET 3.

Fig. 3.



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4 SHEETS—SHEET 4.

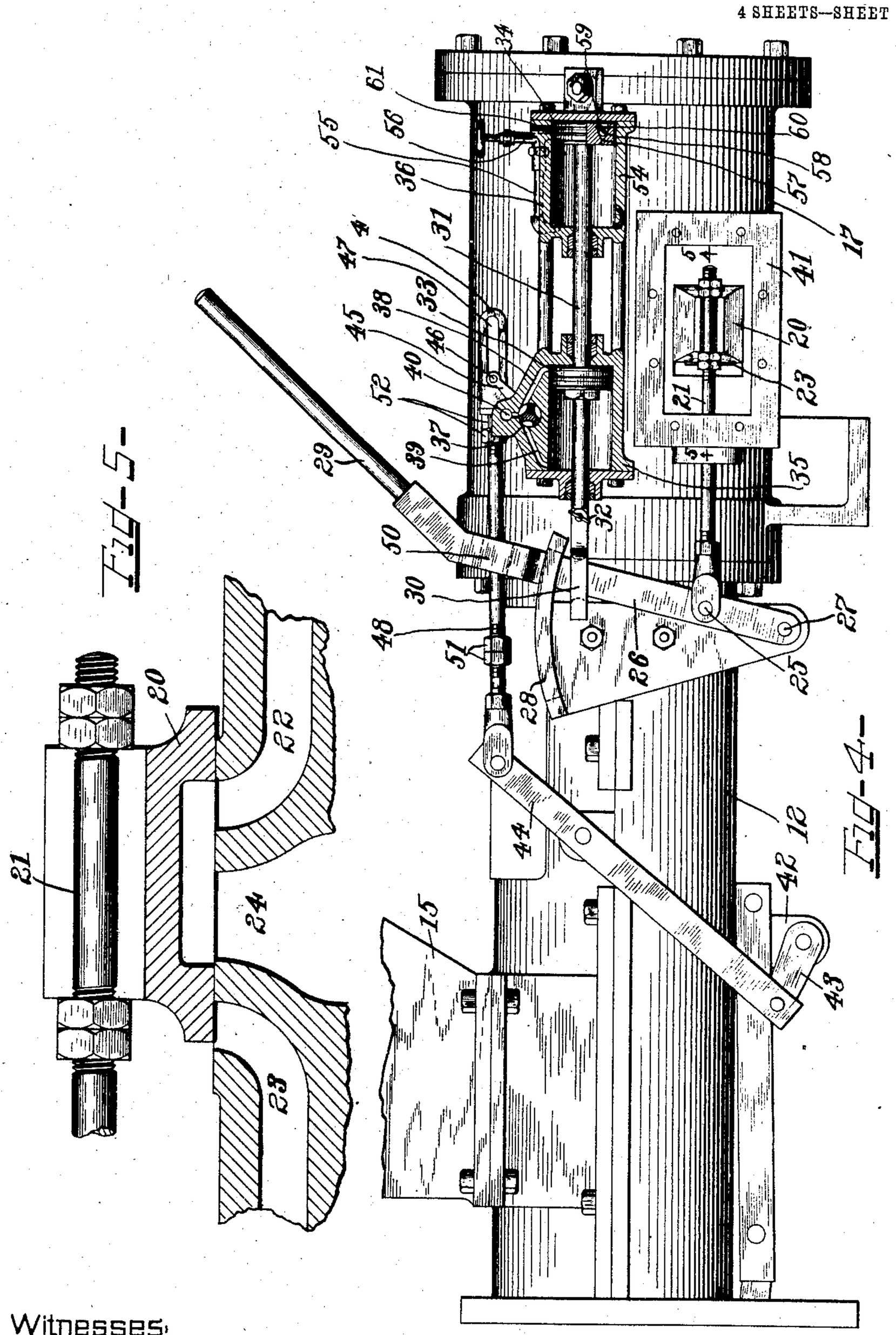

FIG. 5.

FIG. 4.

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No. 789,273. Patented May 9, 1905.

UNITED STATES PATENT OFFICE.

MEDOREM WILLIAM GREER, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE UNDER-FEED STOKER CO. OF AMERICA, OF CHICAGO, ILLINOIS, A CORPORATION OF NEW JERSEY.

CONTROLLING MECHANISM FOR STEAM-CYLINDERS.

SPECIFICATION forming part of Letters Patent No. 789,273, dated May 9, 1905.

Application filed November 13, 1902. Serial No. 131,146.

