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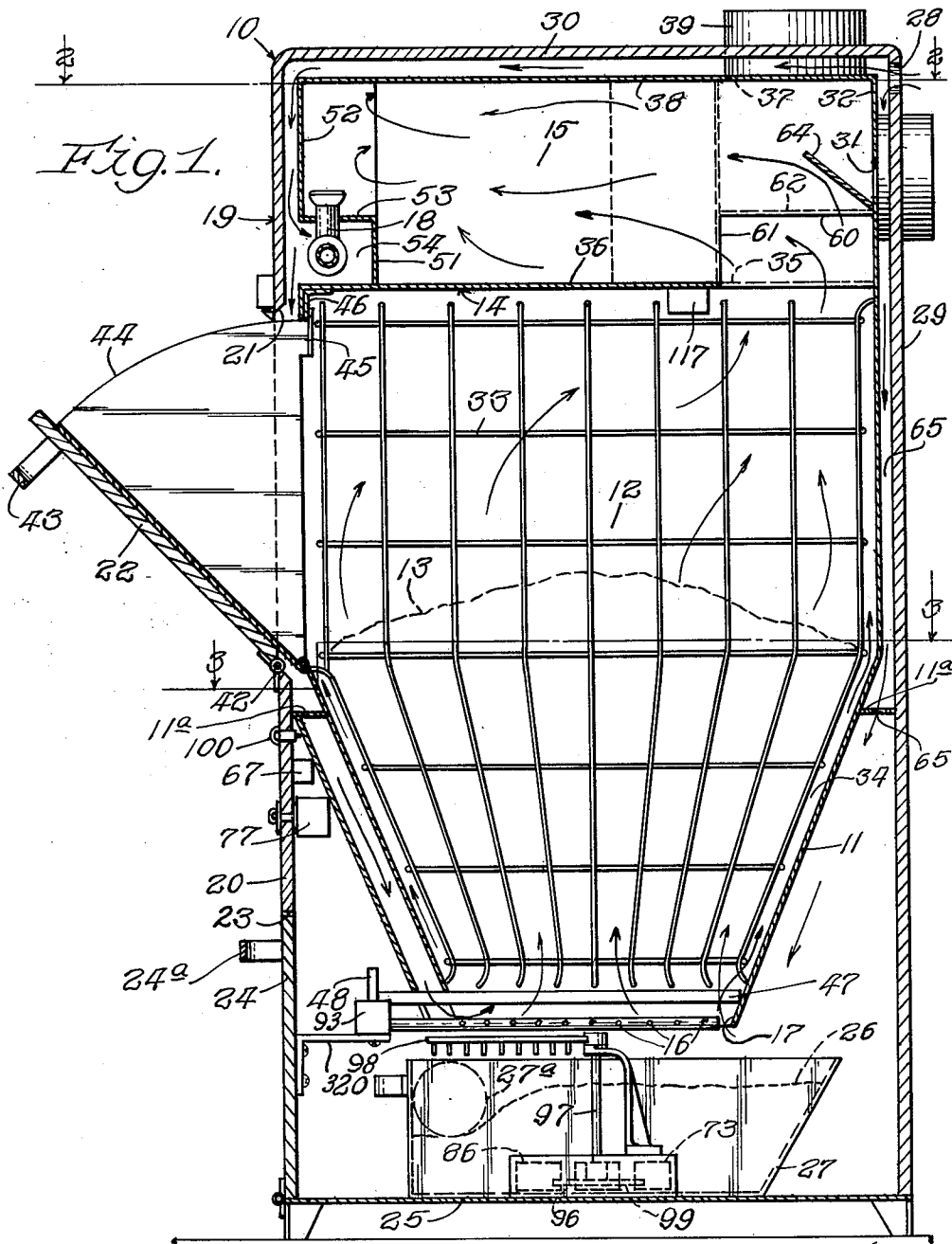
W. R. CRAWFORD ET AL

3,104,629

INCINERATOR

Filed June 20, 1958

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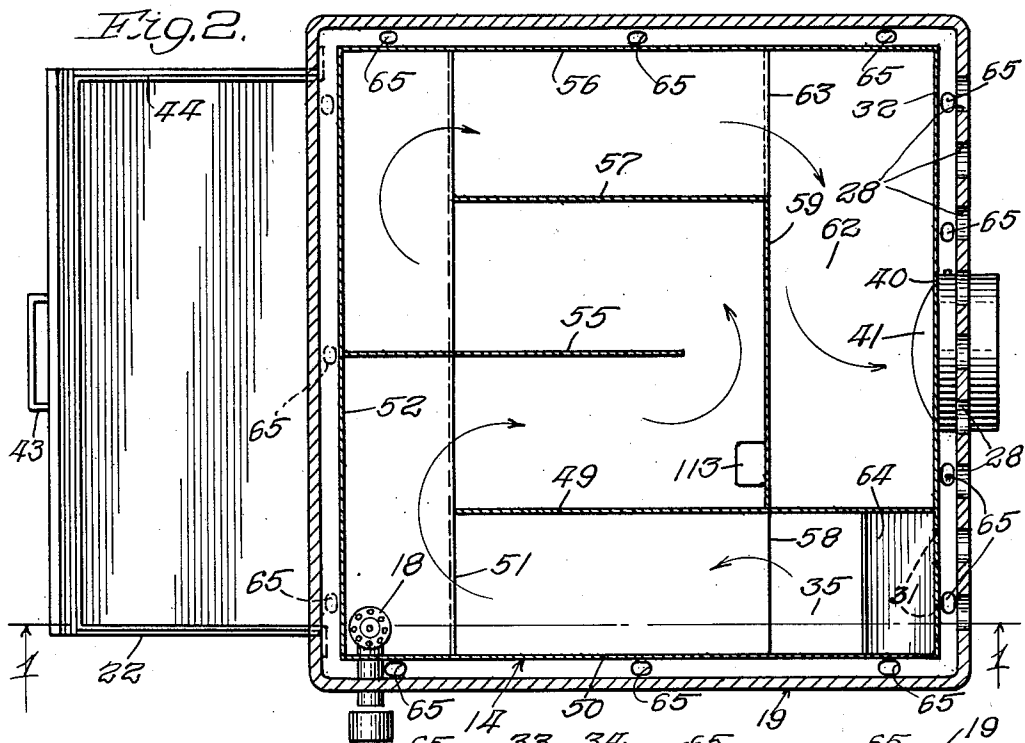
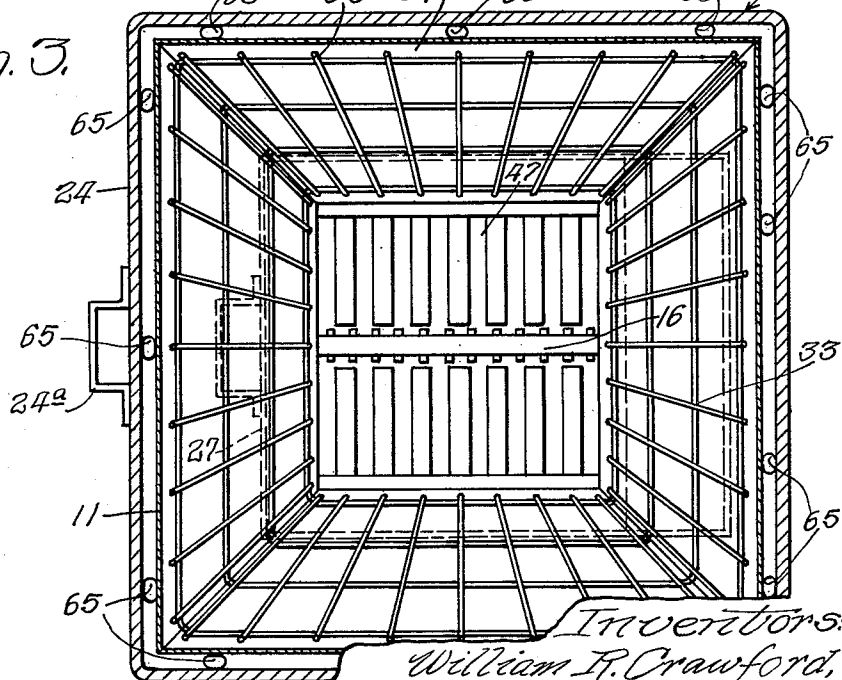


