July 3, 1956 G. A. SHORT ET AL 2,752,870

GAS FIRED INCINERATORS

Filed March 12, 1954 2 Sheets-Sheet 1

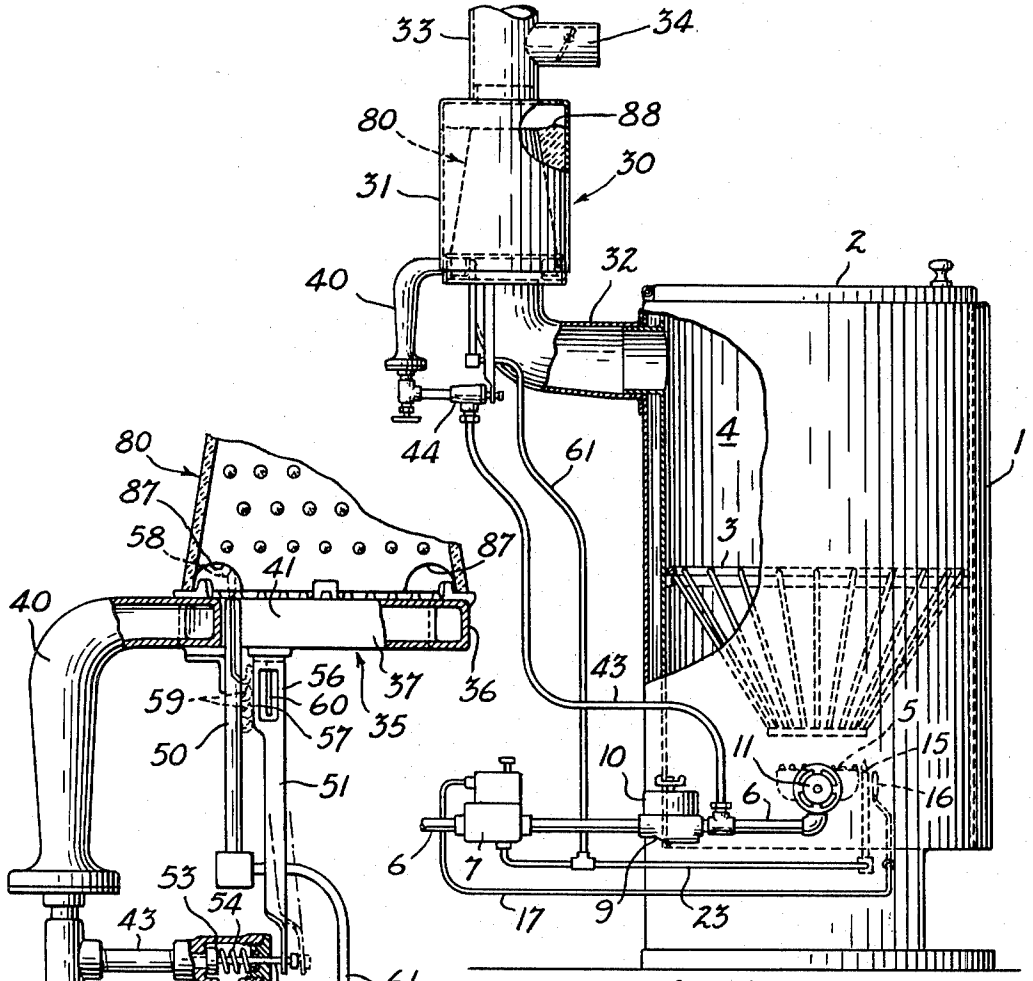


Fig. 1

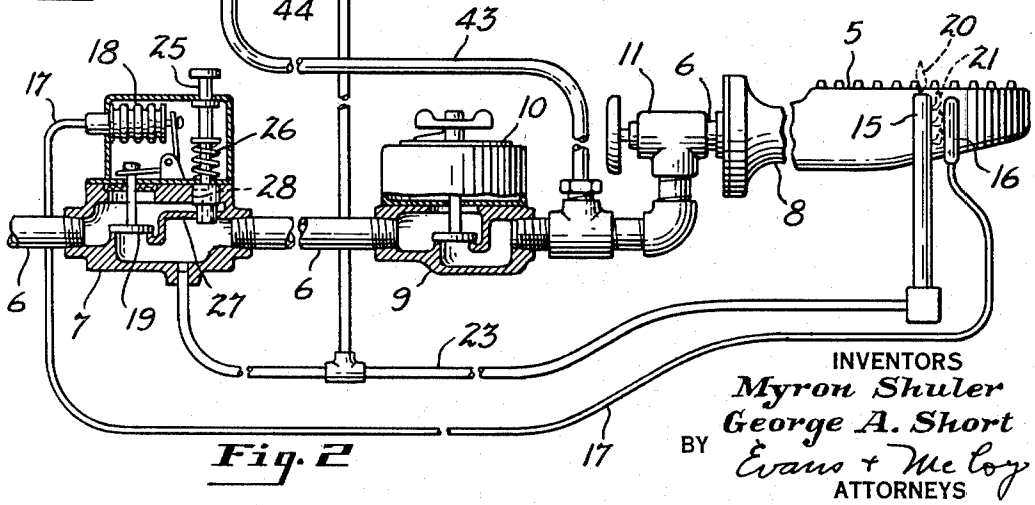


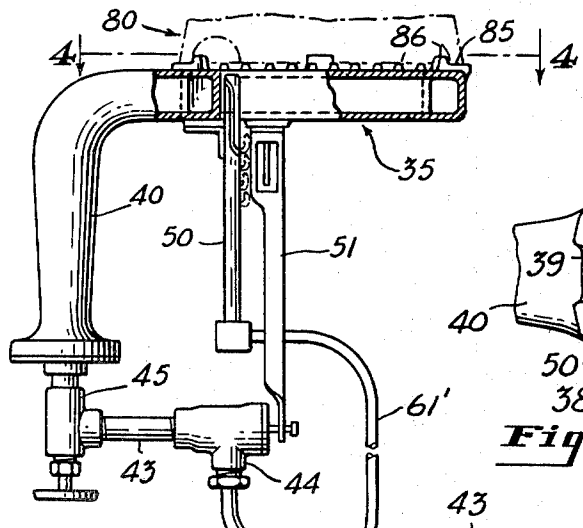
Fig. 2

INVENTORS
Myron Shuler
George A. Short
BY Evans + McCoy
ATTORNEYS

July 3, 1956 G. A. SHORT ET AL 2,752,870

GAS FIRED INCINERATORS

Filed March 12, 1954 2 Sheets-Sheet 2



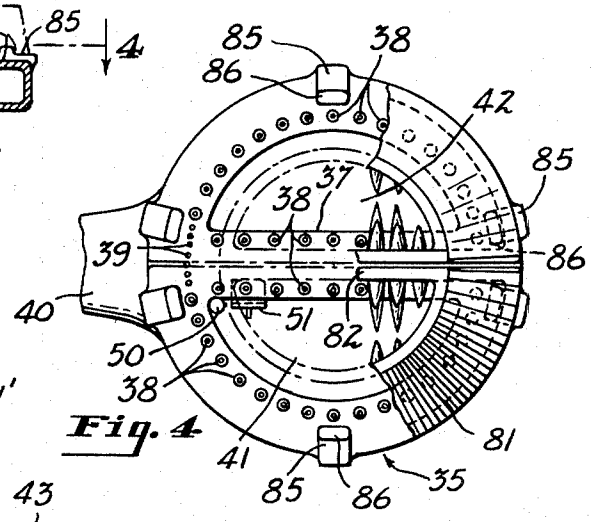


Fig. 4

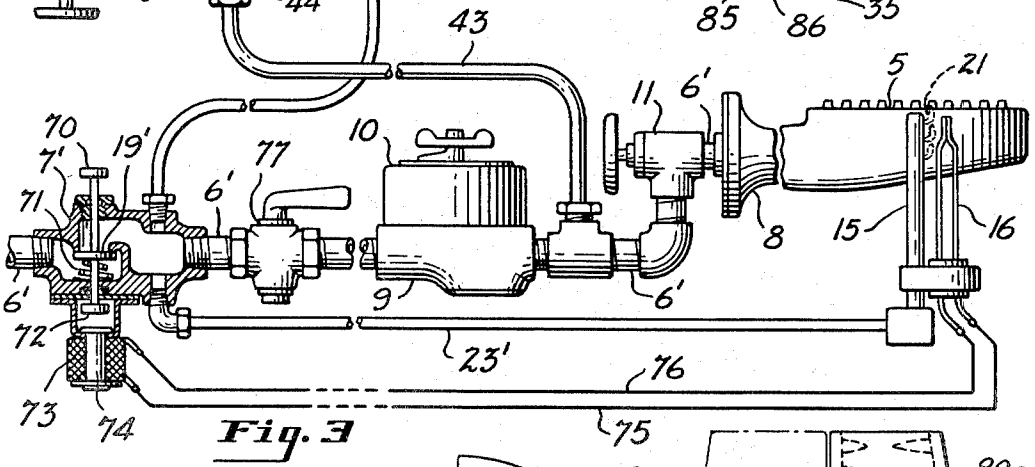


Fig. 3

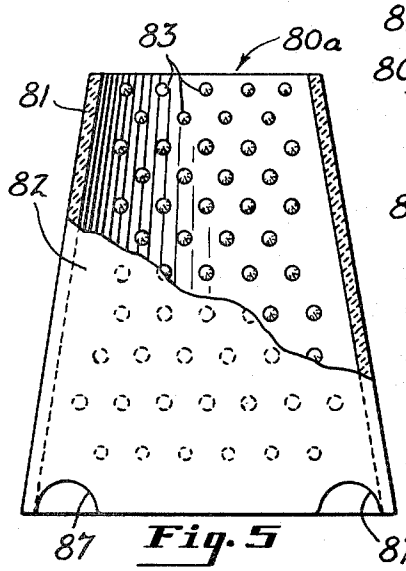


Fig. 5

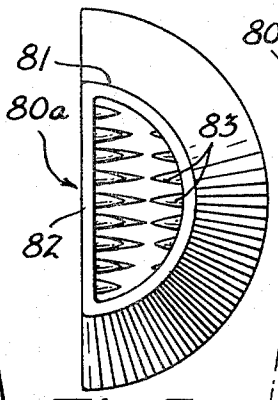


Fig. 6

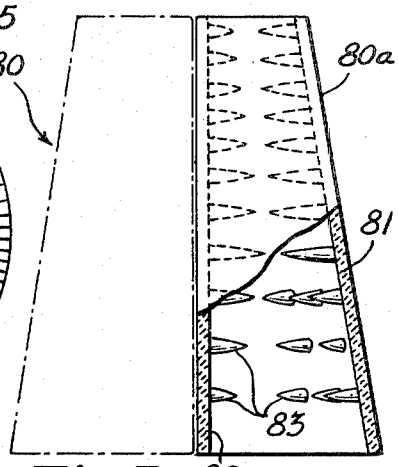


Fig. 7

INVENTORS
Myron Shuler
George A. Short
BY Evans & McCoy
ATTORNEYS

United States Patent Office

2,752,870

Patented July 3, 1956

2,752,870

GAS FIRED INCINERATORS

George A. Short, Chagrin Falls, and Myron Shuler, University Heights, Ohio

Application March 12, 1954, Serial No. 415,771

13 Claims. (Cl. 110—18)

This invention relates to gas fired incinerators, and particularly to gas fired incinerators designed for the disposal of garbage and other household refuse.

One of the principal objections to the burning of garbage and the like in household incinerators, especially in relatively congested residential areas, is the foul odor of the smoke and fumes discharged therefrom because of incomplete combustion. It has previously been proposed to employ auxiliary burners in the flues of such incinerators to effect more complete combustion of the flue gases. However, the difficulty of providing such auxiliary apparatus in a form which is safe and reliable, effective in operation, and sufficiently inexpensive to be acceptable to the ordinary purchaser has delayed the adoption of the proposal in connection with incinerators designed for sale and use as household appliances.