To all whom it may concern:

Be it known that I, MEDOREM WILLIAM GREER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Controlling Mechanism for Steam-Cylinders, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to means for producing intermittent motion—such, for instance, as the intermittent reciprocation of parts controlled by a fluid-cylinder.

My invention is peculiarly adapted for application to automatic stoking mechanism, and especially to so-called "underfeed-stokers." I shall therefore describe my invention as applied to underfeed-stokers. One well-known type of underfeed-stoker feeds coal or other fuel to be burned into the lower part of a fuel-retort. Coal is placed in a cylinder connected with the lower part of the retort, whereupon a plunger forces the coal through the cylinder into the retort. This plunger is desirably operated by a piston-rod connected with a piston adapted to reciprocate in a fluid-cylinder—such, for instance, as a steam-cylinder.

In order that the supply of fuel to the furnace may be regulated and controlled, it is desirable that the rate of reciprocation of the plunger be variable. If the valving mechanism of the fluid-cylinder be controlled by hand, then the fireman may cause an injection of a charge of fuel into the retort whenever in his judgment it is deemed necessary; but where a large number of stokers are applied to a battery of boilers it requires a considerable amount of attention in order to properly operate and control all the fuel-charging mechanism. It has therefore been found desirable to provide means whereby the actuation of the plungers is made automatic, a charge of fuel being thereby injected at predetermined intervals.

The particular object of my invention is to provide automatic means for the control and regulation of such charging mechanism. It is a well-known fact that a steam-cylinder operates at its highest efficiency when the ports controlling the admission of steam thereto are quickly opened and quickly closed, whereby a so-called "wire-drawing" is avoided. It is one of the desirable features of my invention that while the period of reciprocation of the piston may be controlled through a wide range still the inefficient and unsatisfactory results due to the wire-drawing are avoided.

I accomplish the objects of my invention by providing a steam-cylinder, piston, and piston-rod adapted to actuate the charging-plunger. A slide-valve or other suitable valving mechanism is provided to control the admission of steam or other fluid under pressure to the cylinder. The slide-valve is actuated by an auxiliary steam-cylinder whose piston-rod is provided with a second piston adapted to reciprocate in an auxiliary cylinder partially filled with some viscous fluid, such as oil. The reciprocation of this piston-rod, which controls the motion of the main valve, can occur only when a path is provided by which the oil may flow from one side of the associated piston to the other side thereof. This oil-cylinder, therefore, is provided with a by-pass connection between the two ends thereof. The size of the opening in this connection may be varied at will. For instance, I provide a pipe connection between the two ends of the oil-cylinder, in which connection there is desirably placed a regulating-valve. By regulating the size of the by-pass path through this valve it is possible to check the motion of the controlling piston-rod to any desired extent. Since the main valve is designed to be effective in opening the steam-ports only upon reaching the ends of its stroke, I provide a means, hereinafter to be more fully set forth, whereby the main steam-ports are quickly opened when the main valve reaches points near the ends of its stroke.

My invention will be best understood by

reference to the accompanying drawings, in which—

Figure 1 is a sectional view illustrating the application of my invention to a common type of underfeed-stoker. Fig. 2 is a side elevation showing the details of one embodiment of my invention. Fig. 3 is a plan view thereof. Fig. 4 is a view in side elevation, illustrating the preferred embodiment of the principal features of my invention, parts being shown in central longitudinal section taken on line 4 4 of Fig. 3. Fig. 5 is a central sectional view of the main valve and steam-ports, taken on line 5 5 of Fig. 4.

Similar characters of reference are applied to like parts in all of the views.

I have shown a boiler 6 mounted in a suitable boiler-setting 7, having a fire-wall 8 and provided with an uptake-flue 9.

At 10 I have shown a retort of a well-known type of underfeed-stoker, into which fuel to be burned is charged at 11 through the charging-cylinder 12. A plunger 13 is actuated by the piston-rod 14 to force fuel which is charged in through the hopper 15 to the cylinder 12 into the lower part of the retort 10. The piston-rod 14 and plunger 13 are actuated by a piston 16, adapted to reciprocate in a steam-cylinder 17, a cylinder-head 18 and stuffing-gland 19 being provided, as usual. The admission of steam into the head end of the cylinder causes a forward motion of the plunger 13, whereby coal which may have dropped from the hopper 15 into the cylinder 12 is forced into the retort 10. The admission of steam to the reverse end of the cylinder causes a reverse motion of the plunger, drawing it back into position as shown in Fig. 1.