Fig. 3.



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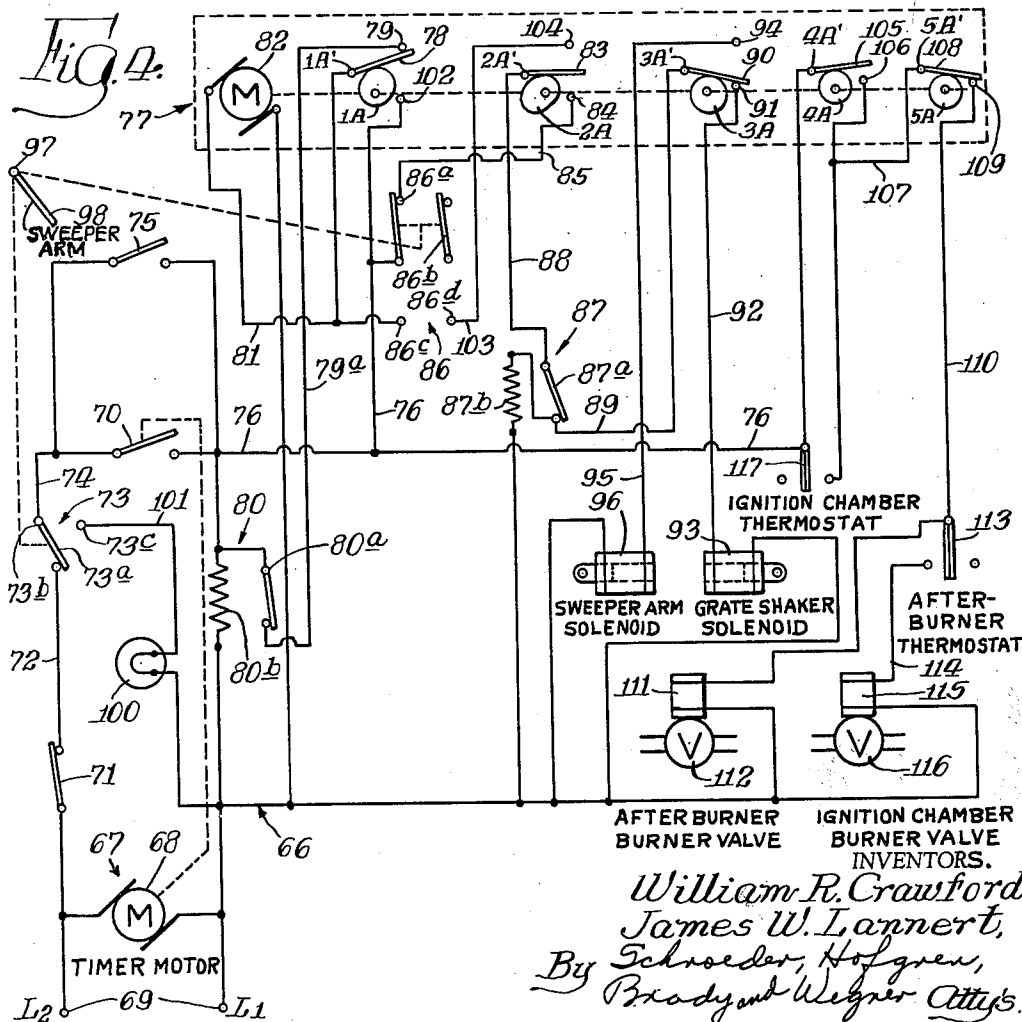
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Fig. 4A.

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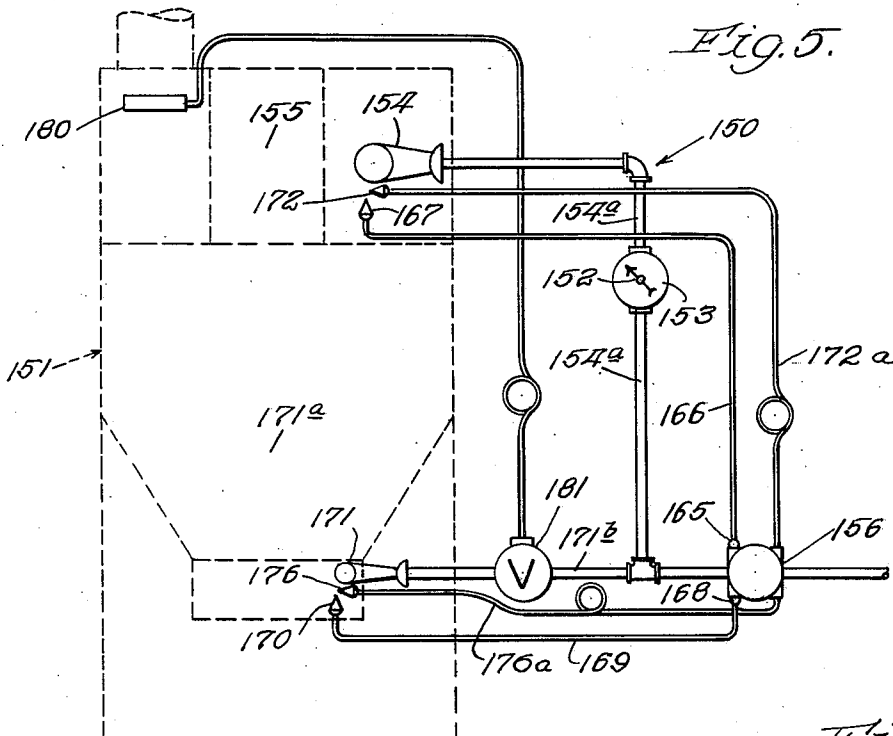
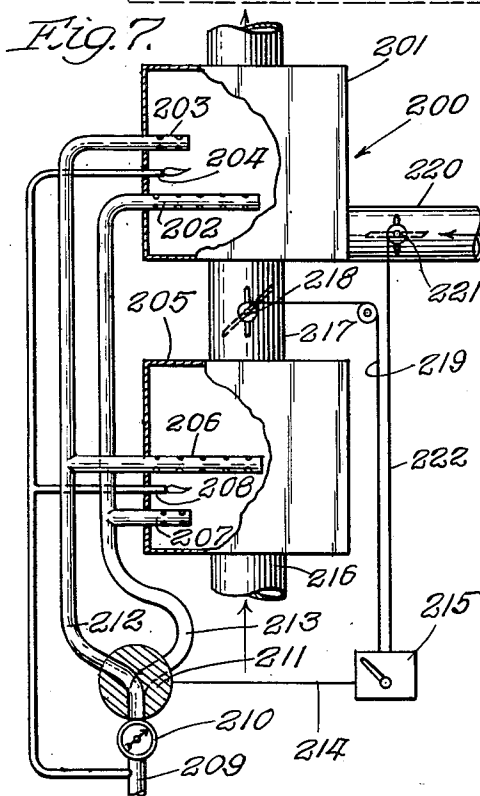
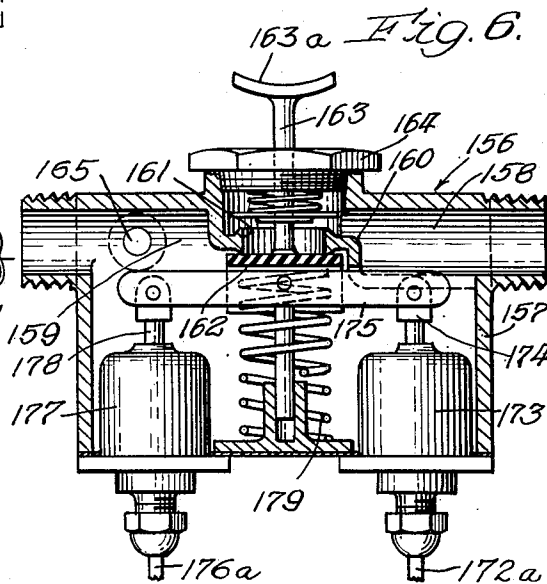
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INCINERATOR