The various objects of the present invention are to provide a gas fired incinerator having a safe and effective after-burner that can be manufactured and incorporated therein at a cost within the means of the average customer for such devices. More particularly, the objects of the invention include the provision of an after-burner of improved yet simple design which will effectively burn substantially all odorous fumes rising from the main combustion zone of an incinerator, which will be efficient from the standpoint of gas consumption, and which can be easily incorporated in present gas fired incinerators at a moderate additional cost. Other, and perhaps the most important objects of the invention are to provide a gas burner control system for the main burner and after-burner which will meet all the safety requirements of testing laboratories and municipal regulations, while including automatic pilots for lighting both the main burner and after-burner of the incinerator in normal operation, and which will permit the after-burner and its pilot to be relighted automatically by heat from the main combustion zone, even though both the after-burner and its pilot have been extinguished by abnormal conditions during the operation of burning refuse, or the after-burner pilot has been extinguished by abnormal conditions during an idle period.

The foregoing and other objects of the invention are achieved by the illustrative embodiments herein disclosed. The principal features of these embodiments which characterize the invention include the following: A novel assembly of a dual flame-ring after-burner and associated ceramic radiant elements adapted for interposition between sections of conventional, sheet metal flue pipe and forming passages through the burner rings and radiant elements so that the combustible flue gases are guided over a multiplicity of substantially incandescent hot points on the radiant elements with a minimum of restriction of flow. Novel, ceramic, radiant elements, for association with the aforesaid after-burner, which form vertical flue gas passages, preferably converging slightly in the direction of flow, with a multiplicity of pointed projections extending inwardly from opposite sides of the passage walls from top to bottom of the passages, the tips

of said projections being located in the path of the flue gases above the burner flame where they are quickly heated substantially to incandescence. Separate safety pilots respectively associated with said after-burner and the main burner of the incinerator, the safety pilot for the main burner controlling a main supply valve in a gas line feeding both burners and their pilots, and the safety pilot of the after-burner controlling another supply valve in a gas line running from the main supply valve to the after-burner only.

The foregoing and various other objects, advantages, and features of the invention will be more fully understood from the following more detailed description thereof, taken in conjunction with the accompanying drawings. In the drawings—

Figure 1 is a largely schematic elevational view of an incinerator embodying the present invention;

Fig. 2 is a similar view showing, in somewhat more detail, the gas burners and safety pilot burners, the gas supply lines therefor, and the relationship of the various valves and pilot controls in the gas system;

Fig. 3 is similar to Fig. 2, but shows a modification of the system illustrated in both Figs. 1 and 2;

Fig. 4 is a plan view of the after-burner employed in both embodiments of the invention, with a pair of ceramic radiant elements mounted thereon and shown partly in solid outline and partly in phantom outline;

Fig. 5 is an elevational view partly broken away, of one of a pair of radiant elements for mounting on the after-burner of Fig. 4;

Fig. 6 is a plan view of the radiant element of Fig. 5;

Fig. 7 is a vertical section through the radiant element of Figs. 5 and 6, and additionally shows in phantom outline how a second identical radiant element is disposed in side by side relationship therewith to form a two-piece, truncated, conical assembly of radiant elements adapted to rest on the after-burner as indicated in Figs. 1, 2, and 3.

Referring first to Figs. 1 and 2, an incinerator housing 1 is shown in simplified form (Fig. 1). The housing is provided with a hinged lid 2 for charging refuse to be burned, a grate 3 for supporting the refuse in a combustion zone 4 defined by the housing 1, and a main gas burner 5 disposed below the grate to assist in igniting the refuse and maintaining its combustion. An ash receptacle below the main burner 5 and various structural details unnecessary to a complete understanding of the invention have been omitted from the drawings for the sake of simplicity.

A main gas supply conduit 6, having a main gas valve 7 interposed therein, extends into the housing and is connected to a conventional manifold 8 for feeding a mixture of gas and air to the main burner 5. A second valve 9 actuated by a manually settable timer 10 of any conventional design is also interposed in the main gas conduit 6. The main valve 7 and timer actuated valve 9 are intended to be fully open or fully closed at all times and are not utilized to regulate the volume of gas flow. The volume of flow of gas through the main gas conduit 6 to the main burner 5 is controlled by a manually adjustable needle valve 11 also interposed in the conduit 6 adjacent the manifold 8.

A safety pilot burner 15 is disposed adjacent the main burner 5 for lighting the latter automatically when gas is supplied thereto. Associated with the safety pilot burner 15 is a thermoresponsive device which is operative in response to heat from the pilot burner 15 for holding the main valve 7 open. This thermoresponsive device may include a bulb 16 communicating through a tube 17 with a bellows 18, all three being filled with a conventional thermo-responsive fluid. The bellows 18 is suitably mounted on the housing of the main valve 7 and is con-

nected to the valve element 19 therein in a well known manner through a lever arrangement 8, all being shown in a simplified diagrammatic form in Fig. 2. The valve 7 is preferably biased toward its closed condition by a suitable spring (not shown) or by resiliency of the bellows 18. As indicated at 20 and 21, the pilot burner 15 is designed to support an upper flame for lighting the main burner and a plurality of side flames playing against the bulb 17. Heat from the latter causes expansion of the fluid in the bulb sufficient to extend the bellows 18 and hold the main valve 7 open so long as the pilot burner 15 is functioning normally as described.

Gas is normally supplied to the pilot burner 15 through a conduit 23 leading from the low pressure side of the valve 7, whereby gas supply to this pilot burner will also be cut-off when the main valve 7 is closed. In order that such gas flow to the pilot burner 15 may be established for lighting the same, a manually actuatable by-pass mechanism is built into the main valve 7 in accordance with conventional practice in safety pilot designs. As diagrammatically shown in Fig. 2, this mechanism may consist of a plunger 25 normally held in its upper position, as shown, by the action of a spring 26. The lower end of the plunger 25 is enlarged and passes through a partition 27 separating the high and low pressure chambers of the valve 7. A passageway 28 extending between the two valve chambers in the lower end of the plunger 25 opens into the low pressure chamber at one end but is normally closed at its opposite end. Manual depression of the plunger moves the latter end of the passageway 28 into communication with the high pressure side of the valve 7, thus establishing an open path for flow of gas around the valve element 19 and into the conduit 23. The plunger is held in its depressed position to light the pilot burner 15 and until the bulb 16 is heated sufficiently to actuate the bellows 18 for initially opening the valve 7 and holding it open so long as the pilot burner 15 is functioning properly.