The slide-valve controlling the admission of steam to the cylinder is best illustrated in Fig. 5, wherein a slide-valve 20 is shown adapted to be actuated by the valve-rod 21. The port 22 leads to the head end of the cylinder, while the port 23 leads to the plunger end thereof. The exhaust-port 24 may be connected with a condenser or with the atmosphere, as may be desired. On account of the large lap of the slide-valve it will be seen that a considerable motion of the same is required in order to change the live-steam connection with the steam-cylinder—that is, supposing the slide-valve, as shown in Fig. 5, be considered to have a motion toward the left the port 23 will be closed, whereafter a considerable motion of the slide-valve must ensue before the port 22 is opened. The reason for this peculiar design of the slide-valve will be hereinafter more fully pointed out.

As best illustrated in Fig. 4, the valve-rod 21 is pivotally connected at 25 with a controlling-lever 26, which is pivoted at 27 and whose motion is limited by the quadrant 28. A handle is provided at 29, whereby the valve 20 may be controlled by hand when desired. However, the automatic control of the main valve is effected through an operating-link 30, connected with the auxiliary piston-rod 31, a removable pin being provided at 32, whereby the operative association between the piston-rod 31 and the controlling-lever 26 may be broken. Upon the auxiliary piston-rod 31 are mounted a steam-cylinder piston 33 and the oil-cylinder piston 34. The piston-rod 31 is adapted to reciprocate when actuated by steam-pressures in the auxiliary steam-cylinder 35 in a manner well understood by those skilled in the art.

Without reference, for the time being, to the function of the oil-cylinder 36 and its associated parts I shall describe the automatic operation of the stoker mechanism. A rotary valve 37 is provided, whereby live steam may be conducted to either the port 38 or the port 39, leading to opposite ends of the cylinder 35. The exhaust-port 40 may connect with the atmosphere or a condenser, as desired.

Taking the various operating parts in positions as shown in Fig. 4, the operation of the automatic stoking mechanism may be traced as follows: It will be seen that the valve 20 is at the extreme right end of its stroke, thereby opening the port 23 to live steam under pressure in the steam-chest 41. Steam being admitted on the left of the main piston 16, the same is forced toward the right. The lug 42, projecting downwardly from the plunger 13, is connected by a link 43 with the lever 44. Thus as the plunger moves toward the right with the piston 16 the lever 44 will be thrown into its reverse position. The crank 45 controls the rotary valve 37, the said crank being provided with a pin 46, over which rides the slotted end 47 of the automatic-cut-off rod 48. As the lug 42 moves toward the right with the plunger and main piston the automatic-cut-off rod will be moved toward the left. Thus when the end 49 of the slot reaches the pin 46 the position of the valve 37 will be reversed upon the completion of the stroke of the main piston. Thus steam will be admitted to the right of the piston 33, while a connection is established between the port 39 and the exhaust-port 40. Upon this reversal of the position of the valve 37 the piston 33 will move to the left end of its stroke, thereby shifting the position of the main valve 20 through the agency of the link lever 26 and the valve-stem 21. This movement of the valve 20 first cuts off steam from the port 23 and then opens the same to exhaust, and upon the completion of the stroke of the piston 33 toward the left the main valve 20 will have been sufficiently moved to admit steam to the head end of the main cylinder 17. The return stroke of the plunger will then begin. The automatic-cut-off rod 48 will travel from its alternate position back toward the position shown in Fig. 4, the reversal of the position

of the valve 37 being accomplished toward the end of this movement of the rod 48. Thus the mechanism will again assume the position shown in Fig. 4, whereat the above-described cycle of operations may be repeated.

The cut-off rod 48 passes through a slot 50 in the link lever 26. The adjustable lock-nuts 51 and 52 are adjusted so as to cause a sufficient actuation of the valve 20 to cut off the steam-supply to the main cylinder at any desired point in the stroke of the main piston. Thus as the main piston carries the lug 42 from the position shown in Fig. 4 toward the right the automatic-cut-off rod will be carried toward the left until the lock-nuts 52 strike the lever 26, thereby cutting off steam from the port 23. Of course it is understood that the operation of the mechanism controlled by the piston 33 may have been sufficiently rapid to have previously cut off steam from the port 23, in which case the use of the more positively controlling cut-off means will not be necessary.

It will be seen that while the steam cut-off for the main cylinder is not entirely dependent upon the operation of the piston 33 still the admission of steam to either the port 22 or the port 23 is controlled by the motion of the piston 33, which actuates the link lever 26, and the admission of steam to either of the above-mentioned main ports occurs only after the piston 33 has reached either one or the other end of its stroke. Thus the main valve, as illustrated in Fig. 4, being in position to admit steam to the left, the main piston will complete its stroke toward the right and there remain until the auxiliary piston 33 shall have reached a point near the left-hand end of its stroke, whereupon the position of the valve 20 will have been sufficiently shifted to open the admission-port 22.