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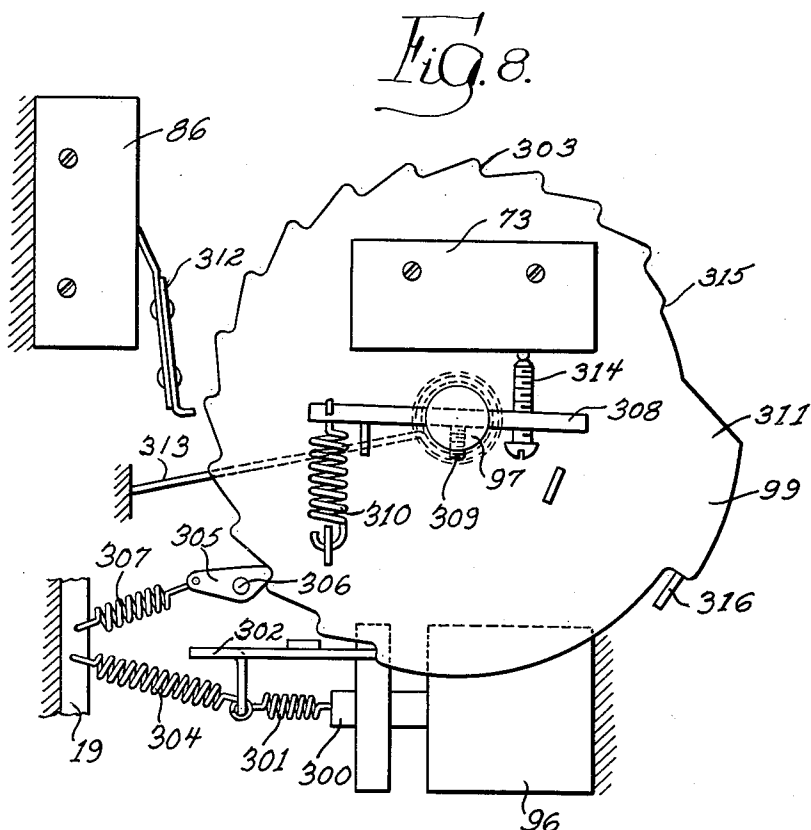
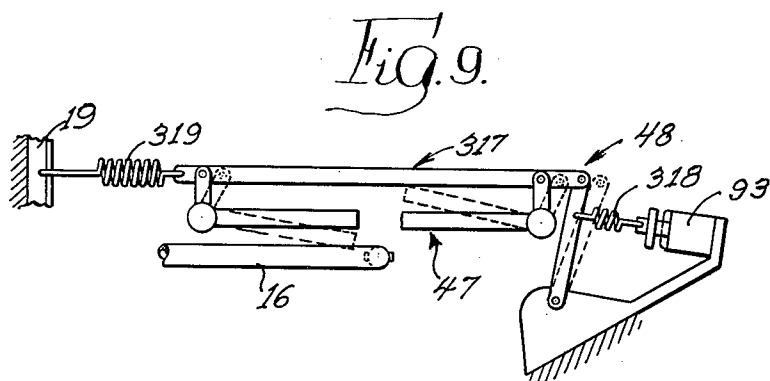
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INCINERATOR

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3,104,629

INCINERATOR

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9 Claims. (Cl. 110—8)

This invention relates to incinerators and in particular to domestic incinerators for effecting combustion of material such as garbage.

In domestic incinerators, substantial elimination of smoke and odors is desirable. Further, as such incinerators are utilized by different persons having different technical abilities, a high degree of efficiency and simplicity of operation is desirable. Another problem that must be considered is that the domestic user may not maintain proper maintenance, such as necessary to provide proper air flow into and from the combustion chambers. The known domestic incinerators do not satisfactorily meet these needs.

The principal feature of the instant invention is the provision of a new and improved incinerator.

Another feature is the provision of such an incinerator having an improvised afterburner means.

A further feature is the provision of such an incinerator wherein the afterburner is associated with a partial combustion chamber in a new and improved manner.

Still another feature is the provision of such an incinerator having new and improved partial combustion chamber means.

A still further feature is the provision of such an incinerator having new and improved air delivery means.

Yet another feature is the provision of such an incinerator having new and improved automatic adjustment means for effecting proper combustion of different types of material.

A further feature is the provision of such an incinerator having new and improved control means for effecting desirable automatic operation thereof.

Another feature is the provision of such an incinerator having new and improved means for automatically providing a clear draft passage to the inlet of the combustion chamber means.

A further feature is the provision of such an incinerator having new and improved means for preventing operation thereof whenever the air inlet passage is not properly clear.

Still another feature is the provision of such an incinerator having automatic control means for effecting desired operation thereof.

A still further feature is the provision of such an incinerator arranged for improved co-ordinated operation of the afterburner and partial combustion burner means for increased efficiency in the operation thereof.

