

Oct. 16, 1934.

R. A. FORESMAN

1,977,181

COMBUSTION APPARATUS

Filed July 27, 1931

7 Sheets-Sheet 1

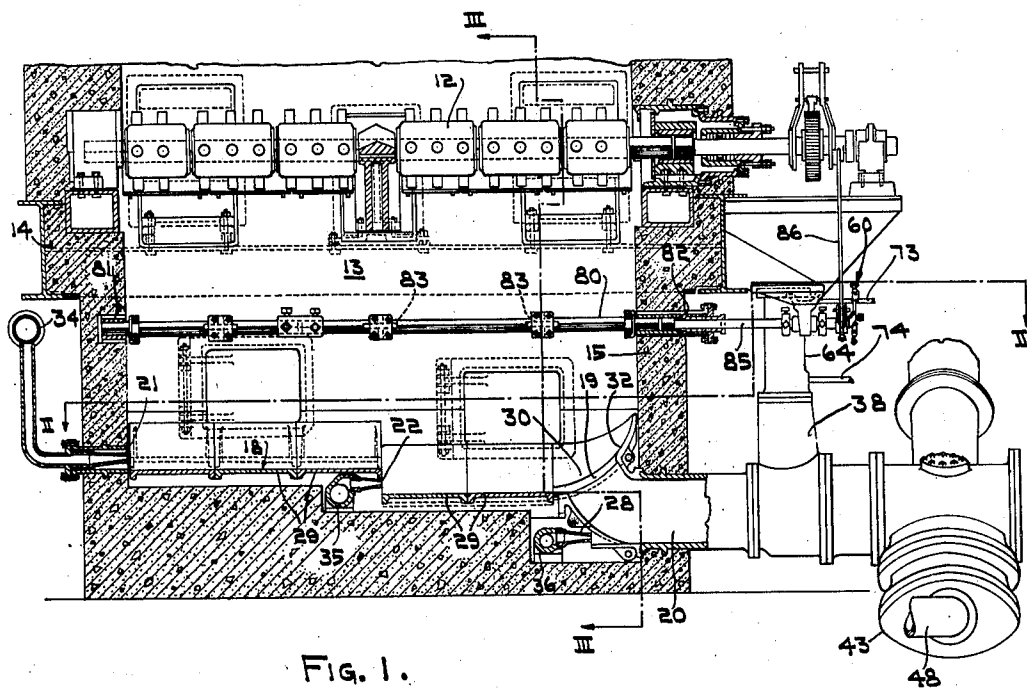


Fig. 1.

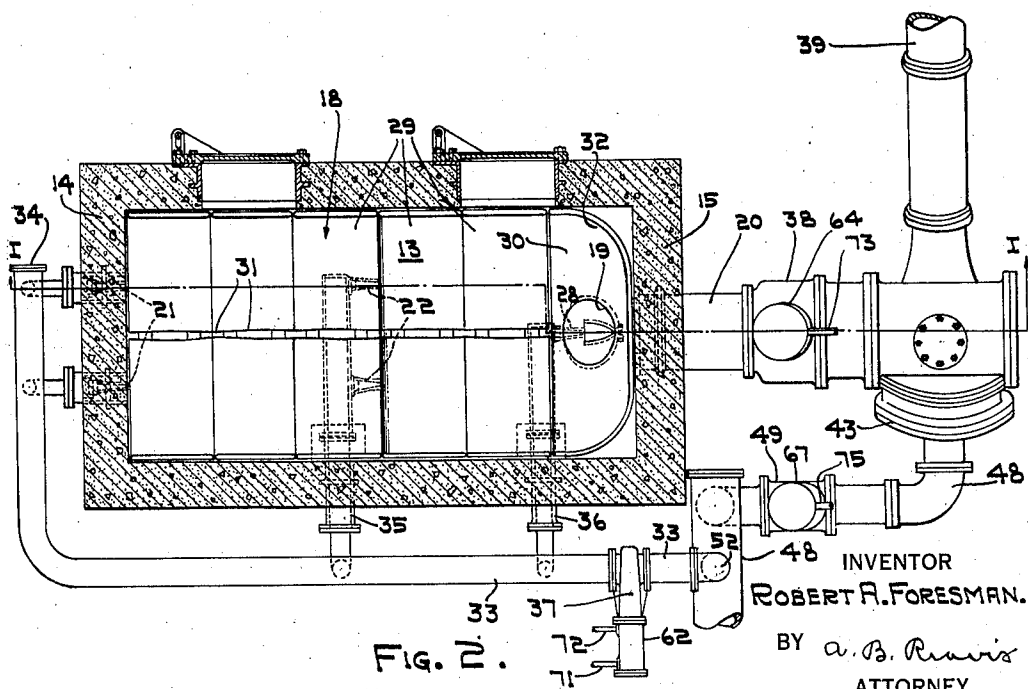


Fig. 2.

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7 Sheets-Sheet 2

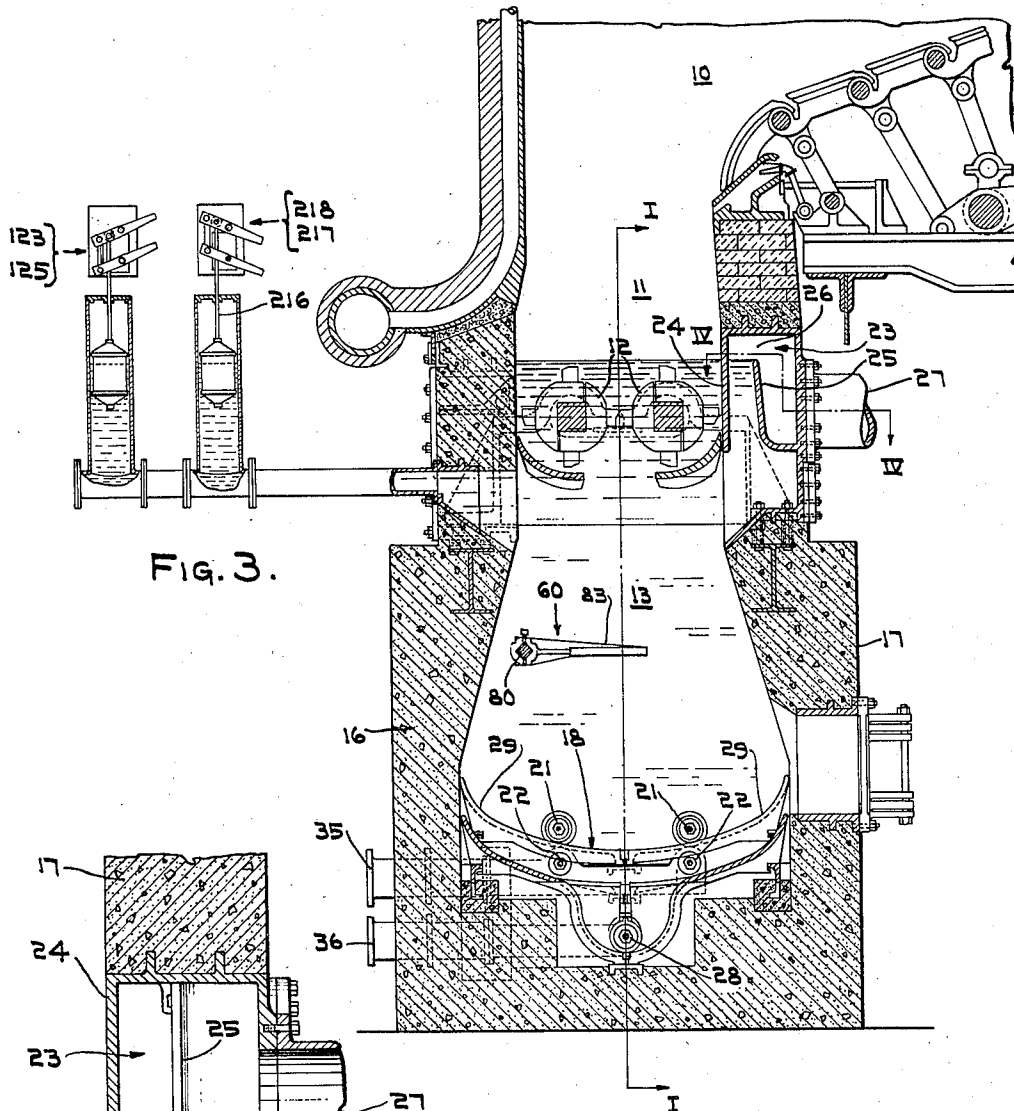


FIG. 3.

FIG. 4.