One of the particular features of my present invention consists in the provison of means whereby the speed of the motion of the auxiliary piston 33 may be controlled so as to control the rate of the reciprocation of the plunger 13. One means of thus controlling the speed of motion of the piston 33 consists in the provision of the throttle-valve 53, whereby the supply of steam to the auxiliary steam-cylinder may be regulated. The other and more dependable means for controlling the speed of motion of the piston-rod 31 consists in the provision of the piston 34, adapted to reciprocate within an oil-cylinder 54. This cylinder 54 is provided with a by-pass-pipe connection 55, including a regulating-valve 56. The oil-cylinder and by-pass pipe are partially filled with oil. In order for the piston 34 to reciprocate in its cylinder, it is necessary that the oil upon one side of the cylinder flow around through the by-pass connection to the other side of the piston. Therefore by allowing only a small opening through the regulating-valve 56 the flow of the oil between the opposite sides of the piston 34 is sufficiently checked to prevent a rapid movement of the piston. The opening may be made so small that the piston 34 will move very slowly indeed.

Since it is desirable that the forward or charging stroke of the plunger 13 be more rapid than the return stroke thereof, I find it desirable to provide the small opening 57 through the oil-piston 34. A valve-seat 58 is provided in this opening, adapted to be closed by the ball-valve 59. A cross-pin 60 is provided to prevent the escape of the ball from the valve-chamber. Thus the motion of the piston 34 toward the left may be much more rapid than its stroke toward the right, because upon the motion toward the left the ball-valve is unseated to allow an opening for oil to flow through the piston between the opposite sides thereof. As the piston moves toward the right, however, the ball-valve is seated, thereby closing the passage of oil through the opening 57 in the piston. Thus after the main piston has forced a charge of fuel into the retort it retains its forward position for a considerable length of time until the auxiliary pistons have moved to the right-hand end of their stroke, when the valve 20 is actuated to admit steam to the left-hand end of the main cylinder, whereupon the plunger is withdrawn from the retort to receive a fresh charge of fuel. The succeeding forward stroke of the main piston and plunger ensues shortly thereafter upon the more rapid movement of the auxiliary pistons toward the left.

The rate of the motion of the auxiliary pistons and piston-rod toward the right may be regulated to a nicety by means of the regulating-valve 56, which may be entirely closed, whereby the motion of the piston 34 is very slow, indeed, on account of the very slight leakage of oil through the closed ball-valve in the piston.

Wire-drawing would ensue if the main port 23 were opened very slowly, as would be the case when actuated by the slow motion of the auxiliary pistons toward the right. In order to prevent this extremely slow motion at the time of opening the port 23, a short channel 61 is provided in the wall of the oil-cylinder 54, this channel extending along one side of the cylinder to a point a slight distance to the left of the piston 34 when at its extreme right-hand-end position. It will be seen that as the piston 34 nears the right-hand end of its stroke this channel will provide a secondary by-pass of considerable size around the said piston. Thus when the piston reaches this point near the end of its stroke it will receive a comparatively rapid motion, due to the large by-pass connection afforded between the opposite sides thereof. This rapid motion of the piston 31 causes a rapid opening of the port 23. A similar channel may or may not be provided,

as desired, at the left-hand end of the cylinder, depending somewhat upon the size of the opening 57 through the piston. This opening 57 may be large enough to permit a sufficiently rapid movement of the piston 31 to prevent wire-drawing upon the opening of the port 22. The lock-nuts 51 and 52, which engage the lever 26, are so adjusted as to cut off the supply of steam to the ends of the main cylinder at such points as to insure the efficient operation of the mechanism.

The quantity of oil placed in the cylinder 54 is such as to allow sufficient clearance to permit a rapid movement of the piston-rod 31, due to the engagement of the cut-off lock-nuts 51 or 52 with the lever 26. This movement of the piston-rod 31, due to the engagement of the lock-nuts with the lever 26, is large enough only to cut off the steam-supply from either port 22 or 23.

It will be seen that my invention provides a highly-efficient and at the same time an automatic means by which the supply of fuel to the boiler-grate may be controlled and regulated through a very wide range.

It will be apparent that the actuation of the regulating-valve 56 or the throttle-valve 53 may be manual or may be controlled by automatic apparatus controlled by the boiler-pressure or the position of the furnace-drafts. The hand-lever 29 provides a means whereby the stoker may be controlled entirely by hand, if desired, after withdrawal of the pin 32.