Other features and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawings wherein:

FIG. 1 is a vertical section, taken approximately along the line 1—1 of FIG. 2, of an incinerator embodying the invention;

FIG. 2 is a horizontal section thereof taken approximately along the line 2—2 of FIG. 1;

FIG. 3 is a horizontal section thereof taken approximately along the line 3—3 of FIG. 1;

FIG. 4 is a schematic electrical diagram of the control means thereof;

FIGURE 4A is a schedule illustrating the relative positions of the timer cam switch contacts in each of the different positions of the timer;

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FIG. 5 is a schematic representation of another form of incinerator having a modified control means;

FIG. 6 is a vertical median section of the safety valve means of the control shown in FIG. 5;

FIG. 7 is a schematic representation of still another form of incinerator having a modified control means;

FIGURE 8 is a bottom plan view of an illustrative sweep arm mechanism; and

FIGURE 9 is a front elevation of the grate shaking mechanism.

In the exemplary embodiment of the invention, as shown in FIGS. 1 through 4 of the drawing, an incinerator 10 comprises a first housing 11 defining an ignition chamber 12 in which an incomplete combustion of material to be incinerated, such as garbage 13, is effected. Directly above chamber 12 is a second housing 14 defining an afterburner chamber 15 arranged to receive the products of combustion from the ignition chamber for completion therein of the combustion of the products of combustion. The partial combustion of garbage 13 in ignition chamber 12 is effected by means of a first burner 16 extending across a lower open end 17 of housing 11. A second burner 18 is disposed within afterburner chamber 15 for providing additional heat energy to assure a completion of the combustion in the afterburner chamber 15.

Surrounding ignition chamber housing 11 and superposed afterburner housing 14 is an outer enclosure 19 provided with a front wall 20 having an opening 21 for admitting garbage 13 to ignition chamber 12. Opening 21 is normally closed by means of a door 22 movably mounted on front wall 20. Below opening 21, front wall 20 is provided with a second opening 23 normally closed by a door 24 having a handle 24a. Opening 23 extends upwardly from bottom wall 25 of enclosure 19 and permits desired removal of ashes 26 resulting from the combustion of garbage 13 in ignition chamber 12. An ash pan 27 is removably disposed on bottom wall 25 below open end 17 of the ignition chamber housing to collect the ashes 26 and facilitate the disposing thereof. An ash compactor 27a may be provided to reduce the volume of ashes in pan 27 and, thus, permit a greater amount of ashes to be received therein before removal is required.

To support the desired combustion within ignition chamber 12 and afterburner chamber 15, accurately controlled volumes of air are delivered to each chamber. For this purpose, a plurality of air inlet openings 28 are provided in rear wall 29 of outer enclosure 19 adjacent upper wall 30 thereof. From openings 28, the air passes over and around the afterburner housing 14, thereby becoming preheated. A portion of this air is drawn into afterburner chamber 15 through a plurality of openings 31 in rear wall 32 of afterburner housing 14. The quantity of air so drawn through openings 31 and around burner 18 is a function of the draft and temperature in the afterburner chamber. The remainder of the air passes between ignition chamber housing 11 and outer enclosure 19 to enter the bottom of ignition chamber 12 through lower open end 17 of housing 11. To provide improved delivery of this air and flame from burner 16 to the different portions of the garbage within the ignition chamber, a wire basket structure 33 is provided therein to receive and effect a spacing of the garbage slightly inwardly of the walls of housing 11, thereby defining an air and flame flow space 34 laterally surrounding the garbage. The gaseous products of combustion pass upwardly from ignition chamber 12 into afterburner chamber 15 through an opening 35 in top wall 36 of ignition chamber housing 11 adjacent the rear wall thereof. Thus, as the gaseous products of combustion enter the after-

burner chamber 15, they are mixed with an additional volume of air delivered through openings 31 to permit the desired completion of the combustion thereof. The resultant purified effluent (having had substantially all smoke and odor removed therefrom in the afterburner chamber) is passed outwardly from the afterburner through an opening 37 in the upper wall 38 of housing 14 and a suitable outlet duct 39 extending from opening 37 through upper wall 39 of outer enclosure 19. Outlet duct 39 may be connected to a suitable stack as desired.

To regulate the draft of the effluent at the afterburner outlet, an opening 40 (FIG. 2) is provided in rear wall 32 of afterburner housing 14 and a damper 41 is disposed movably across opening 40 to vary the airflow through the opening and into chamber 15 as a direct function of the draft suction at opening 37. Thus, should the combustion within incinerator 10 tend to run away such as might occur during incineration of readily combustible material, such as dry paper, damper 41 provides an automatic reduction of the draft through the incinerator.

The general construction of incinerator 10 having been described, the specific detailed structure thereof will now be considered. Housings 11 and 14, and outer enclosure 19 are preferably formed of a sheet metal such as sheet steel. Housing 11 is adapted to hold a substantial amount of garbage, permitting, for example, the use of the incinerator, in an ordinary domestic application, on a once-a-day schedule. However, because of the high efficiency of incinerator 10, the unit may be relatively small, a typical dimensioning of housing 11 being 2 feet wide by 2 feet deep by 4 feet high.

Wire basket 33 is preferably substantially rigid and may be comprised of $\frac{3}{32}$ inch diameter rods secured as by welding. Door 22 may be formed of sheet metal, such as sheet alloy steel, and is preferably pivotally secured at its lower end to enclosure front wall 20 by a hinge 42. A handle 43 is provided on the upper end of the door 22 for manipulation of the door as desired. On the rear of door 22 is secured a chute 44 which guides the garbage through opening 21 and into ignition chamber 12. To facilitate the deposit of garbage, means are provided for retaining door 22 at approximately a 45° angle in the open position, such means being illustrated herein as comprising a clip 45 on chute 44 adapted to engage an overhanging ledge portion 46 of ignition chamber housing 11 when door 22 is thusly disposed.

As best seen in FIGS. 1 and 3, the lower end of ignition chamber housing 11 tapers so that lower open end 17 is restricted in area. Partially closing open end 17 to support garbage 13 in the ignition chamber is a grate 47 comprising a pair of fingered bars. A shaker mechanism 48 is associated with grate 47 to effect a shaking reciprocation thereof, when desired, thereby to cause ashes to pass downwardly through open end 17 and into ash pan 27. Burner 16 is disposed slightly below grate 47 and herein comprises a power burner producing approximately 12,000 B.t.u.'s per hour.

Referring now more specifically to FIGS. 1 and 2, the improved afterburner means is seen to comprise a generally horizontally extending, circuitous passage defined by suitable baffle walls within afterburner housing 14. Four such baffle walls are provided herein, each wall extending vertically from the underside of upper wall 38 to the upper side of wall 36. A first baffle wall 49 is spaced from right side wall 50 of afterburner housing 14 approximately $\frac{1}{4}$ of the width of the afterburner chamber. Wall 49 extends forwardly from rear wall 32 of housing 14 to a short front wall portion 51 of the afterburner housing 14 offset rearwardly from the main front wall portion 52 thereof by an interconnecting horizontal wall 53. As best seen in FIG. 1, walls 51 and 53 define, with the forward end of wall 36, a space 54 extending across the width of the afterburner housing, through a portion of which space extends burner 18.