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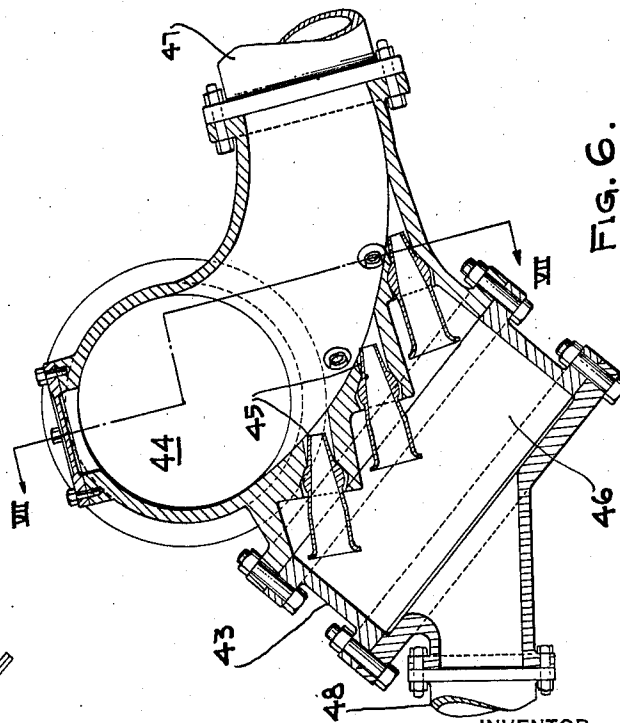
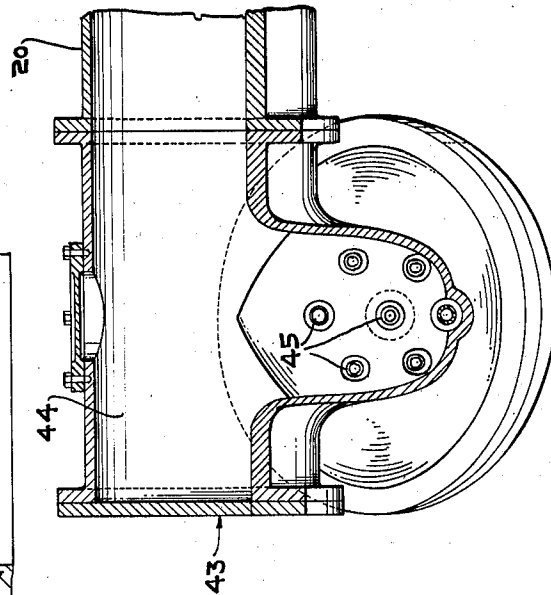
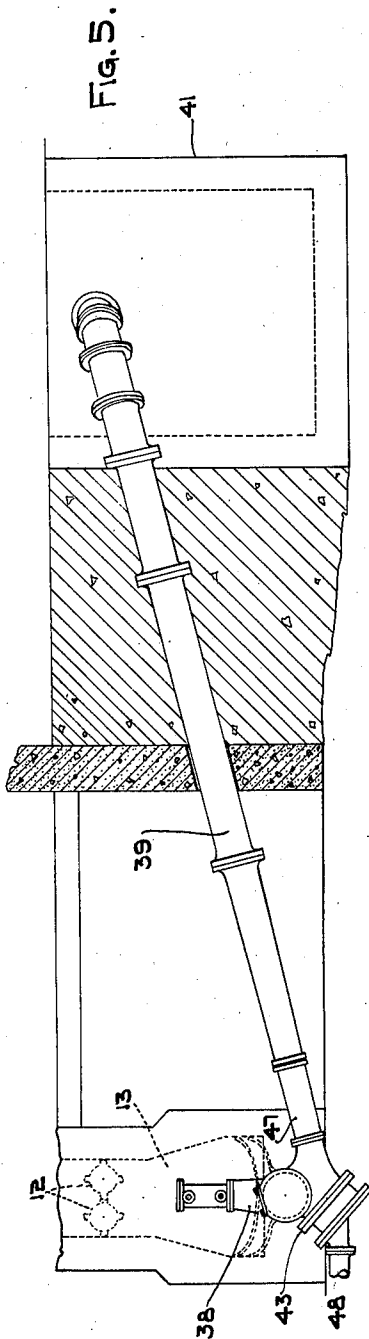
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COMBUSTION APPARATUS

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7 Sheets-Sheet 3



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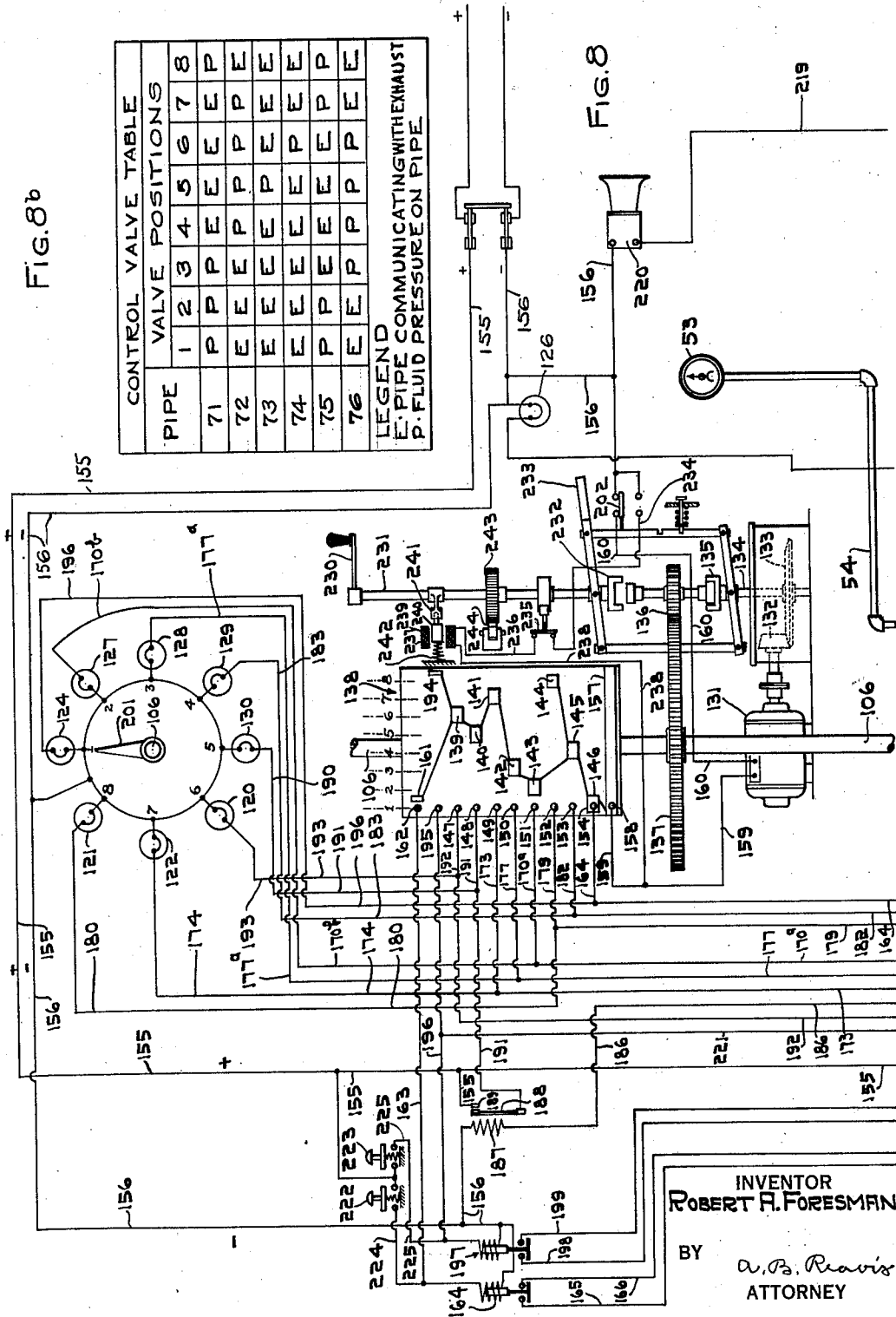
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FIG. 8b



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7 Sheets-Sheet 5

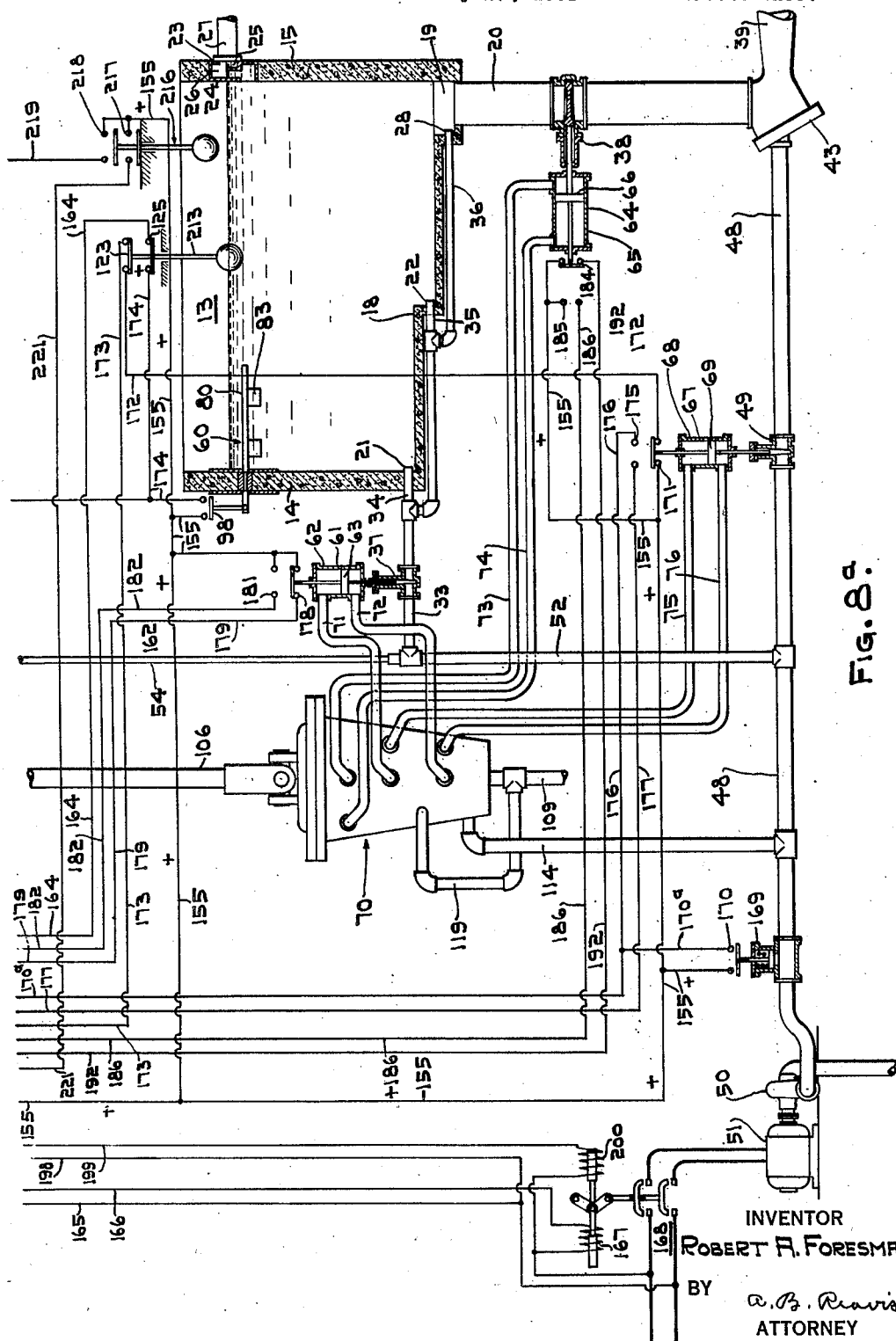


Fig. 8a.