The main burner 5 may then be placed in operation by first opening the control valve 11 an estimated amount, then opening the timer valve 9 for a predetermined period of time by manually setting the timer 10, and finally adjusting the control valve 11 to obtain its proper setting for normal operation of the main burner. The timer valve 9 will be closed automatically by the timer 10 according to its setting, and subsequent operation of the main burner 5 merely requires resetting the timer 9 for the desired period of operation.

Up to this point, the principle of the apparatus described is conventional and is embodied in various commercial incinerators presently on the market. The improvements thereon which constitute the present invention, however, function in cooperation with what has been described above so as to provide a novel combination of interrelated elements. The more or less conventional parts constitute a part of the entire combination and, therefore, have necessarily been described in some detail.

In accordance with the present invention, the simple flue normally provided for incinerators of the type described has interposed therein an after-burner assembly generally designated 30. This assembly may be contained in a cylindrical housing 31 having upper and lower end walls which are apertured to receive the upper end of a lower flue length 32 and the lower end of an upper flue length 33. The upper flue length 33 may communicate directly with any suitable chimney or stack (not shown) and is preferably provided with any conventional form of barometric draft regulator, diagrammatically shown at 34, for suppressing overactive combustion in the main combustion zone 4.

An after-burner 35, shown in more detail in Fig. 4, is positioned within the housing 30. This burner is preferably in the form of a hollow ring having an integrally formed, hollow, chord portion communicating with the interior of the ring at both ends and extending diametrically of the ring. Two sets of gas discharge openings 38 are provided in this burner, the openings of each set being disposed in a continuous array around one-half of the burner ring and along one side of the chord portion of the ring so as to surround one of a pair of vertical flue gas passageways 41 and 42 through the ring on opposite sides of the chord portion thereof. So that gas issuing from one of these sets of openings will be ignited automatically by the burning of gas issuing from the other set, a line of smaller gas openings 39 is provided between the two sets to cause flame to travel from one set to the other. A mixture of gas and air is fed to the after-burner 35 through a conventional manifold 40, which projects into the housing 31 and is joined to the burner ring, preferably adjacent the end of the chord portion thereof which is crossed by the supplemental flame carrying openings 39.

A radiant structure 80 of ceramic material, described in more detail hereinafter, rests on the after-burner 35 and respectively surrounds the two sets of gas openings 38.

A conduit 43 for supplying gas to the after-burner 35 branches off from the main gas supply conduit 6, between the timer actuated valve 9 and the main burner needle valve 11, and is connected to the after-burner manifold 40 for normally supplying gas to the after-burner whenever the timer valve 10 is opened to supply gas to the main burner 5. An automatically operated safety valve 44 and, if desired, a manually adjustable needle valve 45 are interposed in the conduit 43, the safety valve being intended to move between fully open and fully closed positions in response to a safety pilot control associated with the after-burner 35, and the needle valve being manually adjustable merely to establish a proper rate of gas flow to the after-burner. As will be understood, a fixed gas orifice may be substituted for the needle valve 45.

A safety pilot burner 50 projects upwardly through the bottom of the after-burner housing 31 and through the flue gas passageway 41 in the after-burner 35, adjacent both the ring portion 36 and chord portion 37 thereof for lighting one side of the after-burner when gas is applied thereto. As noted above, the issuance of gas through the small burner openings 39 carries the flame from one side of the after-burner to the other for lighting the other side thereof.

Associated with the after-burner pilot 50 is a thermo-responsive device which is operative in response to heat from this pilot burner to actuate the safety valve 44 and hold it open. This thermo-responsive device preferably includes a mono-metallic lever 51 of a well known type. As shown in Figs. 2 and 4 this lever may have its upper end flanged and rigidly secured to the bottom of the after-burner 35, or to any other suitable, fixed support, and may have its lower end connected to a plunger 52 for actuating a valve element 53 in the safety valve 44. If desired, a spring 54 may be employed in the safety valve 44 to urge the valve element 53 toward its valve closing position.

The upper portion of the lever 51 is bifurcated to provide spaced legs 56 and 57, the latter leg being disposed close to the pilot burner 50. The pilot burner 50, in addition to having a gas outlet at the upper end thereof to support a flame 58, has a plurality of gas outlets along one side thereof for directing flames 59 against the adjacent leg 57 of the lever 51. Heat from the flames 59 normally causes thermal elongation of the lever leg 57 relative to the other lever leg 56, thus swinging the lower end of this lever to the position shown in phantom outline in Fig. 2 and opening the safety valve 44. A baffle 60 may be formed integrally with the lever 51 between the legs 56 and 57 thereof to shield the leg 56 from the flames 59.

So long as the pilot burner 50 is operating normally, the lever 51 will be in thermal equilibrium and hold the

valve 44 continually open. Upon failure of the pilot burner 50 to maintain the lever leg 57 at a temperature sufficiently above that of the other lever leg 56, the lever will move toward the condition shown in solid outline in Fig. 2 and close the safety valve 44, thus cutting off the flow of gas to the after-burner 35. Accidental failure of the pilot burner 50 due to drafts in the flue system may be minimized by any suitable baffling of this pilot burner (not shown).

Gas is supplied to the safety pilot burner 50 through a conduit 61 that branches off from the gas supply conduit 23 for the main pilot burner 15, between it and the main valve 7. Thus, gas is always flowing to both pilot burners if it is flowing to either one of them, and both are initially lighted at the same time by starting the flow of gas thereto through the by-pass in the main valve 7, as described above. With the timer valve 9 in its idle, closed condition, no gas flows either to the main burner 5 or after-burner 35 while the pilots are being lighted in spite of the presence of gas in the low pressure side of the main valve 7.

When both pilot burners 15 and 50 have been lighted and the main valve 7 and safety valve 44 have been automatically opened, the entire control system is in its idle position. Thereafter, whenever it is desired to burn refuse placed in the combustion zone 4, the single operation of setting the timer 10 opens the timer valve 9 and supplies gas both to the main burner 5 and to the after-burner 35, which are lighted automatically by their respective pilot burners 15 and 50.