A second baffle wall 55 is spaced approximately midway between right side wall 50 and left side wall 56 of housing 14 and extends rearwardly from the front wall thereof defined by portions 51, 52 and 53 slightly more than $\frac{1}{2}$ the distance toward rear wall 32. A third baffle wall 57 is spaced approximately $\frac{1}{4}$ of the width of the afterburner housing from left side wall 56 and extends rearwardly from front wall portion 51 to the front edge 58 of opening 35. The fourth baffle wall 59 is aligned with edge 58 and extends between third wall 57 and first wall 49. The lower rear corner of first baffle wall 49 is cut out overlying opening 35 (see FIG. 1) to define a horizontal edge 60 and a vertical edge 61. Extending angularly upwardly from the junction of left side wall 56 with horizontal wall 36 to edge 60 is a wall 62 which deflects the products of combustion passing upwardly from ignition chamber 12 through opening 35 toward the space between first baffle wall 49 and right side wall 50. To preclude communication between the passage portion bounded by left side wall 56 and baffle wall 57 and the space under angular wall 62, wall 59 is provided with a projecting portion 63 extending across the opening therebetween. Thus, as best seen in FIG. 2, the flow passage of the effluent through the afterburner chamber is upwardly from the entire opening 35, through the space between baffle wall 49 and right side wall 50, past burner 18 which is disposed at one end of this space and is thus adjacent the inlet of the flow passage, into the space between wall 49 and wall 55 after making a 180° turn, into the space between wall 55 and wall 57 after making another 180° turn, into the space between wall 57 and side wall 56 after making another 180° turn, into the space between wall 59 and rear wall 32 of the housing and over angular wall 62, and thence upwardly through outlet opening 37. This elongated and circuitous path effects a retention of the effluent in the afterburner chamber for a sufficiently long period of time to assure a complete combustion thereof. In addition, the sharp 180° turns assure a turbulent and thorough mixing of the air and effluent providing improved efficiency in the combustion. Still further, as the flow passage extends horizontally, deposit of fly ash does not block any one portion thereof, but rather any such fly ash is deposited over the substantial length of the passage, substantially minimizing cleaning maintenance of the afterburner.

In the illustrated embodiment, burner 18 comprises a power burner providing approximately 24,000 B.t.u.'s per hour. It should be understood that, within the scope of the invention, burners 16 and 18 may comprise other suitable burner means, such as electrically operated burners, and may provide other suitable amounts of heat energy. However, burner 18 must be capable of raising the temperature within afterburner chamber 15 to a sufficient degree to assure a proper completion of the combustion therein. It has been found that the minimum temperature for this purpose is approximately 1300° F.

The instant invention comprehends an improved air delivery to the ignition and afterburner chambers, effecting an automatic regulation of the combustion therein. As indicated above, the combustion air is preheated by its passage against afterburner housing 14 prior to delivery through lower open end 17 of the ignition chamber housing. Such heat transfer provides not only improved efficiency of combustion in ignition chamber 12 but also serves to reduce the outlet temperature of the effluent, which temperature reduction is highly desirable relative to fire hazard considerations. As indicated above, air is drawn into the afterburner chamber 15 through openings 31 as a result of the suction pressure induced in chamber 15 as the products of combustion pass from opening 35 into the space between wall 49 and side wall 50. Thus, a large rate of flow, as might result from the burning in chamber 12 of highly combustible material (such as dry paper or cardboard), effects an increase in the amount of

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air drawn into chamber 15 to be mixed with the products of combustion. Alternatively, a low rate of flow, as might be caused by burning damp garbage in chamber 12, effects a decreased delivery of air. To preclude a reverse flow through openings 31 (of the combustion products entering the afterburner chamber), a baffle plate 64 is carried on wall 32 to extend angularly upwardly in front of openings 31 and deflect the flow away from the openings.

To assure proper operation of incinerator 10, it is desirable to provide only a limited amount of air to ignition chamber 12 so that only a partial combustion of garbage occurs therein, and permit completion of the combustion to occur in afterburner chamber 15. The control of the volume of air admitted through lower end 17 into ignition chamber 12 is effected by properly dimensioning the openings 65 in the member 11a between ignition chamber housing 11 and the outer enclosure 19 so that the openings 65 therebetween properly throttle the air delivery the requisite amount. Thus, the draft through the entire incinerator is controlled automatically by the damper 41 which admits more or less air into the space above angular wall 62 adjacent outlet opening 37 depending on the draft at the outlet opening 37, and the ratio of air volumes delivered to the ignition and afterburner chambers is controlled automatically by the co-ordinated functioning of openings 65 and openings 31 which divert more or less air from openings 65 directly into afterburner chamber 15 depending on the draft adjacent inlet opening 35.

The instant invention further comprehends an automatic operation of incinerator 10 in a new and improved manner. This automatic operation is effected by a number of different control elements electrically associated to define a control circuit 66, as shown in FIG. 4. It is desirable to utilize the incinerator during the early morning hours when people would be least affected by any smoke, odor or fly ash which might result from an abnormal weather condition or the like. To effect operation of the incinerator at such times, a 24-hour timer 67 (FIG. 1) of conventional construction is provided. Timer 67 is provided with a motor 68 which is continuously energized from a suitable power supply 69 through leads L1 and L2. Herein, power supply 69 comprises a 115 volt alternating current supply. Electrically associated with 24-hour timer 67 is a single pole normally open switch 70 arranged to be closed by the action of the timer, e.g., from 12:00 o'clock midnight to 9:00 A.M. Switch 70 is connected to one side of power supply 69 through lead L2, a single pole, single throw manually operable switch 71, lead 72, moving contact 73a of a single pole, double throw switch 73, stationary contact 73b of switch 73, and lead 74. Switch 71 comprises the main "Off-On" switch which the operator places in the closed condition after loading the incinerator. However, as switch 70 remains open until midnight or previously set hour of day, the incinerator normally remains inoperative until that time. However, if for any reason it is desired to effect immediate operation of the incinerator, a manually operable single pole, single throw switch 75, connected in parallel with switch 70, may be operated to bypass open switch 70 and apply potential to lead 76 connected to the secondary side of switch 70 and feed the remainder of the control circuit. When either switch 70 or switch 75 closes, immediate operation of a 72-step program timer 77 is effected. Program timer 77 is of suitable conventional construction and includes a plurality of switches which are selectively opened and closed in each of the 72 steps. As shown in FIGURE 4, the program timer includes a motor 82 driving the cams 1A, 2A, 3A, 4A and 5A which control respectively switches 1A', 2A', 3A', 4A' and 5A'. At the end of each complete operation of program timer 77, a first timer contact 78 of switch 1A' closes with a second timer contact 79 thereof to establish a "Reset" condition. Contact 79 is connected to lead 76 through a lead 79a and a normal-

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ly closed contact 80a of a time delay relay 80 having a heater 80b connected between lead 76 and power supply lead L1. Relay 80 operates to open contact 80a approximately 2½ minutes after heater 80b is energized by the closing of either switch 70 or 75.

