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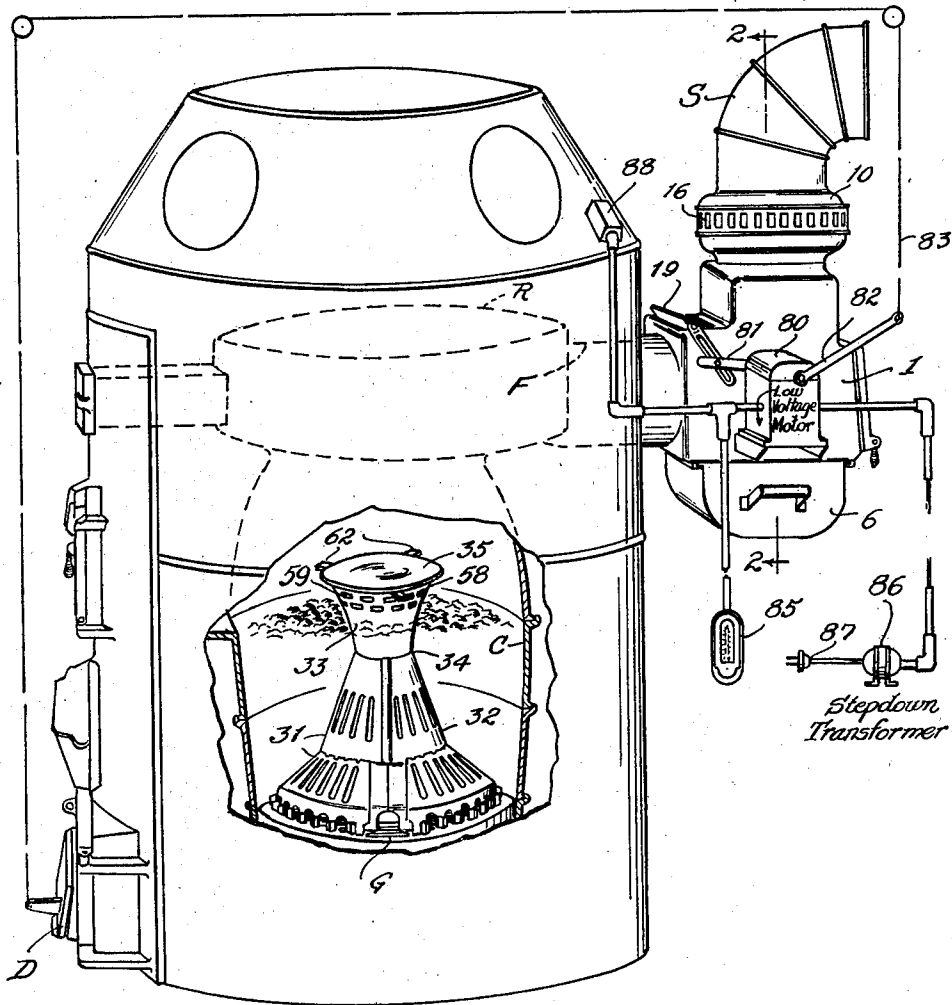
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FUEL BURNING AND RECUPERATING DEVICE