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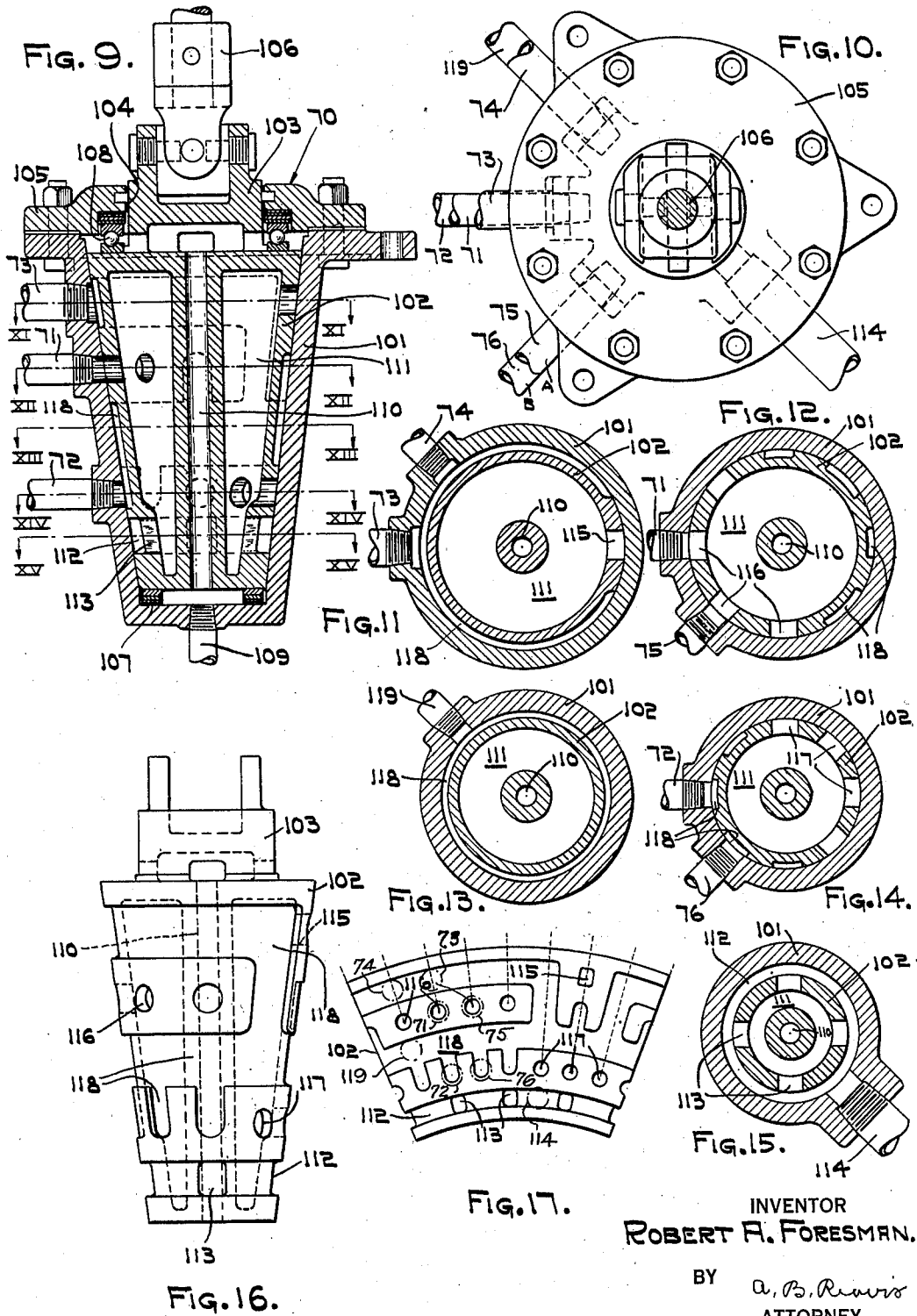
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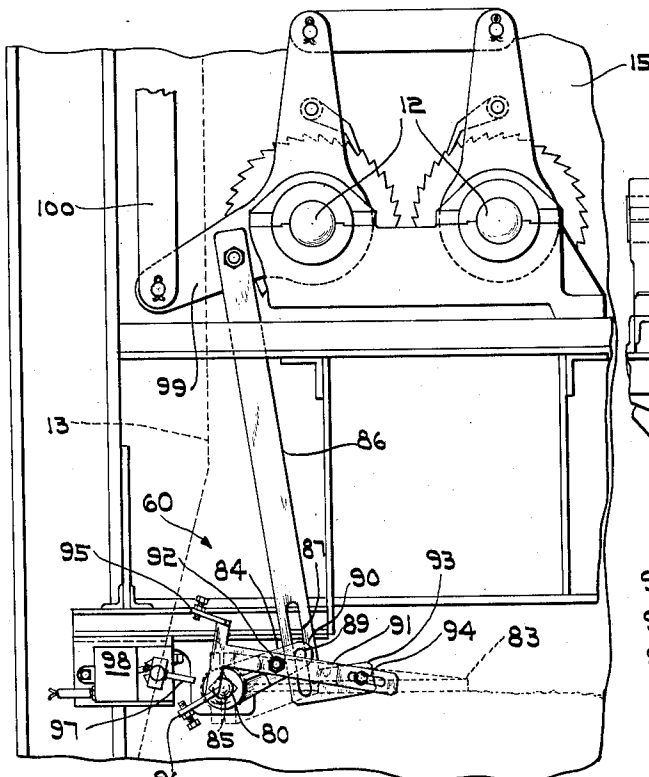


FIG. 18.

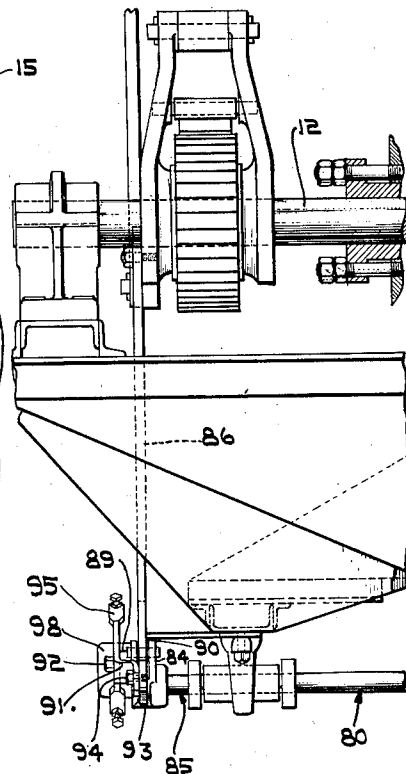


FIG. 19.

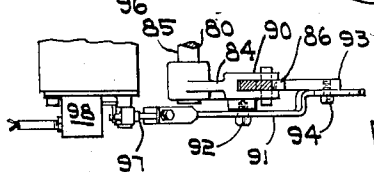


FIG. 20.

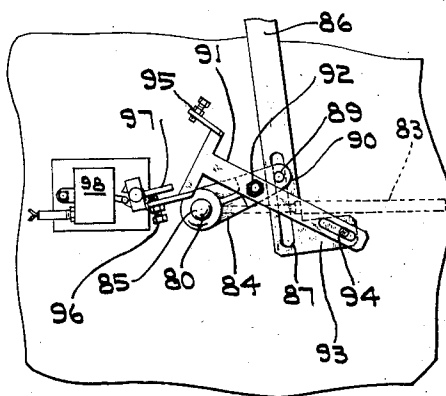


FIG. 21.

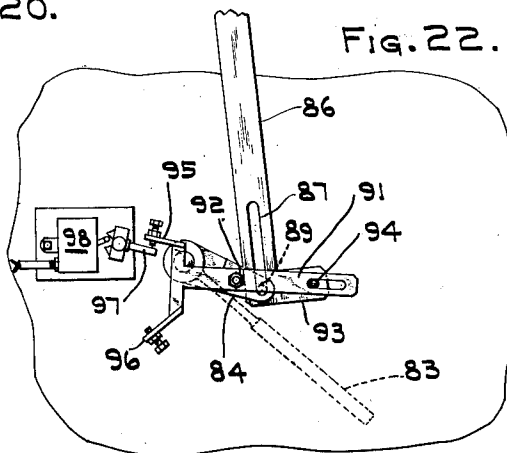


FIG. 22.

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UNITED STATES PATENT OFFICE

1,977,181

COMBUSTION APPARATUS

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Westinghouse Electric & Manufacturing Com-
pany, a corporation of Pennsylvania

Application July 27, 1931, Serial No. 553,443

27 Claims. (Cl. 110—165)

My invention relates to combustion apparatus and more particularly to that part which has to do with the disposal of ash, and it has for a broad object to provide apparatus of this character which is improved in form and arrangement and which operates in an effective and efficient manner.

In apparatus of this character heretofore known to me, it is the usual practice to provide relatively large ash pits which are disposed in ash receiving relation with respect to fuel burning structures and serve to store, over extended periods of time, the ash discharged from such structure. Usually, the ash is removed periodically from the ash pits to a final point of discharge. This latter may be effected either by mechanical or hydraulic means.

In my copending application, Serial No. 378,103, filed July 13, 1929 and assigned to the Westinghouse Electric and Manufacturing Company, I have disclosed and claimed an improved method and apparatus for removing ash from furnaces; the characteristic features of which are the provision of a water-filled ash pit disposed in ash-receiving relation with respect to a fuel burning structure and of means for periodically removing the ash and water from the pit, which latter includes high pressure jets which direct fluid against the ash during the removal period. The water within the pit acts as a vehicle for the ash and the jets assist in the removal by agitating and maintaining in suspension the ash within the water. In the specific embodiment disclosed in the prior copending application referred to, the jets emit water at high velocities which results in the additional function of maintaining the fluency of the mixture of ash and water during the discharge period.

The present application is in the nature of an improvement of the structure and method of operation disclosed in this prior copending application.

A more specific object of the present invention is to provide an improved mechanism for causing the several functions of the apparatus to be performed in their proper sequence.

A further object is to provide as a part of the apparatus an improved means for effectively conveying the ash and water to the final point of discharge.

A further object is to provide an improved actuating mechanism for initiating the operation of the disposal apparatus, which mechanism operates in response to a predetermined level of ash in the pit.

These and other objects are effected by my invention, as will be apparent from the following description and claims taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a longitudinal vertical sectional view taken on the line I—I of Fig. 3 and illustrating my improved apparatus for disposing of ash from fuel burning structures;

Fig. 2 is a horizontal sectional view of the structure shown in Fig. 1, showing the bottom of the pit and the several pipes and valves in plan, the section being taken on the line II—II of Fig. 1;

Fig. 3 is a transverse vertical section taken on the line III—III of Fig. 1 and illustrating in addition portions of a stoker-fired furnace;

Fig. 4 is a fragmentary horizontal sectional view taken on the line IV—IV of Fig. 3 and showing a vacuum-breaking and overflow device which also provides for sealing the pit against the infiltration of outside air;

Fig. 5 is an assembly view illustrating in elevation the pit and means for conveying the ash and water from the pit to the final point of discharge;

Fig. 6 is a sectional view through an ejector which serves as a means for forcing the ash coming from the pit through the sluice conduit to the final point of discharge;

Fig. 7 is a transverse sectional view taken on the line VII—VII of Fig. 6 and illustrating in end elevation the nozzles of the ejector;

Figs. 8 and 8a when taken together illustrate diagrammatically the salient features of my improved apparatus for disposing of ash. The figures appear on Sheets 4 and 5 of the drawings and in order to understand the apparatus, the two sheets should be placed together along their longitudinal edges with Sheet 4 at the top. Fig. 8b is a table disclosing the cycle of operation of the master control valve.