As contact 78 is closed with contact 79 in the first, or "Reset," position of program timer 77, current may pass from contact 78, through a lead 81, to motor 82 of the program timer 77, the other side of which motor is connected to lead L1. This initiates operation of the program timer to operate the timer in 72 increments, each of which is one minute long. At the end of the first minute, the timer moves to the second position wherein a timer contact 83 of switch 2A' closes with a timer contact 84 thereof which is connected by a lead 85 to a stationary contact 86a of a double throw switch 86. Contact 86a is connected to lead 76 through a moving contact 86b of the switch 86. Contact 83 is connected to a thermal interrupter relay 87 by a lead 88. Relay 87 includes a normally closed contact 87a which is intermittently opened by a thermally operative actuating means 87b connected from lead 88 to power supply lead L1, thereby connecting a lead 89 to lead 88. Lead 89 is connected to a timer contact 90 of switch 3A' which is closed with a timer contact 91 thereof in the second timer position to complete a circuit through a lead 92 to a solenoid 93, the other side of which is connected to lead L1. Solenoid 93 comprises the operating means of grate shaker 48 and, thus, during the one minute in which the program timer is in the second position, a repeated shaking operation of grate 47 is effected. Resultingly, a thorough clearing of the ashes through the open lower end 17 of ignition chamber housing 11 is automatically effected prior to a combustion operation of the incinerator.

Should, as a result of the grate shaking, a deposit of ashes result which completely blocks open end 17, thereby preventing proper admission of air to support combustion in chamber 12, malfunctioning of the incinerator would result. To preclude this, automatic means are provided which detect the presence of such an excess quantity of ashes and preclude further operation of the incinerator until the ashes have been removed by the operator. This operation is effected in the third position of the timer wherein contact 90 closes with a timer contact 94 of switch 3A' to apply potential through a lead 95 to one side of a solenoid 96, the other side of which solenoid is connected to power supply lead L1. Solenoid 96 is associated with an upright shaft 97 (FIG. 1) on the upper end of which is secured a sweeper arm 98. Solenoid 96 operates a suitable cam device 99 to effect incremental rotation of shaft 97 about its vertical axis upon successive closings of contact 87a and effects a step by step swinging of arm 98 across the open top of ash pan 27. Should arm 98 encounter a body of ashes in this space above ash pan 27 and below burner 16, the resultant resistance to movement is transmitted to shaft 97 which is associated with switch 73 to throw movable contact 73a thereof, opening the circuit to stationary contact 73b and closing the circuit from lead 72 to a second stationary contact 73c of switch 73. The opening of the circuit to contact 73b immediately stops further operation of the incinerator. To notify the operator that the cause of discontinuation of operation is an excess of ashes, a signal light 100 (FIG. 1) is mounted on the front wall 20 of the housing and is connected to contact 73c by lead 101. The other side of the signal light is connected directly to power supply lead L1 and, thus, when moving contact 73a closes with stationary contact 73c, signal light 100 is illuminated thereby warning the operator of the excess ash condition.

It should be noted that during this third step in the program timer operation, the program timer motor 82 is de-energized, as timer contact 78 is no longer connected to timer contact 79. However, if an excess ash condition does not exist, arm 98 may move completely across the top of ash pan 27, allowing cam device 99 to operate

switch 86 at the end of this movement and throw the movable contact 86b across normally open contacts 86c—86d thereof. Contact 86c is connected to lead 81 and, as moving contact 86b is connected to lead 76, this re-establishes a circuit from lead 76 to timer motor 82. After one minute, the program timer moves to the fourth position wherein a timer contact 102 of switch 1A' connected to lead 76 is closed with timer contact 78, thus maintaining the circuit to program timer motor 82 while allowing switch 86 to be restored to the reset condition (of FIG. 4) by an additional impulse delivered to solenoid 96 from contact 86d, lead 103, and timer contact 104 of switch 2A' which is then closed with timer contact 83. Once switch 86 is thrown to the position of FIG. 4, the circuit to relay 87 is broken, thereby precluding further operation of solenoid 96.

In position 4, another timer contact 105 of switch 4A' connected to lead 76 is closed with a timer contact 106 of switch 4A' connected through a lead 107 to still another timer contact 108 of switch 5A' closed with another timer contact 109 thereof. Contact 109 is connected to a lead 110 connected to one side of a solenoid 111, the other side of which solenoid is connected directly to power supply lead L1. The resultant energization of solenoid 111 opens an associated valve 112 which controls the flow of combustible gas to burner 18 of the afterburner. When the temperature within the afterburner chamber 15 becomes sufficiently high to support the complete combustion of the products of combustion delivered from ignition chamber 12, operation of burner 16 is automatically effected. This is accomplished by a thermostat switch 113 which connects lead 110 to a lead 114 at a predetermined temperature. Lead 114 is connected to one side of a solenoid 115, the other side of which is connected directly to power supply lead L1. Solenoid 115 operates a valve 116 controlling the delivery of combustible gas to burner 16. As seen in FIG. 4, contact 105 remains closed with contact 106, and contact 108 remains closed with contact 109 during all of the last 69 timer positions. Thus, combustion of the garbage 13 in incinerator 10 is effected continuously for 69 minutes.

When the program timer returns to the "Reset" position, the circuit between contact 105 and 106 is broken. This would normally prevent further operation of the incinerator. However, if combustion of the garbage 13 has not been completed, it is desirable to continue the operation of the incinerator. This is automatically effected by means of a second thermostat switch 117 which closes to connect lead 76 to lead 107 whenever the temperature in ignition chamber 12 adjacent opening 35 is above a predetermined value, indicating that an exothermic incineration is continuing (i.e., garbage is still burning within ignition chamber 12). However, program timer 77 remains in the "Reset" position as contact 80a of the time delay relay 80 remains open. Thus, as soon as the temperature within ignition chamber 12 drops below the predetermined value (indicating that combustion is completed), operation of the burners 16 and 18 is discontinued. If completion of the combustion does not occur within the 4-hour interval controlled by switch 70, the opening of switch 70 at the end of the 4-hour period will, nevertheless, stop further operation of the burners. When switch 70 opens, heater 80b of time delay relay 80 is de-energized, permitting contact 80a to close and, thus, re-establish the necessary initial circuit to permit a new cycle of operation of the program timer 77 at the next closing of switch 70 as controlled by the 24-hour timer 67.

Referring now to FIGURE 8, solenoid 96 is shown to include an armature 300 connected by a spring 301 to an actuator arm 302. Spring 301 biases the actuator arm 302 against the cam 99 which is provided with a plurality of ratchet teeth 303. Spring 301 is counterbalanced by a return spring 304 whereby successive operations of solenoid 96 to move armature 300 seriatim to the left and to the right as shown in FIGURE 8 causes a step-by-

step rotation of cam 99. The cam is retained in the respective stepped positions by means of a pawl 305 biased about a pivot 306 by means of a spring 307 to engage the ratchet teeth 303 in the stepped rotation of the cam 99.