While my invention is particularly well adapted for application to an underfeed-stoker, as described, its use is not at all limited to such application and, indeed, may well be employed wherever a variable intermittent motion is required, either reciprocal or rotary. Thus while I have shown and particularly described one embodiment of my invention I do not wish to limit myself to the precise disclosure herein set forth; but

Having described my invention, I claim as new and desire to secure by Letters Patent—

1. In a device of the class described, the combination with primary reciprocating mechanism, driven by a fluid under pressure, of secondary reciprocating mechanism adapted when at opposite ends of its stroke to control the admission of said fluid under pressure to cause correspondingly-reversed strokes of said primary reciprocating mechanism, and means for retarding the motion of said secondary reciprocating mechanism more at the center of the strokes than at the ends thereof, substantially as described.

2. In a device of the class described, the combination with primary reciprocating mechanism, driven by a fluid under pressure, of secondary reciprocating mechanism adapted when at opposite ends of its stroke to control the admission of said fluid under pressure to cause correspondingly-reversed strokes of said primary reciprocating mechanism, and means for retarding the motion of said secondary reciprocating mechanism more at the center of the strokes than at the ends thereof, the operative condition of said secondary reciprocating mechanism being controlled by the position of said primary reciprocating mechanism, substantially as described.

3. In a device of the class described, the combination with primary reciprocating mechanism, driven by a fluid under pressure, of secondary reciprocating mechanism adapted when at one end of its stroke to control the admission of said fluid under pressure to cause one stroke of said primary reciprocating mechanism, means for retarding the motion of said secondary reciprocating mechanism, and means for rendering said retarding means ineffective near the ends of the stroke of said secondary reciprocating mechanism, substantially as described.

4. In a device of the class described, the combination with primary reciprocating mechanism, driven by a fluid under pressure, of secondary reciprocating mechanism adapted when at one end of its stroke to control the admission of said fluid under pressure to cause one stroke of said primary reciprocating mechanism, means for retarding the motion of said reciprocating mechanism, and means for rendering said retarding means ineffective near the ends of the stroke of said secondary reciprocating mechanism, the operative condition of said secondary reciprocating mechanism being controlled by the position of said primary reciprocating mechanism, substantially as described.

5. In a device of the class described, the combination with primary reciprocating mechanism, driven by a fluid under pressure, of secondary reciprocating mechanism adapted when at opposite ends of its stroke to control the admission of said fluid under pressure to cause correspondingly-reversed strokes of said primary reciprocating mechanism, means for retarding the motion of said secondary reciprocating mechanism, and means for rendering said retarding means ineffective near the ends of the stroke of said secondary reciprocating mechanism, substantially as described.

6. In a device of the class described, the combination with primary reciprocating mechanism, driven by a fluid under pressure, of secondary reciprocating mechanism adapted when at opposite ends of its stroke to control the admission of said fluid under pressure to cause correspondingly-reversed strokes of said primary reciprocating mechanism, means for retarding the motion of said secondary reciprocating mechanism, and means for rendering said retarding means ineffective near the ends of the stroke of said secondary reciprocating mechanism, the operative condition of said secondary reciprocating mechanism being controlled by the position of said primary re-

ciprocating mechanism, substantially as described.

7. In a device of the class described, the combination with primary reciprocating mechanism, driven by a fluid under pressure, of secondary reciprocating mechanism adapted when at opposite ends of its stroke to control the admission of said fluid under pressure to cause correspondingly-reversed strokes of said primary reciprocating mechanism, means for retarding the motion of said secondary reciprocating mechanism in one direction more than in the reverse direction, and means for rendering said retarding means ineffective near the ends of the stroke of said secondary reciprocating mechanism, substantially as described.

8. In a device of the class described, the combination with primary reciprocating mechanism, driven by a fluid under pressure, of secondary reciprocating mechanism adapted when at opposite ends of its stroke to control the admission of said fluid under pressure to cause correspondingly-reversed strokes of said primary reciprocating mechanism, means for retarding the motion of said secondary reciprocating mechanism in one direction more than in the reverse direction, and means for rendering said retarding means ineffective near the ends of the stroke of said secondary reciprocating mechanism, the operative condition of said secondary reciprocating mechanism being controlled by the position of said primary reciprocating mechanism, substantially as described.

9. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, auxiliary reciprocating mechanism operatively associated therewith adapted when near the ends of its stroke to actuate said valving mechanism, means for retarding the motion of said auxiliary reciprocating mechanism, and means for rendering said retarding means ineffective near the ends of the stroke of said auxiliary reciprocating mechanism, the operative condition of said auxiliary reciprocating mechanism being controlled by the position of said main reciprocating mechanism, substantially as described.

10. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, auxiliary reciprocating mechanism operatively associated therewith adapted when near the ends of its stroke to actuate said valving mechanism to admit steam to said main cylinder, means for retarding the motion in one direction of said auxiliary reciprocating mechanism, and means for rendering said retarding means ineffective near the ends of the stroke of said auxiliary reciprocating mechanism, the operative condition of said auxiliary reciprocating mechanism being controlled by the position of said main reciprocating mechanism, substantially as described.

11. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, main valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, a reciprocating piston and piston-rod operatively associated therewith adapted when near the ends of its stroke to actuate said main valving mechanism to admit steam to said main cylinder, an oil-cylinder containing oil, a second piston on said piston-rod adapted to reciprocate in said oil-cylinder, a by-pass connection between the ends of said oil-cylinder, a channel in the oil-cylinder wall to afford a secondary by-pass around the oil-cylinder piston when near the end of its stroke, and means whereby the operative condition of said auxiliary reciprocating mechanism is controlled by the position of said main reciprocating mechanism, substantially as described.

12. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, main valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, a reciprocating piston and piston-rod operatively associated therewith adapted when near the ends of its stroke to actuate said main valving mechanism to admit steam to said main cylinder, an oil-cylinder containing oil, a second piston on said piston-rod adapted to reciprocate in said oil-cylinder, a by-pass connection of variable size between the ends of said oil-cylinder, a channel in the oil-cylinder wall to afford a secondary by-pass around the oil-cylinder piston when near the end of its stroke, and means whereby the operative condition of said auxiliary reciprocating mechanism is controlled by the position of said main reciprocating mechanism, substantially as described.

13. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, main valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, a reciprocating piston and piston-rod operatively associated therewith adapted when near the ends of its stroke to actuate said main valving mechanism to admit steam to said main cylinder, an oil-cylinder containing oil, a second piston on said piston-rod adapted to reciprocate in said oil-cylinder, a by-pass connection between the ends of said oil-cylinder, a channel in the oil-cylinder wall to afford a secondary by-pass around the oil-cylinder piston when near the end of its stroke, and mechan-

ism containing lost motion whereby the position of said auxiliary valving mechanism is controlled by the position of said main reciprocating mechanism, substantially as described.

14. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, main valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, a reciprocating piston and piston-rod operatively associated therewith adapted when near the ends of its stroke to actuate said main valving mechanism to admit steam to said main cylinder, an oil-cylinder containing oil, a second piston on said piston-rod adapted to reciprocate in said oil-cylinder, a by-pass connection of variable size between the ends of said oil-cylinder, a channel in the oil-cylinder wall to afford a secondary by-pass around the oil-cylinder piston when near the end of its stroke, and mechanism containing lost motion whereby the position of said auxiliary valving mechanism is controlled by the position of said main reciprocating mechanism, substantially as described.

15. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism associated therewith, main valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, a reciprocating piston and piston-rod operatively associated therewith adapted when near the ends of its stroke to actuate said main valving mechanism to admit steam to said main cylinder, auxiliary valving mechanism for admitting steam to the ends of said auxiliary cylinder, an oil-cylinder containing oil, a second piston on said piston-rod adapted to reciprocate in said oil-cylinder, a by-pass connection between the ends of said oil-cylinder, additional independent by-pass means at the ends of the oil-cylinder, a check-valve in the oil-cylinder piston to permit the passage of fluid in one direction only, and means whereby the position of said auxiliary valving mechanism is controlled by the position of said main reciprocating mechanism, substantially as described.

16. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, main valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, a reciprocating piston and piston-rod operatively associated therewith adapted when near the ends of its stroke to actuate the said main valving mechanism to admit steam to said main cylinder, auxiliary valving mechanism for admitting steam to the ends of said auxiliary cylinder, an oil-cylinder containing oil, a second piston on said piston-rod adapted to reciprocate in said oil-cylinder, a by-pass connection of variable size between the ends of said oil-cylinder, additional independent by-pass means at the ends of the oil-cylinder, a check-valve in the oil-cylinder piston to permit the passage of fluid in one direction only, and means whereby the position of said auxiliary valving mechanism is controlled by the position of said main reciprocating mechanism, substantially as described.

17. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, main valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, a reciprocating piston and piston-rod operatively associated therewith adapted when near the ends of its stroke to actuate said main valving mechanism to admit steam to said main cylinder, auxiliary valving mechanism for admitting steam to the ends of said auxiliary cylinder, an oil-cylinder containing oil, a second piston on said piston-rod adapted to reciprocate in said oil-cylinder, a by-pass connection between the ends of said oil-cylinder, additional independent by-pass means at the ends of the oil-cylinder, a check-valve in the oil-cylinder piston to permit the passage of fluid in one direction only, and mechanism containing lost motion whereby the position of said auxiliary valving mechanism is controlled by the position of said main reciprocating mechanism, substantially as described.

18. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, main valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, a reciprocating piston and piston-rod operatively associated therewith adapted when near the ends of its stroke to actuate said main valving mechanism to admit steam to said main cylinder, auxiliary valving mechanism for admitting steam to the ends of said auxiliary cylinder, an oil-cylinder containing oil, a second piston on said piston-rod adapted to reciprocate in said oil-cylinder, a by-pass connection of variable size between the ends of said oil-cylinder, additional independent by-pass means at the ends of the oil-cylinder, a check-valve in the oil-cylinder piston to permit the passage of fluid in one direction only, and mechanism containing lost motion whereby the position of said auxiliary valving mechanism is controlled by the position of said main reciprocating mechanism, substantially as described.

19. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, main valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, a re-

ciprocating piston and piston-rod operatively associated therewith adapted when near the ends of its stroke to actuate said main valving mechanism to admit steam to said main cylinder, an oil-cylinder, containing oil, a second piston on said piston-rod adapted to reciprocate in said oil-cylinder, a by-pass connection of variable size between the ends of said oil-cylinder, a channel in the oil-cylinder wall to afford a secondary by-pass around the oil-cylinder piston when near the end of its stroke, a check-valve in the oil-cylinder piston to permit the passage of fluid in one direction only, and means whereby the operative condition of said auxiliary reciprocating mechanism is controlled by the position of said main reciprocating mechanism, substantially as described.

20. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, main valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, a reciprocating piston and piston-rod operatively associated therewith adapted when near the ends of its stroke to actuate said main valving mechanism to admit steam to said main cylinder, an oil-cylinder containing oil, a second piston on said piston-rod adapted to reciprocate in said oil-cylinder, a by-pass connection between the ends of said oil-cylinder, a channel in the oil-cylinder wall to afford a secondary by-pass around the oil-cylinder piston when near the end of its stroke, a check-valve in the oil-cylinder piston to permit the passage of fluid in one direction only, and mechanism containing lost motion whereby the position of said auxiliary valving mechanism is controlled by the position of said main reciprocating mechanism, substantially as described.

21. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, main valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, a reciprocating piston and piston-rod operatively associated therewith adapted when near the ends of its stroke to actuate said main valving mechanism to admit steam to said main cylinder, an oil-cylinder containing oil, a second piston on said piston-rod adapted to reciprocate in said oil-cylinder, a by-pass connection of variable size between the ends of said oil-cylinder, a channel in the oil-cylinder wall to afford a secondary by-pass around the oil-cylinder piston when near the end of its stroke, a check-valve in the oil-cylinder piston to permit the passage of fluid in one direction only, and mechanism containing lost motion whereby the position of said auxiliary valving mechanism is controlled by the position of said main reciprocating mechanism, substantially as described.

22. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, main valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, a reciprocating piston and piston-rod operatively associated therewith adapted when near the ends of its stroke to actuate said main valving mechanism to admit steam to said main cylinder, an oil-cylinder containing oil, a second piston on said piston-rod adapted to reciprocate in said oil-cylinder, a by-pass connection between the ends of said oil-cylinder, a channel in the oil-cylinder wall to afford a secondary by-pass around the oil-cylinder piston when near the end of its stroke, a check-valve in the oil-cylinder piston to permit the passage of fluid in one direction only, and means whereby the operative condition of said auxiliary reciprocating mechanism is controlled by the position of said main reciprocating mechanism, substantially as described.

23. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, main valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, a reciprocating piston and piston-rod operatively associated therewith adapted when near the ends of its stroke to actuate said main valving mechanism to admit steam to said main cylinder, an oil-cylinder containing oil, a second piston on said piston-rod adapted to reciprocate in said oil-cylinder, a by-pass connection of variable size between the ends of said oil-cylinder, a channel in the oil-cylinder wall to afford a secondary by-pass around the oil-cylinder piston when near the end of its stroke, mechanism containing lost motion whereby the position of said auxiliary valving mechanism is controlled by the position of said main reciprocating mechanism, and means whereby the cut-off of steam to said main cylinder is positively controlled by the position of said main reciprocating mechanism, substantially as described.