In the event of failure of the main pilot burner 15 for any reason, the main valve 7 will be automatically closed as described above, shutting off all gas to the entire system. This is essential to safety. In the event of failure of the after-burner pilot burner 50, however, only the valve 44 supplying gas to the after-burner itself will be closed, but gas will continue to be fed to the pilot burner 50, as well as to the main burner 5 and its pilot burner 15. This prevents the discharge of any substantial quantity of unburned fuel gas into the flue and eliminates any danger of creating an explosive gas mixture in the flue above the after-burner. Gas will continue to be supplied in low volume to the after-burner pilot 50, but, as will be appreciated, the rate of discharge of unburned gas from this source directly into the flue system is too low to be hazardous.

With the above described gas control system, failure of the after-burner pilot burner 50 will not interrupt combustion of refuse that may be in progress at the time in the combustion zone 4, and will not prevent ignition of a fresh charge of refuse following an idle period. Moreover, normal combustion conditions in the combustion zone 4 will generally cause enough burning ash and flame to travel the short distance along the flue to the after-burner 30 to rekindle the gas being discharged from the after-burner pilot burner 50, thus restoring operation of this pilot and of the after-burner with which it is associated. Particularly when igniting a fresh charge of refuse, with which a substantial amount of rapidly burnable paper or the like should always be used, the after-burner pilot burner 50 will be almost instantaneously relighted and will quickly bring about normal operation of the entire after-burner system, provided only that gas is flowing to this pilot burner at or near its normal rate.

Should the flow of gas to the pilot burner 50 be stopped or substantially reduced, as by clogging of a gas passage (which occurs at infrequent intervals in any automatic pilot system), only the after-burner system will be affected thereby, and the continued operability of the main burner 5 will permit the incinerator to be safely used until the necessary service can be obtained. This is especially important in the case of domestic incinerators because of the common inability of the user to perform even the simplest of servicing operations. Thus, the presence of an after-burner system controlled in accordance with the present invention in no way increases the susceptibility of the remainder of the system to disabling operational conditions. At the worst, the device herein disclosed can be operated in the same manner and with the same safety and reliability as present household gas incinerators until any required servicing of the after-burner system is obtainable.

Before referring in more detail to the radiant structure 80 in the after-burner 30 and the manner in which it contributes to the effectiveness of the after-burner, brief reference should be made to the modified gas control system illustrated in Fig. 3 as an example of the kinds of variations of the system of Figs. 1 and 2 which are contemplated as being within the scope of this invention. In Fig. 3, parts identical to those shown in Figs. 1 and 2 have been identified by the same reference characters and will not be redescribed. Where possible, similar parts in Fig. 3 are identified by corresponding numbers with "primes" added.

In Fig. 3, a modified form of main gas valve 7' and thermo-responsive control therefor are shown, together with the interposition of an additional manually operated valve in the main gas line 8'. In this case, the thermo-responsive element is a thermocouple generator 16' upon which the side flames 21 of the main pilot burner 15 play. Though shown as a single thermocouple 16' for simplicity, any desired number of thermocouple units may be grouped together and connected in series in a well known manner to build up the required electrical current.

The modified main valve 7' may comprise a valve element 19', movable manually in a downward direction from its fully closed to its fully open position by a plunger 70 opposed by a light spring 71 which biases the valve element toward its valve closing position. The valve element 19' has an integrally formed, downwardly projecting, valve stem with an enlarged head 72 of magnetically permeable material at the lower end thereof, and a solenoid 73 with an electromagnetic core 74 is mounted on the valve 7' for magnetically coacting with the magnetic head 72 and holding the valve element 19' in its open position. The solenoid 73 is energized by electrical current generated in the thermocouple generator 16' by heat from the pilot flames 21 and transmitted through electrical conductors 75 and 76.

The additional manually operated valve 77 may be a simple cock interposed in the main gas conduit 6 between the main valve 7' and timer controlled valve 9. This cock is provided for temporarily shutting off the flow of gas to the main burner 5 and after-burner 35 during lighting of the one or both of their respective pilot burners 15 and 50 in the event failure of either or both of those pilot burners is discovered after opening and setting the timer controlled valve 9 to place the incinerator in operation.

The branch conduits 23' and 61' for supplying gas to the pilot burners 15 and 50, respectively, are connected to the main gas conduit 6' between the main valve 7' and the cock 77, as by connecting them into the low pressure side of the main valve 7' itself. Thus gas is supplied to the pilot burners 15 and 50 while the plunger 70 in the main valve 7' is manually depressed to hold this valve open until the pilot burner 15 has been lighted long enough to energize the solenoid 73. Thereupon, the plunger 70 may be released and the pilot burner 50 lighted. If the cock 77 has been closed during these operations to prevent accidental injury from premature lighting of the main burner 5 and after-burner 35, the cock 77 is then opened and normal operation is restored.

The arrangement of parts in Fig. 3, as just described, is illustrative of various modifications that may be made in the control system while employing the essential features of the present invention.

Turning now to the detailed construction of the radiant

structure contained in the after-burner assembly (generally designated **80** in Figs. 1 and 2), and referring particularly to Figs. 4 to 7, the radiant structure is disposed above and rests upon the after-burner 35. This radiant structure is preferably composed of a heat-resistant ceramic material conventionally used in making radiant elements for domestic, gas, space heating stoves of various types.

The composite radiant structure **80** is generally tubular and preferably is in the form of a frusto-conical outer shell **81**, having a vertical, diametrical partition **82** (Fig. 4) that divides the interior of the shell into two, separate, vertical passageways for flue gases. As shown, the composite radiant structure **80** is preferably made in two identical parts, the detailed structure of one of these parts or elements being shown in Figs. 5, 6, and 7. Each of the individual elements (designated **80***a*) forms half of the composite structure, including half of the thickness of the diametrical partition **82** and half of the circumference of the frustoconical shell.