As previously indicated, the incremental rotation of the cam device 99 effects rotation of shaft 97 to cause a step-by-step swinging of arm 98 across the open top of ash pan 27. To this end, an arm 308 is fixedly secured to the shaft 97 by means of a set screw 309. A spring 310 connects one end of the arm 308 to the cam 99. Thus when there is no resistance to movement of shaft 97, the incremental rotation of cam 99 causes a concurrent rotation of shaft 97 to swing the arm 98 as indicated. At the extreme movement of cam 99 a high portion 311 thereof engages the actuator 312 of switch 86 to end the cam movement and re-establish the circuit to the timer motor 82. At this position the pawl 305 engages a modified ratchet surface 315 which positions the pawl to permit free movement of the cam 99 in a clockwise direction as seen in FIGURE 8. A torsion spring 313 is connected to shaft 97 to return the shaft 97, the arm 98, and the cam 99 to the preset position of FIGURE 8. The return movement of cam 99 is limited by a stop 316.

In the event that a body of ashes is in the ash pan 27 preventing the movement of the arm fully across the ash pan, the shaft 97 will be prevented from following cam 99. In this event, switch 73 which is carried by the cam 99 will move away from an adjustable actuator 314 on arm 308 whereby moving contact 73a is moved from contact 73b to de-energize the program timer and energize signal light 100 to notify the operator of the necessity to remove the excess ashes.

Referring now to FIGURE 9, an illustrative grate shaker structure 48 is shown to include the solenoid 93 which as indicated above is intermittently operated during step 2 of the program timer operation to shake the grate 47 and thereby cause ashes to pass downwardly into ash pan 27 prior to the above discussed sweeping operation for determining the level of ashes in the ash pan. As shown in FIGURE 9, the solenoid is carried on a bracket 320 and the grate 47 is connected to the solenoid 93 by means of a linkage 317 and a spring 318. A return spring 319 is connected between the linkage 317 and the frame 19. Thus, intermittent energization of solenoid 93 effects reciprocation of the grate 47 to shake the ashes as indicated above.

Referring now more specifically to FIGS. 5 and 6, another form of burner control 150 is associated with an incinerator 151 generally similar to incinerator 10. Control 150 includes a manually adjustable timer 152 which is set by the operator to effect combustion for a period of time estimated to be proper to effect a complete incineration. Timer 152 operates a valve 153 which controls the delivery of combustible gas through a duct 154a to burner 154 in the afterburner chamber 155. Delivery of combustible gas to duct 154a is, in turn, controlled by a safety control device 156, the specific construction of which is best seen in FIG. 6. Device 156 comprises a valve defined by a body 157 having an inlet chamber 158, an outlet chamber 159, and a wall 160 between the inlet and outlet chambers provided with an opening 161 removably closed by a movable valve member 162. Movable valve member 162 is secured to an operating shaft 163 extending outwardly from inlet chamber 158 through a sealing closure 164. The outer end 163a of shaft 163 defines a button portion adapted for manipulation by the operator to effect the spacing of valve member 162 from wall 160 and permit limited gas flow through opening 161, into chamber 159 and outwardly through a first outlet 165. A duct 166 is connected to outlet 165 to deliver the combustible gas to a pilot 167 associated with burner 154 of the afterburner. At the same time, combustible gas is delivered through a second outlet 168 and a duct 169 connected thereto to a pilot 170 associated with a burner 171 in ignition chamber 171a. The pres-

ence of a flame at pilot 167 is sensed by a thermopile detector 172 which is operatively associated by a connector 172a with a solenoid 173 having its armature 174 connected to one end of a lever 175 pivotally connected to shaft 163 intermediate the ends thereof. A similar thermopile detector 176 is associated with pilot 170 in the ignition chamber and by a connector 176a with a solenoid 177 having its armature 178 connected to the opposite end of lever 175. Whenever a proper flame is provided by both pilots 167 and 170, the two solenoids 173 and 177 are energized to pull armatures 174 and 178 downwardly against the action of a biasing spring 179 to move valve member 162 away from opening 161 and permit flow of combustible gas therethrough.

When valve 153 is opened by timer mechanism 152, it permits flow of combustible gas through duct 154a to burner 154 where it is ignited by pilot 167. When the temperature within afterburner chamber 155 reaches a predetermined value, a thermally-lagged sensing element 180 therein opens a solenoid valve 181 in a duct 171b to permit flow of combustible gas to ignition chamber burner 171. The combustible gas at burner 171 is ignited by pilot 170 and effects the desired partial combustion of the material in chamber 171a.

After a predetermined period of time, timer 152 closes valve 153 to discontinue operation of burner 154. However, as long as the combustion of material continues in ignition chamber 171a, the hot gases therefrom maintain the temperature at sensing element 180 sufficient for maintaining valve 181 open. Upon completion of the combustion operation, the temperature at sensing element 180 drops and after a few minutes (due to the time lag operation of sensing element 180) valve 181 closes to discontinue further operation of burner 171, allowing the incinerator 151 to cool and become automatically reset for a subsequent combustion operation.

Should either of the pilots 167 or 170 become extinguished at any time, the associated solenoid becomes de-energized and spring 179 pivots lever 175 about the connection to the other solenoid to move member 152 upwardly and close opening 161. This immediately stops further flow of combustible gas to the incinerator. Thus, an automatic safety control of the incinerator is effected precluding an explosive build-up of combustible gas therein.

Turning now to FIG. 7, another incinerator means 200 is shown to include a modified form of control permitting an automatic adjustment of the incinerator for proper combustion of different types of combustible materials. It has been found, for example, that combustion of wet garbage requires a large volume of air and high heat energy delivery in the ignition chamber and little air and heat delivery in the afterburner, whereas combustion of more readily combustible material, such as dry paper or cardboard, requires little heat and air delivery in the ignition chamber and high heat and air delivery in the afterburner. To provide automatically the desirable plurality of operating arrangements, incinerator 200 is provided with an afterburner 201 having a high heat burner 202, a low heat burner 203 and a pilot 204 for igniting the burners. The ignition chamber means 205 is similarly provided with a high heat burner 206, a low heat burner 207 and a pilot 208 for igniting the ignition chamber burners. Combustible gas is delivered to the pilots 204 and 208 from a supply duct 209. The combustible gas is delivered from supply duct 209 through a timer valve 210 and a two-way selector valve 211 alternatively to a first distribution duct 212 and a second distribution duct 213. From duct 212 combustible gas is delivered to low heat burner 203 of the afterburner and high heat burner 206 of the ignition chamber means. From duct 213 combustible gas is delivered to high heat burner 202 of the afterburner and low heat burner 207 of the ignition chamber means. Two-way valve 211 may be of suitable conventional construction and is provided with means, such

as control cable 214 connected to a suitable control lever means 215, for effecting the selection of the valve to either of its alternative distributing positions.

Air is delivered to ignition chamber means 205 through an inlet 216. The gaseous products of combustion in ignition chamber means 205 are delivered to afterburner 201 through an interconnecting duct 217 in which is disposed an adjustable damper 218 operated by a control cable 219 connected to control lever means 215. Air is admitted to afterburner 201 through an air inlet 220 provided with a damper 221 controlled by a cable 222 also connected to control lever means 215.