Fig. 9 is an enlarged vertical transverse sectional view illustrating my improved multi-port control valve for controlling the operation of certain parts of my apparatus;

Fig. 10 is a plan view illustrating the valve shown in Fig. 9;

Fig. 11 is a transverse sectional view taken on the line XI—XI of Fig. 9;

Fig. 12 is a transverse sectional view taken on the line XII—XII of Fig. 9;

Fig. 13 is a transverse sectional view taken on the line XIII—XIII of Fig. 9;

Fig. 14 is a transverse sectional view taken on the line XIV—XIV of Fig. 9;

Fig. 15 is a transverse sectional view taken on the line XV—XV of Fig. 9;

5 Fig. 16 is a detail elevational view of the movable portion of the valve shown in Fig. 9;

Fig. 17 is a developed view showing the exterior face of the movable portion shown in Fig. 16;

10 Fig. 18 is a fragmentary view illustrating mechanism operating in response to a predetermined level of ash within the pit for initiating the operation of the ash disposal system;

Fig. 19 is a view taken at right angles to Fig. 18;

15 Fig. 20 is a fragmentary plan view showing the lower portion of the mechanism shown in Fig. 18;

Fig. 21 is a fragmentary elevational view of the lower portion of Fig. 18 showing the position of the parts immediately after the operation of the mechanism; and,

20 Fig. 22 is a view similar to Fig. 21 illustrating the position of the parts before the ash pit becomes filled.

According to a preferred embodiment of my invention which is shown on the accompanying drawings, I provide a water-filled ash pit which is disposed in ash-receiving relation with respect to a fuel burning structure and is provided in the lower portion thereof with a discharge opening. I also provide, preferably in the lower portion of the pit, a plurality of jets arranged to direct streams of water at high velocity into the interior thereof so as to maintain the ash in suspension in the water during the discharge period and thereby to assist in the discharge of such ash. The jets also serve to refill the pit with water after a discharge period.

35 I also provide a final point of discharge, a closed conduit connecting the discharge opening of the pit with the final point of discharge, an ejector for forcing the ash and water, as it is discharged from the pit, through the conduit and to the final point of discharge, a first valve means for controlling the flow of water to the jets within the pit, a second valve means for controlling the flow of water and ash through the discharge opening, and a third valve means for controlling the flow of motivating water to the ejector.

40 I further provide a step-by-step mechanism for opening in sequence the third, (ejector), first (jet), and second (ash discharge opening) valve means, providing a predetermined dwell in the operation, and then closing in sequence the second (ash discharge opening), third (ejector), and first (jet) valve means. The step-by-step mechanism includes as a part thereof means operating in response to a predetermined level of ash for initiating the operation.

Referring now in detail to the construction illustrated and particularly in Figs. 1 to 7, inclusive, of the drawings, I have shown my invention as applied to a stoker-fired boiler furnace indicated by the reference numeral 10, such furnace including a clinker pit 11, and grinder rolls 12 disposed in the lower portion of the pit and operable to support and gradually remove the ash from the furnace.

50 An ash pit 13 is disposed beneath the clinker pit and receives the ash as it is discharged from the rolls. The pit 13 comprises upright end walls 14 and 15, side walls 16 and 17, and an inclined bottom wall 18. The side and end walls are formed as continuations of the walls of the clinker pit so as to prevent the infiltration of outside air. The side and end walls may be formed of any suitable material, for example, concrete,

and the side walls preferably diverge downwardly from the top to provide the maximum storage space for a given height of pit.

A discharge opening 19 is provided in the bottom wall of the pit at one end thereof, and a conduit 20 serves to conduct away the ash and water flowing through the discharge opening, as will appear more fully hereinafter.

I provide a plurality of water jets 21, 21 and 22, 22 for moving the ash toward the discharge opening, for agitating and maintaining the ash in suspension in the water, and for maintaining the fluency of the mixture of ash and water during a discharge period, thereby providing for the quick and effective discharge of the ash and water through the opening 19 and conduit 20. The jets 21, 21 and 22, 22 also serve to refill the pit with water after a discharge period.

The jets 21, 21 and 22, 22 may be disposed within any portion of the pit and directed to introduce water at any angle so long as the aforementioned functions are performed thereby. In the drawings, I have shown the jets 21, 21 as disposed within the end wall 14 which is most remote from the discharge opening and directed toward the discharge opening, and the jets 22, 22 as disposed within the bottom wall intermediate the ends thereof and also directed toward the discharge opening. An additional jet 28 is provided in the conduit 20 for the purpose of effectively removing the ash and water from beneath the discharge opening and thereby aid in preventing the clogging of the latter.

In order to relieve any vacuum condition which might be caused by the outrush of water and ash during a sluicing period, I provide a vacuum breaking device 23. (See Figs. 3 and 4.) The device 23 is in the form of a box casting 24 set in the wall 17 and having a partition 25 defining in the casting an inverted U-passage 26 opening at one end into the pit 13 and communicating at its other end with a pipe 27 under atmospheric pressure. The vacuum breaking device also provides an overflow for the pit and provides for a liquid seal when the water level is up to normal, thereby preventing the infiltration of outside air.

The bottom wall 18 of the pit may be constructed in any desired manner, the main requirement being that suitable provision be made for the complete emptying of the pit through the discharge opening. According to the embodiment shown on the drawings, the bottom wall is formed for the most part of cast iron sections 29 of unit size and extending from the side walls of the pit to the center thereof, cast iron being well adapted to withstand the abrasive action of the ash. A special cast iron section 30 is provided at the discharge end of the pit and the opening 19 is provided in this section. The sections 29 are held in position by wedges 31 placed between the adjacent ends of opposite sections.

The sections 29 are arranged in two groups as shown in Fig. 1, and the sections of one group which are disposed nearest the discharge opening 19 are at a lower level than those of the other group which are adjacent the end wall 14. This arrangement provides for the effective emptying of the pit and permits the arrangement of the nozzles 22, 22 intermediate the ends of the pit without necessitating the provision of special castings.

The special section 30 is preferably inclined or curved upwardly as indicated at 32, the purpose of which is to prevent the arching over of material adjacent the discharge opening. Due to

this construction, ash is not permitted to collect adjacent the discharge opening, for any ash which does not readily enter the discharge opening will be forced along the incline and away from the vicinity of such opening by the water issuing from the jets.

The several jets 21, 21, 22, 22, and 28 are supplied with water under pressure by branch pipes 34, 35, and 36, respectively, which are connected to a main pipe 33. Flow of water to the several jets is controlled by a single gate valve 37 within the pipe 33.

A sluice gate valve 38 in the conduit 20 serves to hold the water and ash within the pit during the storage period and permits such ash and water to flow out of the pit during the discharge period. The conduit 20 communicates with a sluice pipe 39, and the latter conducts the ash and water to a suitable final point of discharge which, as in the present instance, may be a well or sump 41 (see Figs. 5, 6, and 7).

Pumping means is provided for removing the ash and water from the pit 13 and forcing such ash and water through the sluice pipe 39 to the final point of discharge. This means may be any suitable apparatus for performing this function. Preferably, it is in the form of a water motivated ejector 43 comprising an entrainment chamber 44 communicating with the exhaust end of the conduit 20, one or more nozzles 45, 45 supplied with motivating water from a water box 46, and a diffuser 47 connected to the sluice pipe 39.

In reality, the conduit 20, entrainment chamber 44, diffuser 47, and sluice pipe 39 form a continuous closed conduit or pipe connecting the discharge opening 19 of the pit with the final point of discharge.

Water under pressure is supplied to the water box 46 from a pipe 48, and an ejector valve 49 controls the flow of the motivating water through such pipe.

Water under pressure is supplied to the pipe 48 by a suitable pump 50 operated by an electric motor 51. (See Figs. 8 and 8a.) The pipe 33 receives the supply of water under pressure from a pipe 52 which is connected to the pipe 48 at the pump side of the valve 49. A suitable pressure gauge 53 indicates the pressure of the water supply from the pump, the gauge being connected to a pipe 54 which is in turn connected to the pipe 52.

In addition to the functions already set forth for the jets 21, 21, 22, 22 and 28, it is to be observed that they also maintain the pipe 20 filled and thereby provide for keeping the ejector 43 primed with water during a discharge period, so as to insure the efficient operation of the ejector. This function is important should it be desired to remove the ash and refuse from a pit which has not been filled with water previous to a discharge period.

As has been pointed out, the pit 13 receives and stores for relatively long periods of time the ash discharged from the fuel burning structure, and during this period the pit is preferably maintained full of water. Periodically, the sluice gate 38 is opened and the ash and water is removed through the discharge opening 19, and conveyed to a final point of discharge by the ejector 43. The water in the pit provides a vehicle for the ash and the water and the jets assist in the removal in the manner hereinbefore stated. After the pit is emptied, the jets may be used to refill the pit with water.

The cycle of operation is best carried out by opening the valves 49, 37, and 38 in sequence, providing a predetermined dwell so as to permit the pit to be emptied, and then closing the valves 38, 49, and 37 in sequence. The valve 49 is opened first so as to be sure that the sluice pipe is free of obstructions and to provide for the proper transfer of the material when the sluice gate is opened. The valve 37 is opened before the sluice gate valve so as to stir the ash and water in the pit and permit the mixture to readily flow out of the pit and also to prime the ejector the moment the valve 38 is opened. These conditions having been satisfied, the ash and water will be quickly removed to the sump upon the opening of the sluice gate valve 38. The valve 49 is closed after the valve 38 so as to clean the system of all ash. The valve 37 is closed last because the jets in the pit serve to refill the pit with water. It is to be observed at this point that should it be desired not to use a water-filled pit for receiving the ash, or should means other than the pit nozzles be used to fill the pit with water, the valve 37 may be closed at any time after the ash is removed from the pit and ash pipe.

I provide an improved step-by-step mechanism for effecting the cycle of operation outlined above, which mechanism includes as a part thereof means operating in response to a predetermined level of ash in the pit for initiating its operation. The mechanism may be operated either automatically or by hand. In either event, provision is made whereby any step in the cycle of operation cannot be performed until the preceding step has been completed. The system also includes indicating mechanism for informing the operator at all times of the position of the several elements of the apparatus and of the particular step in the cycle which is being performed.