Inside of each element **80***a*, a multiplicity of projections **83** are formed on the surface of the shell portion **81** and on the surface of the partition **82**, the projections tapering from the surfaces on which they are formed to tips of relatively small cross section for providing, in the aggregate, a large area of highly heated surface. The projections on the inner surface of the shell portion **81** are distributable over substantially the entire surface thereof in closely spaced relationship in parallel, horizontal rows, with the projections of each row staggered with respect to the projections of the row on either side thereof. The projections on the oppositely facing surface of the partition portion **82** are similarly distributed. As shown, all of the projections on both the shell portion **81** and on the partition portion **82** extend along generally parallel lines substantially normal to the plane of the partition **82**, though this relationship is of no critical importance. Also, the projections vary in length from a minimum adjacent the top, bottom, and sides of each surface on which they are formed to a maximum adjacent the center of each surface on which they are formed, the projections adjacent the center of the shell portion **81** projecting nearly into contact with the projections adjacent the center of the partition **82**, and the remainder of the projections on each surface terminating at their tips progressively further from the tips of the generally opposite projections on the opposite surface, toward the top, bottom and side edges of each surface. As is characteristic of radiant elements, the portions of smallest cross section are most easily heated substantially to incandescence for promoting complete combustion of gases in contact therewith, and the arrangement of the projections shown and described distributes the tips of small cross section of the projections **83** generally throughout the horizontal cross section of the flue gas conduit formed by each individual element **80***a* without seriously impeding the flow of gases therethrough. As a result, the radiant elements, when heated by the burner **35**, are highly efficient in promoting combustion of the combustible components of gases traveling therethrough.

The pair of elements **80***a*, disposed with their partition portions **82** substantially in registry, rest upon a plurality of supporting bosses **85** having upwardly projecting inner lips **86** which extend upwardly into the individual elements **80***a* for positioning them in proper alignment with the arrays of burner openings **38**. As best shown in Fig. 4, the burner openings **38** are disposed a substantially uniform, short distance inwardly (with respect to the conduit defined by each element **80***a*) from the walls of each element **80***a*, so that the flames issuing from the burner openings concentrate their heat on the multiplicity of projections **83** on the inner walls of each of said elements.

In order to prevent the partitions **82** of the ceramic elements **80***a* from blocking the travel of flame from one side of the burner **35** along the array of small burner openings **39** to the opposite side of the burner **35**, and in order to make the radiant elements **80***a* interchangeable so that they cannot be improperly positioned to produce such an obstacle, the partition portion **82** of each element is provided with a pair of notches **87** at opposite sides thereof. One of the notches **87** on each element **80***a* spans the array of small burner openings **39** on one side of the radiant member **80**. In the event the elements of the radiant assembly should be reversed accidentally, the notches on the opposite sides thereof will provide the necessary passageway for the travel of flame along the small burner openings **39**, thus preventing any possibility of interfering with the function of these burner openings by reversing the relationship of the individual radiant elements **80***a*.

The flue section **32** immediately below the after-burner **35** directs the gaseous products of partial combustion of refuse in the combustion zone **4** upwardly through the openings **41** and **42** in the burner ring **35** and through the conduits defined by the pair of radiant elements **80***a*, where they come into contact with the highly heated projections **83**. Combustible gaseous components of these flue gases are efficiently ignited and burned as the gases pass upwardly through the radiant elements. Because the amount of oxygen present in this region is necessarily limited, the burning of the flue gases therein is not instantaneous, but continues as the gases move upwardly over a substantial distance, creating what is commonly referred to as a "floating flame." This flame assists in maintaining the desired temperature of the interior of the radiant elements, thus supplementing the effect of the after-burner **35**. The floating flame effect also requires that the radiant elements **80***a* extend vertically for a substantial distance to insure complete combustion of the gases passing therethrough. In practice, I have found that a vertical height of 7 to 10 inches or so is desirable for a radiant member **80** of approximately 6½ inches O. D., when employed in association with a standard 4 inch sheet metal flue section **32**.

Both to assist in securely positioning the radiant elements **80***a* on the after-burner **35** within the housing **31** and to insure that all of the flue gases from the combustion zone of the incinerator pass through the ring of the burner **35** and through the radiant element passageways, the space between the outer surface of the radiant structure **80** and the inner surface of the cylindrical housing **31** may be packed with any desired heat resistant or refractory material **88** (Fig. 1), such as rock wool or a settable cementitious mixture of powdered vermiculite and a hydraulic cement binder.

From the foregoing detailed illustration and description of preferred embodiments of the present invention, and of the mode of operation thereof, it will be appreciated that a safe, reliable and efficient after-burner system and control therefor have been provided and that the simplicity of the system admirably adapts it for incorporation in conventional gas fired incinerators heretofore in extensive use for the disposal of domestic refuse. It will also be appreciated that various departures from the specific embodiments illustrated and described may be employed to obtain the many advantages of the invention without departing from the true spirit and scope of the appended claims.

Having described our invention, we claim:

1. In a gas fired incinerator having means defining a main combustion zone, a primary gas burner disposed to ignite combustible material in said main combustion zone, means defining a flue leading from said main combustion zone, and a gas after-burner in said flue, the combination of a first pilot burner for said primary burner, a second pilot burner for said after-burner, a gas main having branch connections respectively to said primary burner, said after-burner, and said first and second pilot burners, a main valve in said gas main upstream from

all of said branch connections for simultaneously controlling the flow of gas from said gas main to each of said branch connections, means responsive to heat from said first pilot burner for holding said main valve open and maintaining gas flow to all of said branch connections and responsive to reduction of the heat from said first pilot burner for closing said main valve, an after-burner valve in the branch connection to said after-burner, and means responsive to heat from said second pilot burner for holding said after-burner valve open and responsive to reduction of the heat from said second pilot burner for closing said after-burner valve.

2. A gas incinerator according to claim 1 in which said after-burner comprises a hollow ring disposed with its axis vertical, means for supplying a combustible gas mixture into said hollow ring, said ring having an array of gas discharge openings formed in and spaced around said ring, a hollow, tubular, radiant member substantially coaxial with said ring and having its lower end closely surrounding said array of discharge openings, whereby the burning of gas discharged from said openings will heat the inner surface of said radiant member, and means for conducting gaseous products of partial combustion from said main combustion zone upwardly through said ring and said tubular radiant member and into contact with the heated inner surface of the latter.