The two-way valve 211 and dampers 218 and 221 are arranged so that when valve 211 is disposed to pass combustible gas to duct 212, damper 218 extends longitudinally of duct 217 permitting maximum flow therethrough, and damper 221 extends transversely across duct 220 to close substantially that duct. Thus, the incinerator is automatically arranged to effect combustion of material such as damp garbage, as it provides a substantial amount of heat in the ignition chamber means 205 and causes a substantial amount of air to be drawn in through inlet 216 to support the combustion in chamber 205.

When a highly combustible material is to be incinerated, control lever means 215 is operated to rearrange valve 211 for delivery of the combustible gas to duct 213, and to reposition damper 218 to block partially duct 217 and damper 221 to extend longitudinally of duct 220 permitting free air flow into afterburner 201. Thus, in this arrangement, only a small amount of heat is delivered to the ignition chamber means 205 by burner 207 and a damper 218 acts to prevent a runaway combustion of the material in chamber 205. However, as a rapid combustion takes place within chamber 205, high heat burner 202 of afterburner 201 effectively completes the combustion of the products delivered through duct 217 and the large volume of air delivered through duct 217 and the large volume of air delivered to afterburner 201 through its air inlet 220 to eliminate completely any smoke and odors which would otherwise result from the starved combustion within ignition chamber 205.

In illustrating this form of the invention, two different types of combustible materials were specifically considered, namely damp garbage and highly combustible paper and cardboard. It should be understood that the invention comprehends suitable means for arranging an incinerator for automatic proper combustion of other types of combustible materials as well as the illustrated types. Also, to illustrate this form of the invention, a mechanically operated control means is shown. It should be understood, however, that the invention comprehends other suitable control means such as electrically, hydraulically, or pneumatically operative controls as are well-known in the art.

While we have shown and described certain embodiments of our invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as defined in the appended claims.

We claim:

1. An incinerator, comprising: an ignition chamber; an afterburner receiving products of combustion from the ignition chamber; a first burner in said ignition chamber; a second burner in said afterburner; means effecting operation of said second burner; means responsive to a predetermined temperature rise effected by operation of said second burner to effect operation of the first burner; means stopping operation of the second burner after a predetermined time; and means subsequently stopping operation of the first burner when the temperature in the incinerator drops below a predetermined temperature.

2. The incinerator of claim 1 wherein the last named means includes means measuring the temperature at the outlet from the incinerator.

3. The incinerator of claim 1 wherein said predetermined temperature is a minimum temperature effected as a result of exothermic incineration in said ignition chamber.

4. An incinerator, comprising: an ignition chamber; an afterburner receiving products of combustion from the ignition chamber; a first burner in said ignition chamber; a second burner in said afterburner; and means effecting an automatic sequential operation of said burners wherein the second burner is operated for an initial period, the first burner is operated upon the reaching of a predetermined temperature condition in the afterburner, operation of the second burner is discontinued at the end of said period, and operation of the first burner is continued until the temperature in the afterburner decreases to a predetermined value as a result of substantial discontinuation of exothermic combustion in the ignition chamber.

5. An incinerator, comprising: chamber means; burner means for effecting combustion of material to be incinerated in said chamber means; means for receiving ashes resulting from combustion of said material in said chamber; and means automatically operative to detect the quantity of ashes in said receiving means and preclude operation of said burner means whenever the quantity of ashes therein is greater than a predetermined amount.

6. An incinerator, comprising: chamber means; burner means for effecting combustion of the material to be incinerated in said chamber means; a grate for supporting the material to be incinerated in said chamber means; and means automatically shaking the grate whenever operation of the burner means is to be effected; means for receiving ashes resulting from combustion of said material in said chamber; and means automatically operative subsequent to a shaking of the grate by said shaking means to detect the quantity of ashes in said receiving means and preclude operation of said burner means whenever the quantity of ashes therein is greater than a predetermined amount.

7. An incinerator, comprising: chamber means; burner means for effecting combustion of material to be incinerated in said chamber means; control means arranged to effect successive operations of the burner means for a plurality of periods of time; and thermo-responsive means precluding initiation of the second of said successive operations whenever combustion of all of the material in the chamber means occurs prior to the commencement of the second period of time.

8. An incinerator, comprising: an ignition chamber; first burner means for effecting partial combustion of material to be incinerated in said ignition chamber; an afterburner chamber for receiving products of combustion of the material in said ignition chamber; second burner means in said afterburner chamber for completing combustion of said products of combustion; a grate for supporting the material to be incinerated in said ignition chamber; means for shaking said grate; an ash pan for receiving ashes resulting from combustion of said material in said ignition chamber; means for determining the height of ashes in said ash pan; and timer controlled means for effecting automatically at a pre-

terminated time sequentially an operation of said grate shaking means, an operation of said ash height determining means, an operation of said second burner means only if the height of ashes determined by said determining means is less than a predetermined height, an operation of said first burner means upon the effecting of a predetermined temperature elevation in the afterburner by said second burner means, a discontinuation of the operation of the second burner means, and a discontinuation of the operation of the first burner means upon the first to occur of a reaching of the end of a predetermined period of time and of the completion of combustion of the material in said chamber means.

9. An incinerator, comprising: an ignition chamber; first burner means for effecting partial combustion of material to be incinerated in said ignition chamber; an afterburner chamber in communication with said ignition chamber for receiving products of combustion of the material in said ignition chamber; second burner means in said afterburner chamber for completing combustion of said products of combustion; an ash pan subjacent said ignition chamber for receiving ashes resulting from combustion of said material in said ignition chamber; means for determining the height of ashes in said ash pan; and timer controlled means for effecting automatically an operation of said ash height determining means, an operation of said second burner means only if the height of ashes determined by said determining means is less than a predetermined height, an operation of said first burner means upon the effecting of a predetermined temperature elevation in the afterburner by said second burner means, a discontinuation of the operation of the second burner means, and a discontinuation of the operation of the first burner means upon a completion of combustion of the material in said ignition chamber means.

References Cited in the file of this patent

UNITED STATES PATENTS

1,137,232	Ricketts	Apr. 27, 1915
1,281,488	Best	Oct. 15, 1918
1,528,816	Cummings	Mar. 10, 1925
1,545,497	Kener	July 14, 1925
1,887,768	Maloney	Nov. 15, 1932
1,995,723	Van Denburg	Mar. 26, 1935
2,041,449	Adams	May 19, 1936
2,118,651	Macchi	May 24, 1938
2,549,517	Persons	Apr. 17, 1951
2,601,332	Shaffer	June 24, 1952
2,610,682	Weber	Sept. 16, 1952
2,646,758	Greenen	July 28, 1953
2,653,213	Comstock	Sept. 22, 1953
2,711,139	Martin	June 21, 1955
2,716,386	Smart	Aug. 30, 1955
2,752,870	Short et al.	July 3, 1956
2,847,951	Triggs	Aug. 19, 1958
2,863,406	Anderson et al.	Dec. 9, 1958

FOREIGN PATENTS

771,919	Great Britain	Apr. 10, 1957
59,075	Norway	Mar. 7, 1938