The step-by-step mechanism includes an ash level responsive device 60 illustrated diagrammatically in Fig. 8a and in detail in Figs. 18 to 22, inclusive; a servo motor 61 for operating the valve 37 and including a cylinder 62 and piston 63; a servo-motor 64 for operating the sluice gate valve 38 and including a cylinder 65 and piston 66; a servo-motor 67 for operating the ejector valve 49 and including a cylinder 68 and piston 69; a multi-port master selector valve 70 for controlling the flow of fluid to and exhaust from the several servo motors, pipes 71 and 72 connecting the valve 70 with the servo-motor 61 at opposite sides of the piston 63, pipes 73 and 74 connecting in a like manner the valve 70 and servo-motor 64, and pipes 75 and 76 connecting the valve 70 and servo-motor 67; and an electrical system providing for either the automatic or hand operation of the valve 70.

Referring particularly to Figs. 1, 3, and 18 to 22, inclusive, the ash level responsive device 60 includes a rocker shaft 80 extending longitudinally of the upper portions of the pit and at one side thereof and is carried by journal bearings 81 and 82 in the end walls 14 and 15, respectively. The device also includes paddles or ash contacting members 83 fixed at one of their ends to the shaft 80 and extending laterally from the latter. A lever arm 84 is disposed exteriorly of the pit and is fixed at one of its ends to an extension 85 of the shaft 80. An L-shaped operating link 86 is connected by a lost motion connection with the outer end of the lever arm 84, such lost motion connection consisting of a longitudinally-extending slot 87 in the link 86 receiving a pin 89 extending through and fixed to a bifurcated outer

end 90 of the lever arm 84. A switch actuating lever 91 is fulcrumed intermediate its ends on a pin 92 carried by the mid portions of the arm 84, and is operatively connected to the outer end 5 of a foot portion 93 of the L-shaped link 86 by a pin and slot connection 94. The lever 91 is provided at the end opposite to the connection 94 with spaced fingers 95 and 96 which are adapted to actuate a switch operating element 97 of an 10 electric switch 98. The fingers 95 and 96 are adapted to engage respectively opposite sides of the element 97 and move the latter to its off and on position.

Figs. 18, 19, and 20 show the relative position 15 of the parts when the ash has reached the predetermined level and just before the switch 98 is closed; Fig. 21 shows the position of the parts after the switch has been closed; and Fig. 22 indicates the position of the parts before the ash 20 pit is filled and with the switch 98 in open position.

The operating arm 86 may be reciprocated by any desired means such for example as an operating part of the fuel burning structure, or by a 25 separate motor reduction gear set. Preferably, the link 86 is reciprocated by the mechanism which drives the clinker grinder rolls 12. The upper end of the link 86 is connected to an operating arm 99, which in turn is operated by a rod 30 100 driven from any suitable source of power.

During the time the pit is being filled with ash, and before the paddles 83 contact with the ash, the paddles 83, by reason of their weight and their rigid connection with shaft 80 and the rigid connection between the latter and the arm 84, cause 35 the pin 89 to engage the bottom of the slot 87. Thus, when the arm 86 is moved up and down due to the action of the lever 99, the paddles 83 move up and down. The parts are shown in Fig. 22 as being in the extreme down position of their movement. One of the paddles 83 appears in dotted 40 lines. The element 97 is shown in its down or off position and cannot be engaged by the fingers 95 and 96.

As the level of the ash nears the predetermined point, the paddles 83 in moving downward engage the body of ash and stop, and the lost motion connection 87, 89 permits the link 86 to continue 50 its downward movement until the lower extent of its travel has been reached. Thus, the magnitude of movement of the paddles 83 and arm 84 becomes less and less as the ash nears the predetermined level and eventually the pin 89 is held at such a height that the bottom of the slot 87 can impart 55 very little if any upward movement to the pin 89 and arm 84.

As the ash is nearing the predetermined level and the extent of downward movement of the arm 84 is being limited by the engagement of the paddles 83 with the rising body of ash, further downward movement of the arm 86, after the paddles engage the ash, results in the foot 93 moving the lever 91 about its fulcrum 92 in a clockwise direction. The fulcrum pin 92 assumes higher and higher positions along with the arm 84 and paddles 83 and eventually will reach a point where 60 a down-stroke of the link 86 will cause the foot 93 to impart sufficient movement to the lever 91 to cause the finger 96 to engage the underside of the element 97 and close the switch 98. Fig. 18 shows the position of the parts when the pit is full of ash and the link 86 is half way down in its stroke. Fig. 21 shows the same condition with 65 the link 86 at its lowermost position. The ele-

ment 97 has just been moved up and the switch closed.

The closing of the switch 98 initiates the operation of the step-by-step mechanism and thereby causes the valves 37, 38 and 49 to be operated in 80 their proper order and empty the pit of ash and water.

As the ash moves out of the pit, the weight of the paddles 83 causes the latter and the arm 84 to move downwardly, until the pin 89 again engages the bottom of the slot 87. If the link 86 is at the lower end of its travel when the ash moves out of the pit, downward movement of the paddles 83 and arm 84 will also cause the pin 92 to move the lever 91 in a counter-clockwise 85 direction about the pin and slot connection 94, which will result in the finger 95 engaging the element 97 and opening the switch 98. If the link 86 is not at the lower end of its travel when the ash moves out of the pit, the switch 98 will remain closed until the link 86 moves downward sufficiently to permit the weight of the paddle 83 to act on the arm 84 and lever 91 to open the switch in the manner just explained. The parts are thus placed in position to be actuated when 90 the pit again becomes full of ash.

The multi-port master selector valve 70 is indicated diagrammatically in Fig. 8a and in detail in Figs. 9 to 17, inclusive. The valve is of the plug type and comprises a valve body 101 and a 95 rotatable hollow plug 102 having an upper operating portion 103 extending through an opening 104 in a cover 105 and connected to an operating shaft 106.

Shims 107 are disposed between the bottom of 100 the plug and the valve body to provide proper spacing for the plug and to prevent it from binding while turning. A thrust ball bearing 108 is provided between the top of the plug and the cover 105 to assure ease of operation in case the 105 plug becomes unbalanced due to unequal areas of ports and chambers.

The spaces above and below the plug are at all times connected to a drain pipe 109 so as to prevent the building up of pressure against the 120 ends of the plug. The drain 109 is connected directly to the space below the plug and is connected to the space above the plug by a passage 110 extending through the center thereof.

The plug is hollow as indicated at 111 and water 125 under high pressure flows into the interior during the time the pump 50 is operating. The outside of the plug is cut away to provide an annular space 112, and openings 113 in the plug connect the space 112 with the interior space 111. A pipe 130 114 connects the annular space 112 with the pipe 48 which contains water under pressure. (See Figs. 9, 15, 16, and 17.)

The pipes 71, 72, 73, 74, 75, and 76 connect at the proper times with the interior 111 by means 135 of openings 115, 116, and 117 in the plug. The pipes 73 and 74 which control the servo-motor 64 are connected to the valve body 101 in the same transverse plane and communicate at the proper time with the interior 111, of the plug, 140 through the opening 115. (See Fig. 11.) The pipes 71 and 75 connect into the valve in the same plane and communicate when in the proper position with the interior 111 by means of the openings 116. (See Fig. 12.) Pipes 72 and 76 145 connect into the valve in the same plane and communicate with the interior by the openings 117. (See Fig. 14.) Figure 17 is a developed view of the exterior face of the plug 102, and the pipes 71 to 76, inclusive, 119 and 114 are indicated in 150

dot and dash lines and occupy the same relative positions with respect to the plug as is shown in Figs. 9 to 15, inclusive.

Except for the space 112, for the metal around the openings 115, 116, and 117, and for sufficient metal to provide a proper bearing surface; the exterior face of the plug 102 is cut away as indicated at 118 to provide passages to conduct exhaust water from the pipes 71, 72, 73, 74, 75, and 76 to an exhaust pipe 119. The pipe 119 is at all times in communication with the cut-away portion or exhaust space 118.

The plug 102 is moved in steps and in a clockwise direction as viewed in Figs. 11 to 15, inclusive. There are eight positions to the valve or one for every 45° of each revolution. During each revolution of the valve the interior space 111 and the exhaust space 118, come into communication with the different sides of the pistons 63, 66, and 69 and effect the sequential opening and closing of the valves 37, 38, and 49, the sluicing of the ashes from the pit 13, and the refilling of such pit with water.

In the drawings, the parts are shown in the first or 0° position. The pipe 71 is under pressure and 72 is under exhaust, hence the valve 37 is in closed position. The pipes 73 and 74 are both in communication with the exhaust and the valve 38 is in closed position. The pipe 75 is under pressure and 76 is under exhaust, and the valve 49 therefore is in closed position. (See also Figs. 8, 8a and 8b.)

Should the valve be moved to the second position or 45° from the position shown in the drawings, no change will take place as the pipes 71, 72, 73, 74, 75, and 76 will still communicate with the pressure and exhaust in the same manner as in the first position. The purpose of having two identical positions will appear more fully hereinafter.

Upon rotating the plug 102 to the third position or 90° from the position in the drawings, the pipe 71 is still under pressure, and the pipe 72 under exhaust, hence the valve 37 remains closed. The pipes 73 and 74 are both still under exhaust and the valve 38 remains closed. However, the pipe 76 now is under pressure and the pipe 75 under exhaust, which causes the servo-motor 67 to open the valve 49 and admit water under pressure to the ejector 43.

Upon a rotation of the plug 102 to the fourth position or 135° from the position shown in the drawings, the pipe 71 is connected to the exhaust space 118, and the pipe 72 is connected to the pressure space 111; therefore, the servo-motor 61 operates to open the valve 37 and admit water under pressure to the pit nozzles 21, 21, 22, 22, and 28. The pipes 73 and 74 are still under exhaust and the sluice gate valve 38 is therefore still in closed position. The pipe 76 is still under pressure and the pipe 75 under exhaust; hence, the ejector valve 49 is still in open position and the ejector is operating.

For the fifth position of the valve or 180° from the position shown in the drawings, the pipe 72 is still under pressure and the pipe 71 under exhaust. Hence, the pit nozzles are still open. Also, the pipe 76 is still under pressure and the pipe 75 is under exhaust and the ejector valve 49 is in open position. For this position, the pipe 73 is placed under pressure and the pipe 74 under exhaust. Hence, the servo-motor 64 operates to open the sluice gate valve 38 and permit the water and ash in the pit to flow out.