Filed Aug. 14, 1933

2 Sheets-Sheet 1



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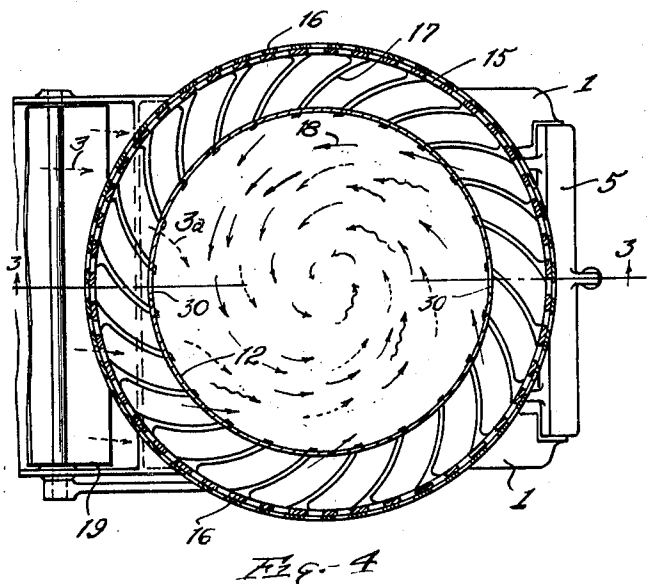
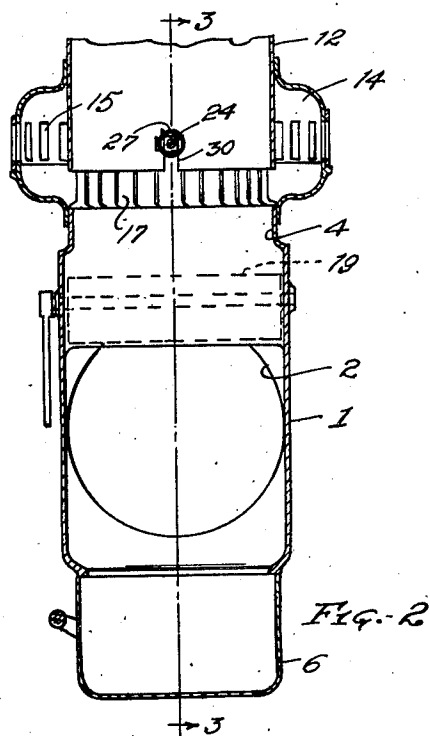
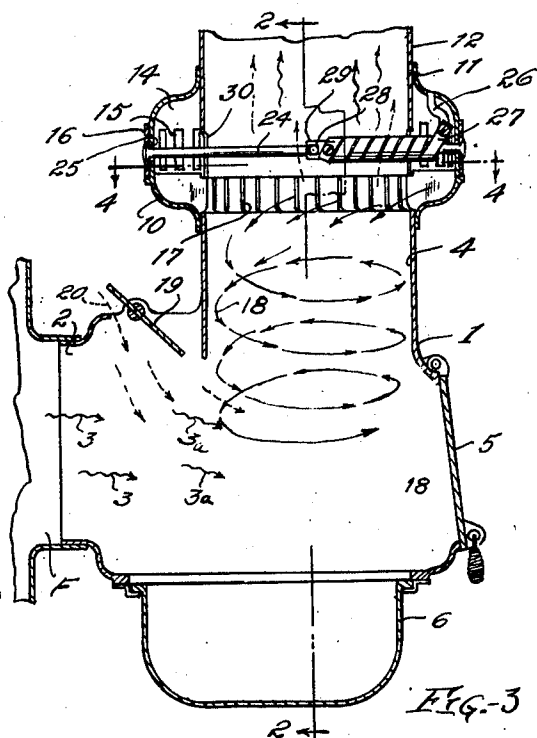
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FUEL BURNING AND RECUPERATING DEVICE

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,070,536

FUEL BURNING AND RECUPERATING
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Application August 14, 1933, Serial No. 685,123

9 Claims. (Cl. 110—119)

This invention relates to an apparatus for effecting more efficient combustion of carbonaceous fuel and for aerating and cleaning the products of combustion resulting from burning of such fuels.

The principal objects of the present invention are to burn carbonaceous fuels efficiently in a combustion chamber of a furnace, to aerate and effect secondary combustion of the resultant products and utilization of the additional heat so obtained, and to clean the products so that unburned combustible matter and soot are removed and entrapped and prevented from passing into the stack.

Another object is to maintain a predetermined balance between the amount of air discharged through and over the fuel bed and the amount utilized for aerating and cleaning the exhaust products.

Still another object of the invention is to maintain automatically a balance between the rate of combustion of the fuel, the secondary combustion of the products discharged from the combustion chamber and the cleaning operation of the finally resulting products.

A correlative object is to aerate the exhaust products from the combustion chamber with air directed in a manner to effect mechanical separation of suspended matter from the products before discharge thereof into the furnace stack.