3. A gas incinerator according to claim 1 in which said after-burner comprises a hollow ring disposed with its axis vertical, means for supplying a combustible gas mixture into said hollow ring, said ring having an array of gas discharge openings formed in and spaced around said ring, a hollow, tubular, radiant member substantially coaxial with said ring and having its lower end closely surrounding said array of discharge openings, whereby the burning of gas discharged from said openings will heat the inner surface of said radiant member, and means for conducting gaseous products of partial combustion from said main combustion zone upwardly through said ring and said tubular radiant member and into contact with the heated inner surface of the latter, the inner surface of said tubular radiant member including a multiplicity of inwardly directed, inwardly tapering projections terminating in tips of relatively small cross section for providing a large, highly heated, surface area in the path of said gaseous products.

4. A gas incinerator according to claim 1 in which said after-burner comprises a hollow ring disposed with its axis vertical, means for supplying a combustible gas mixture into said hollow ring, said ring having an array of gas discharge openings formed in and spaced around said ring, a hollow tubular radiant member substantially coaxial with said ring and having its lower end closely surrounding said array of discharge openings, whereby the burning of gas discharged from said openings will heat the inner surface of said radiant member, and means for conducting gaseous products of partial combustion from said main combustion zone upwardly through said ring and said tubular radiant member and into contact with the heated inner surface of the latter, the inner surface of said tubular radiant member including a multiplicity of inwardly directed, inwardly tapering projections terminating in tips of relatively small cross section for providing a large, highly heated, surface area in the path of said gaseous products, said tubular radiant member being formed in two halves separable along a vertical diametrical plane and having adjacent surfaces forming a partition in said plane that divides the interior of said member into two, generally parallel, vertical passageways.

5. A gas incinerator according to claim 1 in which said after-burner comprises a hollow ring disposed with its axis vertical, means for supplying a combustible gas mixture into said hollow ring, said ring having an array of gas discharge openings formed in and spaced around said ring, a hollow, tubular, radiant member substantially coaxial with said ring and having its lower end closely surrounding said array of discharge openings, whereby the burning of gas discharged from said openings will heat the inner surface of said radiant member, and means for conducting gaseous products of partial combustion from said main combustion zone upwardly through said ring and said tubular radiant member and into contact with the heated inner surface of the latter, the inner surface of said tubular radiant member including a multiplicity of inwardly directed, inwardly tapering projections terminating in tips of relatively small cross section for providing a large, highly heated, surface area in the path of said gaseous products, said tubular radiant member being formed in two halves separable along a vertical diametrical plane and having adjacent surfaces forming a partition in said plane that divides the interior of said member into two, generally parallel, vertical passageways, and said hollow ring having a hollow diametrical chord portion communicating with the interior of said ring and vertically aligned with said partition, said chord portion having arrays of additional gas discharge openings extending therealong on opposite sides of said partition for supporting flames to heat opposite sides of said partition.

6. A gas incinerator according to claim 1 in which said after-burner comprises a hollow ring disposed with its axis vertical, means for supplying a combustible gas mixture into said hollow ring, said ring having an array of gas discharge openings formed in and spaced around said ring, a hollow, tubular, radiant member substantially coaxial with said ring and having its lower end closely surrounding said array of discharge openings, whereby the burning of gas discharged from said openings will heat the inner surface of said radiant member, and means for conducting gaseous products of partial combustion from said main combustion zone upwardly through said ring and said tubular radiant member and into contact with the heated inner surface of the latter, the inner surface of said tubular radiant member including a multiplicity of inwardly directed, inwardly tapering projections terminating in tips of relatively small cross section for providing a large, highly heated, surface area in the path of said gaseous products, said tubular radiant member being formed in two halves separable along a vertical diametrical plane and having adjacent surfaces forming a partition in said plane that divides the interior of said member into two, generally parallel, vertical passageways, and said hollow ring having a hollow diametrical chord portion communicating with the interior of said ring and vertically aligned with said partition, said chord portion having arrays of additional gas discharge openings extending therealong on opposite sides of said partition for supporting flames to heat opposite sides of said partition, and said partition including a multiplicity of outwardly directed, outwardly tapering projections terminating in tips of relatively small cross-section for providing additional, highly heated, surface area in the paths of said gaseous products on opposite sides of said partition.

7. A gas incinerator according to claim 1 in which said after-burner comprises a hollow ring disposed with its axis vertical, means for supplying a combustible gas mixture into said hollow ring, said ring having an array of gas discharge openings formed in and spaced around said ring, a frustro conical radiant member substantially coaxial with said ring and having its large end closely surrounding said array of discharge openings, whereby the burning of gas discharged from said openings will heat the inner surface of said radiant member, and means for conducting gaseous products of partial combustion from said main combustion zone upwardly through said ring and said frustro conical radiant member and into contact with the heated inner surface of the latter.

8. A gas incinerator according to claim 1 in which said after-burner comprises a hollow ring disposed with its axis vertical, means for supplying a combustible gas mixture into said hollow ring, said ring having an array of gas discharge openings formed in and spaced around said

ring, a frustro conical radiant member substantially coaxial with said ring and having its large end closely surrounding said array of discharge openings, whereby the burning of gas discharged from said openings will heat the inner surface of said radiant member, and means for conducting gaseous products of partial combustion from said main combustion zone upwardly through said ring and said frustro conical radiant member and into contact with the heated inner surface of the latter, said radiant member being formed in two halves separable along a vertical diametrical plane and having adjacent walls forming a partition substantially in said plane that divides the interior of said member into two, generally parallel, vertical passageways, the inner surfaces of said passageways including a multiplicity of inwardly directed, inwardly tapering projections terminating in tips of relatively small cross-section for providing a large, highly heated, surface area in the path of said gaseous products.

9. In a gas fired incinerator having means defining a main combustion zone, a primary gas burner disposed to ignite combustible material in said main combustion zone, means defining a flue leading from said main combustion zone, and a gas after-burner in said flue, the combination of a first pilot burner for said primary burner, a second pilot burner for said after-burner, a gas main having branch connections respectively to said primary burner, said after-burner, and said first and second pilot burners, a main-valve in said gas main upstream from all of said branch connections for simultaneously controlling the flow of gas from said gas main to each of said branch connections, means responsive to heat from said first pilot burner for holding said main valve open and maintaining gas flow to all of said branch connections and responsive to reduction of the heat from said first pilot burner for closing said main valve, an after-burner valve in the branch connection to said after-burner, and means responsive to heat from said second pilot burner for holding said after-burner valve open and responsive to reduction of the heat from said second pilot burner for closing said after-burner valve, said means responsive to heat from said second pilot burner comprising a mono-metallic thermo-responsive lever connected to said after-burner valve for opening and closing the same with a gradual movement.