When the valve is in its sixth position or 225°

from the position shown on the drawings, the pipes 71 and 75 are still under exhaust and pipes 72 and 76 under pressure. Hence, the valves 37 and 49 are still open. In this position, the pipe 73 is changed to exhaust and the pipe 74 to pressure and the servo-motor 64 therefore operates to close the sluice gate valve 38.

In the seventh position of the valve or 270° from the position shown, the pipes 73 and 74 are both under exhaust and the valve 38 therefore remains in closed position. The pipe 72 is still under pressure and 71 is still under exhaust and hence the valve 37 remains in open position. For this position, the pipe 75 is placed under pressure and the pipe 76 under exhaust and the ejector valve 49 is closed.

For the eighth position of the valve or 315° from the position shown, the pipes 73 and 74 are still under exhaust and the sluice gate valve 38 remains closed. The pipe 75 is still under pressure and 76 under exhaust and the ejector valve 49 remains closed. In this position, the pipe 71 is changed to pressure and 72 to exhaust, and, as a result, the pit nozzle valve 37 closes. The valve is then rotated another 45° to the zero degree position and the parts are as shown in the drawings and as described above.

The table shown in Fig. 8b summarizes the above described cycle of operation of the control valve 70. From the table, it can be readily determined, for any given position of the valve, whether or not the pipes 71 to 76, inclusive, are in communication either with the pressure pipe 114 or the exhaust pipe 119.

While I have described a hydraulic system for securing sequential operation of the ejector, pit nozzle, and sluice gate valves in opening and of the gate, ejector, and pit nozzle valves in closing, it is to be understood that any suitable means may be employed to secure these sequences of opening and closing of valves. Preferably, the master valve 70 is operated in the manner pointed out by means of an electrical system which may be controlled either automatically or by hand, and this system provides for preventing any step being performed until the proper preceding step has been completed. I also provide an indicating mechanism for showing the condition of operation. The indicating mechanism preferably incorporates a multiplicity of lamps, lamps 120, and 121 indicating, respectively, closure of the sluice gate valve 38 and the pit nozzle valve 37; lamp 122 indicating that ejector valve is closed and float switch 123 is closed, the latter being dependent upon the pit being full of water; lamp 124 indicating the closure of the ash level switch 98 and float switch 125, the latter being also dependent upon the pit being full of water; lamp 126 indicating that the ash level switch is closed; lamp 127 indicating the proper fluid or pump pressure to secure evacuation; lamps 128 and 129 indicating respectively the opening of the ejector valve 49, the pit nozzle valve 37; and lamp 130 indicating that a predetermined time provided for the evacuation of the ash and water from the pit has elapsed, and the sluice gate valve 38 should be closed.

The master valve 70 is turned in the step-by-step manner indicated by means of an electric motor 131 driving a bevel pinion 132 engaging a bevel gear 133 carried by a shaft 134, the latter being arranged to be connected by a clutch 135 to a pinion 136 meshing with a gear 137 on the shaft 106, which is connected to the plug 102 of the master valve 70. The shaft 106 also drives

a drum 138 having contact segments 139, 140, 141, 142, 143, 144, 145 and 146, thereon for engagement with stationary fingers 147, 148, 149, 150, 151, 152, 153 and 154, respectively, in order to establish circuits through the motor from the positive side 155 to the negative side 156 of the supply for step-by-step operation of the motor 131, the motor coming to a stop with interruption of a circuit by a contact segment being disengaged from its finger and the next contact segment being engaged with its corresponding finger so as to establish another circuit through the motor upon the happening of a subsequent event, such as, operation of one of the valves referred to. Incidental to the establishment of circuits for the motor 131 in order to secure the desired operation of the master valve, indicator circuits are also established through the lamps so that the lamps may give a visual indication of the operation or the condition of operation of the apparatus. It will be noted that all of the segmental contacts on the drum 138 are connected in series and to an annular strip or contact 157 engaging the contact finger 158 of the lead 159 going to the motor 131. Hence, if any of the segmental contacts engages a finger and the finger should be connected to the positive side 155 of the supply line, current will be supplied to the motor 131 for operating the latter, the motor having a lead 160 connected to the negative side 156 of the supply line.

In Fig. 8, the commutator drum 131 is shown in the first position, in which position the master valve is arranged to supply fluid under pressure to the pipes 71 and 75 to maintain the pit nozzle and ejector valves, respectively, closed and the segment 146 engages the finger 154. When the ash switch 98 closes, provided that the float switch 125 is closed, the positive side 155 of the supply line is connected to the negative through the motor and the motor turns until contact of the segment 146 with the finger 154 is broken. Also, with closure of the pit switch 98 and the float switch 125, circuits are completed through the lamps 124 and 126, the latter indicating closure of such switches. The motor turns the master valve and drum 45° until the contact of segment 146 with finger 154 is broken and segment 143 is engaged with finger 151 when the drum and master valve will be in the second, or 45°, position.

During the first 45° movement, or movement from first to second position, of the drum, a segment 161 of the drum engages a finger 162 completing a circuit through a lead 163 and relay 164 to the negative side 156 of the supply, whereby the relay is energized to close a shunt circuit, made up of leads 165 and 166 to energize a solenoid 167 to close the pump motor switch 168, whereupon the motor 51 drives the pump 50 to build up water pressure in the conduit 48 and to supply water thereto for the purposes herein pointed out.

With the drum in the second, or 45°, position and the segment 143 and the finger 151 engaging and with building up of water pressure sufficient to actuate a pressure-responsive device 169 to close a switch 170, a circuit is again completed through the motor to turn the drum and master valve a further 45° to the third, or 90°, position. When the switch 170 is closed, the circuit is completed through 170a to the contact 151 and through 170b to the lamp 127 to indicate that the water pressure has been built up.

When the third, or 90°, position is attained,

the motor circuit is interrupted by the disengagement of the segment 143 and the finger 151. The segment 142 and finger 150 engage, and in this position the master valve 70 supplies pressure through the pipe 76 to operate the servo-motor 67 to open the ejector valve 49 to supply water to the ejector 43. As the valve 49 is opened, switch 171 is opened to break the circuit, including the lead 172, float switch 123 and leads 173 and 174, for the lamp 122 (indicating closure of ejector valve and that pit is full of water).

With the drum and valve in the 90° position, the ejector 43 is in operation, and the segment 142 and finger 150 are engaging. Complete opening of the ejector valve closes the switch 175 to complete a circuit from the positive side 155 of the supply through the pressure closed switch 170, leads 170a, 176 and 177, the finger 150 and segment 142, the motor 131 to the negative side 156 of the supply and also through lead 177a to the light 128. The motor then moves the master valve 70 and the drum a further step of 45° to the fourth, or 135° position, whereupon the motor circuit is broken by segment 142 and finger 150 disengaging with engagement of segment 145 and finger 153.

With the master valve 70 in the fourth, or 135° position, pressure is supplied to the pipes 72 and 76, the pressure to the pipe 76 maintaining the ejector valve open and the pressure supplied to the pipe 72 operating the servo-motor 61 to open the pit nozzle valve 37. As the latter valve opens, the circuit for the lamp 121, indicating closure of the valve, is broken by opening of the switch 178, such circuit including the switch 178 and leads 179 and 180. With the valve 37 fully open, the switch 181 for the circuit of the indicating lamp 129 is closed, the latter circuit being traced as follows: from the positive side of supply 155 through the switch 181, lead 182, and the lead 183.

Closure of the switch 181 completes the circuit for the motor 131 through the segment 145 and the finger 153 and the master valve 70 and the drum are advanced a further 45° to the fifth, or 180°, position, until the segment 145 and the finger 153 disengage and the segment 140 and the finger 148 engage. In this position of the master valve, fluid under pressure is supplied to the pipes 72 and 76 to maintain the ejector and pit nozzle valves 49 and 37, respectively, open and to the pipe 73 for motivating the servo-motor 64 to open the sluice gate valve 38.

As the sluice gate valve 38 is opened, switch 184 is opened to break the circuit for lamp 120 used to indicate closure of such valve. With the sluice gate valve open, the switch 185 is closed, completing a circuit from the positive side of the supply 155, through the lead 186 and heating element 187 to the negative side 156. Heat from the element 187 expands a bimetallic switch element 188 to close a switch 189, whereupon the circuit for the motor 131 will be completed through the finger 148 and the segment 140, already engaged, to operate the motor for a further step of 45°, this continuing until the segment 140 and the finger 148 disengage and the segment 139 and the finger 147 engage, at which time the master valve 70 and the drum will be in the sixth, or 225°, position. With completion of the circuit for the motor by closure of the thermal switch, a parallel circuit is also established through the lead 190 and the lamp 130. The thermal switch provides for an interval sufficiently long to secure evacuation of the pit; and, with

elapsing of such interval, the switch 189 is closed and, current is supplied directly from the positive side of the line 155, through lead 191, and the finger 148 and the segmental contact 140 to energize the motor 131 for a further step of operation to bring about closure of the ash sluice gate valve 38. It will, therefore, be clear that sufficient time should be allowed, to provide for pit evacuation, as the step of opening of the ash sluice gate valve 38 is followed by the step of closing of such valve.

With the master valve 70 in the sixth, or 225°, position, pressure is supplied through the pipes 72 and 76 to maintain the pit nozzle and ejector valves open and through the pipe 76 to close the ash sluice gate valve, opening switch 185 and the circuit for the lamp 130 is broken. The switch 184 is closed to complete the motor circuit from the positive side 155, through the lead 192 and the engaged segment 139 and finger 147 and to complete the circuit through lead 193 for the lamp 120, indicating closure of the gate valve. The motor moves the master valve a further 45° to the seventh, or 270°, position, the segment 139 and the finger 147 disengaging and the segment 141 and the finger 149 engaging.

In the seventh position, the master valve supplies fluid to the pipe 72 to hold the pit nozzle valve 37 open and to the pipe 75 to operate the servo-motor 67 to close the ejector valve 49. As the ejector valve 49 is closed, the switch 175 is opened, thereby opening the circuit of the lamp 128, which, when illuminated, indicates that the ejector valve 49 is open. With closure of the valve 49, the switch 171 is closed, completing a motor circuit from the positive side 155, lead 172, float switch 123, lead 173 and the segment 141 and the finger 149 already engaged and a circuit through lead 174 to lamp 122 indicating closure of the ejector valve. As the float switch 123 is in series with the switch 171, neither the motor nor the lamp circuits just mentioned can be completed until a predetermined water level is attained in the pit. With completion of this current flows through the motor circuit, and the motor turns the drum and the master valve a further 45° to the eighth, or 315°, position when the segment 141 and the finger 149 are disengaged and the segment 144 and the finger 152 are engaged.