24. In a device of the class described, the combination with primary reciprocating mechanism driven by a fluid under pressure, of secondary reciprocating mechanism adapted when at one end of its stroke to control the admission of said fluid under pressure to cause one stroke of said primary reciprocating mechanism, means for retarding the motion of said secondary reciprocating mechanism independent of the position of said primary reciprocating mechanism, and means for rendering the retarding means ineffective near the ends of the stroke of the secondary reciprocating mechanism, substantially as described.

25. In a device of the class described, the combination with primary reciprocating mechanism driven by a fluid under pressure, of secondary reciprocating mechanism adapt-

ed when at one end of its stroke to control the admission of said fluid under pressure, to control one stroke of the said primary reciprocating mechanism, means for retarding the motion of said secondary reciprocating mechanism, independent of the motion of said primary reciprocating mechanism, and means for rendering the retarding means ineffective near the ends of the stroke of the secondary reciprocating mechanism, the operative condition of said secondary reciprocating mechanism being controlled by the position of said primary reciprocating mechanism, substantially as described.

26. In a device of the class described, the combination with primary reciprocating mechanism driven by a fluid under pressure, of secondary reciprocating mechanism adapted when at opposite ends of its stroke to control the admission of said fluid under pressure, to cause correspondingly-reversed strokes of said primary reciprocating mechanism, means for retarding the motion of said secondary reciprocating mechanism independent of said primary reciprocating mechanism, and means for rendering the retarding means ineffective near the ends of the stroke of the secondary reciprocating mechanism, substantially as described.

27. In a device of the class described, the combination with primary reciprocating mechanism, driven by a fluid under pressure, of secondary reciprocating mechanism adapted when at opposite ends of its stroke to control the admission of said fluid under pressure to cause correspondingly-reversed strokes of said primary reciprocating mechanism, means for retarding the motion of said secondary reciprocating mechanism independent of said primary reciprocating mechanism, and means for rendering the retarding means ineffective near the ends of the stroke of the secondary reciprocating mechanism, the operative condition of said secondary reciprocating mechanism being controlled by the position of said primary reciprocating mechanism, substantially as described.

28. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, auxiliary reciprocating mechanism operatively associated therewith adapted when near the ends of its stroke to actuate said valving mechanism to admit steam to said main cylinder, means for retarding the motion in one direction of said auxiliary reciprocating mechanism independent of said main reciprocating mechanism, and means for rendering the retarding means ineffective near the ends of the stroke of the secondary reciprocating mechanism, the operative condition of said auxiliary reciprocating mechanism being controlled by the position of said main reciprocating mechanism, substantially as described.

29. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, main valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, a reciprocating piston and piston-rod operatively associated therewith adapted when near the ends of its stroke to actuate said main valving mechanism to admit steam to said main cylinder, an oil-cylinder containing oil, a second piston on said piston-rod adapted to reciprocate in said oil-cylinder, and a by-pass connection between the ends of said oil-cylinder and additional independent by-pass means at the ends of the oil-cylinder, said oil-cylinder being stationarily mounted with respect to said main reciprocating mechanism, substantially as described.

30. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism operatively associated therewith, main valving mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, a reciprocating piston and piston-rod operatively associated therewith adapted when near the ends of its stroke to actuate said main valving mechanism to admit steam to said main cylinder, an oil-cylinder containing oil, a second piston on said piston-rod adapted to reciprocate in said oil-cylinder, and a by-pass connection of variable size between the ends of said oil-cylinder and additional independent by-pass means at the ends of the oil-cylinder, said oil-cylinder being immovably connected with said steam-cylinder.

31. In a device of the class described, the combination with a main steam-cylinder, of main reciprocating mechanism for controlling the admission of steam to said cylinder, an auxiliary steam-cylinder, a reciprocating piston and piston-rod operatively associated therewith, adapted when near the ends of its stroke to actuate said main valving mechanism to admit steam to said main cylinder, an oil-cylinder, rigidly mounted on said main steam-cylinder, containing oil, a second piston on said piston-rod adapted to reciprocate in said oil-cylinder, a by-pass connection of variable size between the ends of said oil-cylinder and additional independent by-pass means at the ends of the oil-cylinder, and means whereby the operative condition of said auxiliary reciprocating mechanism is controlled by the position of said main reciprocating mechanism, substantially as described.

In witness whereof I hereunto subscribe my name this 6th day of November, A. D. 1902.

MEDOREM WILLIAM GREER.

Witnesses:

HARVEY L. HANSON,

JOHN STAHR.