10. In a gas fired incinerator having means defining a main combustion zone, a primary gas burner disposed to ignite combustible material in said main combustion zone, means defining a flue leading from said main combustion zone, and a gas after-burner in said flue, the combination of a first pilot burner for said primary burner, a second pilot burner for said after-burner, a gas main having branch connections respectively to said primary burner, said after-burner, and said first and second pilot burners, a main valve in said gas main upstream from all of said branch connections for simultaneously controlling the flow of gas from said gas main to each of said branch connections, means responsive to heat from said first pilot burner for holding said main valve open and maintaining gas flow to all of said branch connections and responsive to reduction of the heat from said first pilot burner for closing said main valve, an after-burner valve in the branch connection to said after-burner, and means responsive to heat from said second pilot burner for holding said after-burner valve open and responsive to reduction of the heat from said second pilot burner for closing said after-burner valve, an additional valve interposed in said gas main between said main valve and the branch connections to said primary burner and said after-burner, and a manually settable timer control mechanism associated with said additional valve and manually operable to open said additional valve for a predetermined period of time and then close the same, said branch connections to said first and second pilot burners leading from said gas main at a point between said main valve and said additional valve for by-passing the latter.

11. In a gas fired incinerator having means defining a main combustion zone, a primary gas burner disposed to ignite combustible material in said main combustion zone, means defining a flue leading from said main combustion zone, and a gas after-burner in said flue, the combination of a first pilot burner for said primary burner, a second pilot burner for said after-burner, a gas main having branch connections respectively to said primary burner, said after-burner, and said first and second pilot burners, a main valve in said gas main upstream from all of said branch connections for simultaneously controlling the flow of gas from said gas main to each of said branch connections, means responsive to heat from said first pilot burner for holding said main valve open and maintaining gas flow to all of said branch connections and responsive to reduction of the heat from said first pilot burner for closing said main valve, an after-burner valve in the branch connection to said after-burner, and means responsive to heat from said second pilot burner for holding said after-burner valve open and responsive to reduction of the heat from said second pilot burner for closing said after-burner valve, said means responsive to heat from said second pilot burner comprising a mono-metallic thermoresponsive lever connected to said after-burner valve for opening and closing the same with a gradual movement, an additional valve interposed in said gas main between said main valve and the branch connections to said primary burner and said after-burner, and a manually settable timer control mechanism associated with said additional valve and manually operable to open said additional valve for a predetermined period of time and then close the same, said branch connections to said first and second pilot burners leading from said gas main at a point between said main valve and said additional valve for by-passing the latter.

12. An after-burner assembly comprising a gas burner in the form of a hollow ring disposed with its axis vertical, and having an array of gas discharge openings extending generally around said ring, a hollow, tubular, radiant member substantially coaxial with said ring, and having its lower end closely surrounding said discharge openings, whereby the burning of gas discharged from said openings will heat the inner surface of said radiant member, and means for conducting gaseous products of partial combustion upwardly through said hollow ring and said radiant member and into contact with the inner surface of the latter, said radiant member including a multiplicity of inwardly directed, inwardly tapering projections terminating in tips of relatively small cross section and providing a large, highly heated, surface area in the path of said gaseous products, said tubular radiant member being formed in two halves separable along a vertical diametrical plane and having adjacent walls in substantial registry for forming a partition substantially in said plane and dividing the interior of said member into two, generally parallel, vertical, passageways, said hollow ring having a hollow diametrical chord portion communicating with the interior of said ring and vertically aligned with said partition, said chord portion having arrays of additional gas discharge openings extendng therealong on opposite sides of said partition for maintaining flames to heat opposite sides of said partition.

13. An after-burner assembly comprising a gas burner in the form of a hollow ring disposed with its axis vertical, and having an array of gas discharge openings extending generally around said ring, a hollow, tubular, radiant member substantially coaxial with said ring, and having its lower end closely surrounding said discharge openings, whereby the burning of gas discharged from said openings will heat the inner surface of said radiant member, and means for conducting gaseous products of partial combustion upwardly through said hollow ring and said radiant member and into contact with the inner surface of the latter, said radiant member including a multiplicity of inwardly directed, inwardly tapering pro-

jections terminating in tips of relatively small cross section and providing a large, highly heated, surface area in the path of said gaseous products, said tubular radiant member being formed in two halves separable along a vertical diametrical plane and having adjacent walls in substantial registry for forming a partition substantially in said plane and dividing the interior of said member into two, generally parallel, vertical passageways, said hollow ring having a hollow diametrical chord portion communicating with the interior of said ring and vertically aligned with said partition, said chord portion having arrays of additional gas discharge openings extending therealong on opposite sides of said partition for maintaining flames to heat opposite sides of said partition, and said partition including a multiplicity of outwardly directed, outwardly tapering projections terminating in tips of relatively small cross section for providing additional, highly heated, surface area in the paths of said gaseous products on opposite sides of said partition.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 16,122	Risinger	July 21, 1925
765,534	Williams	July 19, 1904
1,223,182	Lamb	Apr. 17, 1917
1,488,677	Hoffman	Apr. 1, 1924
1,528,816	Cummings	Mar. 10, 1925
1,529,871	Conroy	Mar. 17, 1925
1,594,744	Moore	Aug. 3, 1926
1,683,375	Wiederhold	Sept. 4, 1928
1,810,852	Possons	June 16, 1931
2,131,929	Amme	Oct. 4, 1938
2,183,855	Mansky	Dec. 19, 1939
2,212,352	Plein	Aug. 20, 1940
2,658,742	Suter	Nov. 10, 1953

FOREIGN PATENTS

220,778	Great Britain	Aug. 28, 1924
68,593	Denmark	Feb. 21, 1949