In the eighth position, the master valve supplies fluid under pressure by the pipe 71 to the servo-motor 61 to close the pit nozzle valve 37, the switch 181 of the lamp 129 (indicating pit nozzle valve open) circuit being opened and the switch 178 closing to establish motor and lamp circuits through the engaged segment 144 and finger 152 and the lamp 121 (indicating pit nozzle valve closed and water at desired level in pit). The motor now operates to turn the master valve and drum a further 45° to the starting, or 360°, position, disengaging the segment 144 and finger 152 and reengaging segment 146 and finger 154. During this movement, segment 194 engages the finger 195, permitting current to flow through conductor 196 for operating a relay 197 for closing a shunt circuit formed by the leads 198 and 199 for energizing a solenoid 200 to open the pump motor switch 168, whereupon the system will be in normal condition of inactivity between evacuating intervals with all valves closed, the pit full of water, and the pump 51 stopped.

I also provide a float responsive safety device 216 which operates to close simultaneously switches 217 and 218. The provision of the de-

vice 216 is merely a safety measure. The device is constructed to close the switches in case the water in the pit reaches a predetermined high level. This condition might arise due to an unforeseen difficulty in the operation, for example, it would arise should the nozzles 21, 22, 22 and 28 be admitting water to the pit and either the opening 19, pipe 20 or sluice pipe 39 be clogged up.

When the switch 218 is closed current will flow therethrough from the positive conductor 155 to a conductor 219 and one side of a signal horn 220, the other side of the horn being connected to the negative conductor 156.

When the switch 217 is closed current will flow therethrough from the positive conductor 155 to a conductor 221 which is connected to conductor 196. As the latter is connected to the relay 197, current flowing therethrough from the conductor 221 will cause such relay to close and thereby close the shunt circuit formed by the conductors 198 and 199 and energize the solenoid 200 and open the motor switch 168, thereby stopping the motor 51.

I also provide a pair of hand operated switches 222 and 223 which operate respectively to start and stop the motor 51. One side of the switch 222 is connected to the positive conductor 155 and the other side is connected by a conductor 224 to the relay 164. One side of the hand operated switch 223 is connected to the positive conductor 155 and the other side thereof is connected by conductor 225 to the relay 197 for stopping the motor.

In addition to the several lights for indicating the several steps in the cycle of operation, an indicating pointer 201 is keyed to the upper end of the shaft 106 and rotates with the drum 138 and master valve 70 to inform the operator of the exact position of the latter parts.

I also provide a means for operating the system by hand, and the latter also includes the feature of not permitting any step to be performed until the preceding step has been effected. The difference between the hand-operated system and the full automatic system just described is that instead of having a motor to turn the drum controller 138, indicator 201, and multiport master valve 70, I rotate these parts by hand.

As shown, a hand crank 230 is fixed to the upper end of an operating shaft 231, and the latter is connected to the pinion 136 by a disconnectible clutch 232, the arrangement being such that when the clutch 232 is in engagement the clutch 135 is out of engagement and vice versa. A hand-operated lever 233 serves to engage and disengage the clutches 232 and 135.

A switch 202 is a double throw switch and is also operated by the clutch operating lever 233. When the lever 233 is in the position shown in the drawings the negative conductor 156 is in contact with the conductor 160 leading to the motor. When the lever 233 is operated to engage the clutch 232, the switch 202 is operated to open the connection to the motor and to connect the negative conductor 156 by means other than the motor with the conductor 159 leading to the drum controller. The latter connection is effected by a conductor 234 connecting the switch 202 with one side of a cam operated switch 235, a conductor 236 connecting the other side of the cam switch with one side of a solenoid operated interlock 237, and a conductor 238 connecting the other side of the interlock with the conductor 159.

The solenoid interlock includes coil 239 and core 240 having an extension adapted when in one posi-

tion to extend into the path of an arm 241 fixed to the shaft 231 and thereby prevent rotation of the shaft past the extension of the core. A spring 242 acts to hold the core in the latter position when the current is off. When the current is on, the core is withdrawn from the path of the arm 241 against the action of the spring, and the shaft is permitted to be rotated.

The arrangement is such that with the crank 230 in the position shown on the drawings the cam switch 235 is closed and the interlock in engagement. When current flows to one of the segments 139 to 146 inclusive on the drum in the manner previously described in connection with the automatic operation, such current will energize the solenoid 237 and disengage the interlock, thus permitting the operator to rotate the crank a full revolution, which operation rotates the drum 138 and valve 70 one eighth of a turn. Rotation of the shaft causes the cam-operated switch 235 to open and breaks the control circuit, thereby permitting the spring to act on the core 240 and cause the end thereof to again extend into the path of the arm 241 on the shaft. When the crank has completed its revolution and further movement is prevented by the interlock, it is in position for the next succeeding step in the operation.

A ratchet wheel 243 keyed to the shaft 231 and a pivoted detent 244 engaging such wheel, serve to prevent the shaft 231 from being turned backwards.

It will thus be seen that I have provided an improved apparatus for disposing of the ash discharged by fuel burning structures. As stated, the apparatus is in the form of a closed system comprising the pit 13, nozzles 21, 21, 22, 22, and 28, pipe 20, ejector 43, and sluice pipe 39, and thereby provides an effective and efficient means for disposing of the ash periodically and in a relatively short period of time. Also, the improved step-by-step mechanism which may be either motor or hand operated, provides for the performance of the several steps in the cycle of operation in the proper sequence.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications, without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. In combustion apparatus, the combination of a fuel-burning structure; a water-filled ash pit for receiving the ash from the fuel-burning structure and having a discharge opening in the lower portion thereof; valve means for opening and closing the discharge opening; means dependent upon a predetermined level of ash within the pit to provide for the opening of the valve means and for the removal of the ash and water from the pit; and means for refilling the ash pit with water.

2. In combustion apparatus, the combination of a fuel-burning structure; a water-filled ash pit for receiving the ash from the fuel-burning structure and having a discharge opening in the lower portion thereof; valve means for opening and closing the discharge opening; means responsive to a predetermined level of ash within the pit for opening the valve means so as to permit the water and ash to flow through the discharge opening; and means for directing jets of water into the pit during the time the valve means is

open so as to agitate the ash and water and maintain the fluency of the mixture; and means for refilling the ash pit with water.

3. In combustion apparatus, the combination of a fuel-burning structure; a water-filled ash pit for receiving over a period of time ash and refuse from the fuel-burning structure and having a discharge opening in the lower portion thereof; a final point of discharge; conduit means connecting the ash pit with the final point of discharge; valve means controlling the flow of ash and water through the discharge opening into the conduit means; means responsive to a predetermined level of ash within the pit for opening the valve means and permitting the ash and water to flow out of the pit into the conduit means; and means for maintaining a stream of water within the conduit means during the time the valve means is open for conveying the ash along the conduit means to the final point of discharge.

4. In combustion apparatus, the combination of a fuel-burning structure; a water-filled ash pit for receiving over a period of time ash and refuse from the fuel-burning structure and having a discharge opening in the lower portion thereof; a final point of discharge; a pipe connecting the ash pit with the final point of discharge; a valve for controlling the flow of ash and water through the ash-discharge opening into the pipe; means responsive to a predetermined level of ash in the pit for opening the valve; and means providing a high velocity stream of water in the pipe when the valve is open for conveying the ash through the pipe to the final point of discharge.

5. The combination with fuel-burning apparatus and a storage pit disposed to receive the ash and refuse as it is discharged from such structure; of means for removing such ash and refuse from the pit and comprising a discharge pipe opening at one end into the lower portion of the pit, an ejector in the pipe for effecting translation of the ash, and means for supplying water to the interior of the pit during the operation of the ejector, whereby the portion of the pipe between the ejector and the pit is maintained filled with water and the ejector is kept primed.

6. The combination with fuel-burning apparatus and a storage pit disposed to receive the ash and refuse as it is discharged from such structure; of means for removing such ash and refuse from the pit and comprising a discharge pipe opening at one end into the lower portion of the pit, an ejector in the pipe for effecting translation of the ash, and water-jet means within the pit and operable while the ejector is operating to move the ash toward the inlet end of the pipe and to maintain such inlet end and that portion of the pipe which is between the pit and ejector filled with water, whereby the ejector is kept primed.

7. The combination with fuel burning apparatus and a storage pit disposed to receive the ash and refuse as it is discharged from such structure; of means responsive to a predetermined level of ash and refuse in the pit for removing such ash and refuse from the pit and comprising a discharge pipe opening at one end into the lower portion of the pit, an ejector in the pipe for effecting translation of the ash, and means for supplying water to the interior of the pit during the operation of the ejector, whereby the portion of the pipe between the ejector and the pit is maintained filled with water and the ejector kept primed.

8. In combustion apparatus, the combination of a fuel-burning structure; an ash pit disposed to receive the ash and refuse from the fuel-burning structure and having a discharge opening in the lower portion thereof; means for filling the pit with water; means for periodically removing the ash and water from the pit including pumping means having its inlet communicating with the discharge opening of the pit; and means operable during the removal period for agitating the ash within the pit and for keeping the inlet to the pumping means flooded with water.

9. In combustion apparatus, the combination of a fuel-burning structure; a pit connected to the fuel-burning structure in an air-tight manner and operative to receive and store for a relatively long period of time the ash or refuse discharged from the fuel-burning structure; means for maintaining a body of water within the pit during the storage period; means for removing the ash and water from the pit in a relatively short period of time and including pumping means having its inlet communicating with the ash storage pit in an air-tight manner; and means within the pit and operable during the removal period for agitating the ash within the pit and for keeping the inlet of the pumping means flooded with water.

10. In combustion apparatus, the combination of a fuel-burning structure; a storage pit disposed to receive the ash or refuse from the fuel-burning structure and having a discharge opening in the lower portion thereof; a final point of discharge; a pipe connecting the discharge outlet and the final point of discharge; pumping means for removing in a relatively short period of time the ash from the lower portion of the pit and for forcing such ash through the pipe; means for maintaining a body of water in the pit when the pumping means is not operating and for agitating the ash and maintaining the inlet of the pumping means flooded when the latter is operating.

11. In combustion apparatus, the combination of a fuel burning structure; an ash pit for receiving ash as it is discharged from such structure; liquid jet means within the pit; valve means controlling the flow of liquid to such jet means; a final point of discharge; conduit means providing communication between the lower portion of the pit and the final point of discharge; means providing for the translation of ash through the conduit means; a second valve means controlling the flow of ash from the pit and into said conduit means; and means providing for the opening in sequence of said first and second valve means; and means for closing both of said valve means after the ash has been removed from the pit.

12. In combustion apparatus, the combination of a fuel burning structure; an ash pit for receiving ash as it is discharged from such structure; liquid jet means within the pit; valve means controlling the flow of liquid to such jet means; a final point of discharge; conduit means providing communication between the lower portion of the pit and the final point of discharge; means providing for the translation of ash through the conduit means; a second valve means controlling the flow of ash from the pit and into said conduit means; and means providing for the opening in sequence of said first and second valve means, said means operating in response to a predetermined level of ash in the pit; and means for closing both of said valve means after the ash has been removed from the pit.

13. In combustion apparatus, the combination of a fuel burning structure; an ash pit for receiving ash as it is discharged from such structure; liquid jet means within the pit; valve means controlling the flow of liquid to such jet means; a final point of discharge; conduit means providing communication between the lower portion of the pit and the final point of discharge; a second valve means for controlling the flow of ash from the pit; liquid jet means in the conduit means providing for the movement of ash there-through; a third valve means controlling the flow of liquid to the last-named jet means; and means providing for the opening in sequence of said third, first and second valve means; and means for closing the several valve means after the ash has been removed from the pit.

14. In combustion apparatus, the combination of a fuel burning structure; an ash pit for receiving ash as it is discharged from such structure; liquid jet means within the pit; valve means controlling the flow of liquid to such jet means; a final point of discharge; conduit means providing communication between the lower portion of the pit and the final point of discharge; a second valve means for controlling the flow of ash from the pit; a water-motivated ejector in the conduit means and providing for the translation of ash from the pit to the final point of discharge; a third valve means controlling the supply of motivating water to the ejector; and means providing for the opening in sequence of said third, first and second valve means; and means for closing the valve means after a discharge period.

15. The combination with combustion apparatus having a refuse pit provided with discharge means; of first valve means for operating the discharge means; jet means arranged in the lower portion of the pit to secure agitation therein and to assist in the discharge; second valve means for supplying or shutting off water to the jet means; step-by-step mechanism for opening in sequence the second and first valve means followed by a predetermined dwell and then to close in sequence the first and second valve means; and means responsive to the level of ash in the pit to initiate operation of said mechanism.

16. The combination with combustion apparatus having a refuse pit provided with discharge means; of first valve means for operating the discharge means; jet means arranged in the lower portion of the pit to secure agitation therein and to assist in the discharge; second valve means for supplying or shutting off water to the jet means; step-by-step mechanism for opening in sequence the second and first valve means followed by a predetermined dwell and then to close in sequence the first and second valve means; means responsive to the level of ash in the pit to initiate operation of said mechanism; and means for indicating the several positions of the step-by-step mechanism.

17. In combustion apparatus, the combination of a fuel burning structure; an ash pit for receiving and storing the ash as it is discharged from such structure; fluid jet means within the pit; valve means controlling the flow of fluid to such jet means; a final point of discharge; conduit means providing communication between the lower portion of the pit and the final point of discharge; a second valve means for controlling the flow of ash through such conduit; an ejector in said conduit between the second-named valve means and the final point of discharge; means for supplying motivating fluid to the ejector; a

third valve means controlling the flow of motivating fluid to said ejector; and means providing for the opening of the third, first, and second valve means in sequence and for closing of the second, third, and first valve means in sequence.

18. In combustion apparatus, the combination of a fuel burning structure; an ash pit for receiving and storing the ash as it is discharged from such structure; fluid jet means within the pit; valve means controlling the flow of fluid to such jet means; a final point of discharge; conduit means providing communication between the lower portion of the pit and the final point of discharge; a second valve means for controlling the flow of ash through such conduit; an ejector in said conduit between the second-named valve means and the final point of discharge; means for supplying motivating fluid to the ejector; a third valve means controlling the flow of motivating fluid to said ejector; means providing for the opening of the third, first and second valve means in sequence; an element operative upon the lapse of a predetermined period of time after the opening of the second valve means; and means dependent upon the operation of the time element and providing for the closing of the second, third, and first valve means in sequence.

19. In combustion apparatus, the combination of a fuel burning structure; a water-filled ash pit for receiving and storing the ash as it is discharged from such structure; fluid jet means within the pit; valve means controlling the flow of fluid to such jet means; a final point of discharge; conduit means providing communication between the lower portion of the pit and the final point of discharge; a second valve means for controlling the flow of ash and water through such conduit; an ejector in said conduit between the second-named valve means and the final point of discharge; means for supplying motivating fluid to the ejector; a third valve means controlling the flow of motivating fluid to said ejector; and means dependent upon a predetermined level of ash and water in the pit and providing for the opening of the third, first, and second valve means in sequence and for closing of the second, third, and first valve means in sequence.

20. In combustion apparatus, the combination of a fuel burning structure; an ash pit for receiving and storing the ash as it is discharged from such structure; fluid jet means within the pit; valve means controlling the flow of fluid to such jet means; a final point of discharge; conduit means providing communication between the lower portion of the pit and the final point of discharge; a second valve means for controlling the flow of ash through such conduit; an ejector in said conduit between the second-named valve means and the final point of discharge; means for supplying motivating fluid to the ejector; a third valve means controlling the flow of motivating fluid to said ejector; means providing for the opening of the third, first, and second valve means in sequence and for closing of the second, third, and first valve means in sequence; and means operable to indicate to the operator the different positions of the several valve means.

21. In combustion apparatus, the combination of a fuel burning structure; an ash pit for receiving and storing the ash as it is discharged from such structure; liquid-jet means within the pit; a final point of discharge; conduit means connecting the lower portion of the pit with the final point of discharge; valve means for controlling the flow of ash from the pit into the con-

duit means; liquid propelling means for conveying the ash through the conduit means to the final point of discharge; means responsive to a predetermined level of ash within the pit for rendering the liquid-propelling means and the liquid-jet means effective; means responsive to the operation of the liquid-jet means for opening the valve means; an element operative upon the lapse of a predetermined period of time after the opening of the valve means; means responsive to the operation of the time element for closing the valve means; and means responsive to the closing of the valve means for rendering the liquid-propelling means and the liquid-jet means ineffective.

22. In combustion apparatus, the combination of a fuel burning structure; a water-filled ash pit for receiving and storing the ash as it is discharged from such structure; liquid-jet means within the pit; a final point of discharge; conduit means connecting the lower portion of the pit with the final point of discharge; valve means for controlling the flow of ash and water from the pit into the conduit means; liquid-propelling means for conveying the ash and water through the conduit means to the final point of discharge; means responsive to a predetermined level of ash within the pit for rendering the liquid-propelling means and the liquid jet means effective; means responsive to the operation of the liquid-jet means for opening the valve means; an element operative upon the lapse of a predetermined period of time after the opening of the valve means; means responsive to the operation of the time element for closing the valve means; means responsive to the closing of the valve means for rendering the liquid-propelling means ineffective; and means responsive to a predetermined level of water within the pit for rendering the liquid-jet means ineffective.

23. In combustion apparatus, the combination of a fuel burning structure; a water-filled ash pit for receiving and storing the ash as it is discharged from such structure; liquid-jet means within the pit; a final point of discharge; conduit means connecting the lower portion of the pit with the final point of discharge; valve means for controlling the flow of ash and water from the pit into the conduit means; liquid-propelling means for conveying the ash and water through the conduit means to the final point of discharge; a pump for supplying liquid to the jet means and to the liquid propelling means; means responsive to a predetermined level of ash within the pit for starting the pump; means responsive to a predetermined pressure of liquid developed by the pump for rendering the liquid-propelling means effective; means responsive to the operation of the liquid-propelling means for rendering the liquid-jet means effective; means responsive to the operation of the liquid-jet means for opening the valve means controlling the flow of ash and water from the pit; a time element operable upon the lapse of a predetermined period of time after the opening of the valve means for closing such valve means; and means responsive to the closing of the valve means for rendering the liquid-propelling means and the liquid-jet means ineffective and for stopping the pump.

24. In combustion apparatus, the combination of a fuel burning structure; a water-filled pit for receiving and storing the ash as it is discharged from such structure; liquid-jet means within the pit; a final point of discharge; conduit means connecting the lower portion of the pit with the

final point of discharge; valve means for controlling the flow of ash and water from the pit into the conduit means; liquid propelling means for conveying the ash and water through the conduit means to the final point of discharge; a pump for supplying liquid to the liquid jet means and to the liquid-propelling means; means responsive to a predetermined level of ash within the pit for starting the pump; means responsive to a predetermined pressure of the liquid developed by the pump for rendering the liquid-propelling means effective; means responsive to the operation of the liquid-propelling means for rendering the liquid-jet means in the pit effective; means responsive to the operation of the liquid-jet means for opening the valve means controlling the flow of ash and water from the pit; a time element operable upon the lapse of a predetermined period of time after the opening of the valve means for closing such valve means; means responsive to the closing of the valve means for rendering the liquid-propelling means ineffective; means responsive to a predetermined level of water within the ash pit for rendering the liquid-jet means ineffective; and means for stopping the pump.

25. In combustion apparatus, the combination of fuel-burning structure, a pit disposed to receive ash and refuse discharged from said structure, discharge means for the pit including a conduit communicating with the lower portion thereof and an ejector arranged in the conduit to effect translation of media therethrough, jet means in the pit and operative to facilitate movement of ash and refuse into the inlet end of the conduit, means for supplying fluid to the ejector and to the jet means for motivation thereof, and means for controlling the last-named means so that the ejector is motivated before the jet means.

26. In combustion apparatus, the combination of a fuel-burning structure, a pit disposed to receive ash and refuse discharged from said structure, discharge means for the pit including a conduit communicating with the bottom thereof, an ejector arranged in the conduit to effect translation of media therethrough, jet means in the pit and disposed to discharge toward the inlet end of said conduit so as to facilitate movement of ash and refuse into the inlet end of the conduit, means for supplying water to the ejector and to the jet means for motivation thereof, and means for controlling the last-named means so that the ejector is motivated before the jet means.

27. In combustion apparatus, the combination of fuel-burning structure, a water filled ash pit disposed to receive ash and refuse from said structure and having a discharge opening in the lower portion thereof, a discharge pipe communicating with said opening, valve means controlling the flow of ash and water through the discharge opening and said pipe, an ejector for conveying water and ash through said pipe when the valve means is opened, jet means in the pit and operated to facilitate the movement of media from the pit and through the discharge opening when the valve means is open, means for supplying water to the ejector and to the jet means for the motivation thereof, means for opening and closing said valve means, and means providing for motivation of the ejector before the valve means is opened.

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