Another object is to provide a Venturi grate for discharging air over the fuel bed in the combustion chamber and to regulate the air discharged therefrom both in a predetermined relation to the air used for cleaning the products of combustion and in the predetermined relation to the heat in the combustion chamber.

Still another object is to provide a Venturi grate arranged for discharging air into the combustion chamber with means in the grate for controlling the discharge of air therefrom in response to changes in the temperature within the grate itself.

Other objects and advantages will become apparent from the following specification wherein reference is made to the following drawings:

Fig. 1 is a side elevation of a warm air furnace with apparatus embodying the present invention installed therein, part of the furnace being shown in section for clearness in illustration;

Fig. 2 is a vertical sectional view through the cleaning and aerating device and is taken on a plane indicated by the line 2—2 on Fig. 1;

Fig. 3 is a vertical sectional view through the cleaning and aerating device and is taken on the plane indicated by the line 3—3 of Fig. 2;

Fig. 4 is a cross sectional view of the cleaning and aerating device and is taken on the plane indicated by the line 4—4 of Fig. 3.

Referring to Fig. 1, a preferred embodiment of the invention is shown, for purposes of illustration, in conjunction with a hot air furnace of the commonly used type comprising a fire pot or combustion chamber "C", spanned at the bottom by the usual grate bars "G" which admit air from the ash pit of the furnace into the combustion chamber, the volume of air so admitted being controlled by the usual adjustable damper "D". The fire pot terminates upwardly in a radiator head "R" which communicates with the usual exhaust passage or flue "F" from which flue the products of combustion, gases and suspended matter may be exhausted from the chamber and passed to the outside atmosphere through the furnace stack "S".

The part of the invention most directly concerned with aerating and cleaning the products of combustion from the chamber "C" comprises a hollow body 1, preferably upright and having an inlet passage 2 adapted for communication with the exhaust flue "F" so as to receive the products discharged from the chamber "C" and discharge the same preferably horizontally transversely of the interior of the body, as indicated by the arrows 3.

The body 1 has an exhaust passage 4 angularly disposed to the inlet passage 2 and preferably upright, the exhaust passage 4 communicating at its lower end with the interior of the body near or above the level of the inlet passage 2. A clean-out passage, closed during operation by a suitable door 5, is provided in the body wall to permit access to the interior thereof. The body is closed at the lower end by a removable hopper or bin 6 aligned with the exhaust passage 4.

Surmounting the body is a globular shell 10 which communicates at its lower end with the exhaust passage 4 and is preferably coaxial therewith. At the opposite end of the shell 10 is a discharge passage 11 which discharges into the stack "S" and through this stack communicates with the outside atmosphere. Thus the exhaust gases and products issuing from the combustion chamber "C" pass into the body 1, upwardly through the passage 4, and into the shell 10 and thence to the stack. Ordinarily, in so doing, these products would convey suspended matter and an appreciable amount of combustible gases and heat therethrough.

In order to recuperate the heat, to effect a secondary combustion of the combustible gases and part of the suspended matter and to separate any remaining suspended matter from the products, means must be provided for passing air into the stream of products before the same pass out of the body 1 to aerate the same thoroughly. By the present apparatus, such air is directed in a manner to effect also mechanical separation of

suspended matter from the outgoing stream of products.

For accomplishing this purpose a sleeve 12 which forms, in effect, a continuation of the stack "S", is provided, the sleeve 12 protruding inwardly of the shell 10 through the discharge passage 11 and extending coaxially of and part way through the interior of the shell 10 toward the inlet passage of the shell.

In the illustrative example shown, the sleeve terminates inwardly of the shell 10 beyond its mid-portion toward the inlet passage of the shell thus defining with the side walls of the shell an annular trough 14. In order to introduce outside air into the shell 10 a number of passages 15 are provided around the periphery of the shell, these passages being so positioned longitudinally of the shell as to discharge into the trough 14. For controlling the volume of air admitted through the passages 15, a suitable air register 16, preferably of the rotary type, is mounted about the circumference of the shell 10 and cooperates with the passages 15 so as to vary the effective size of the same as the register is rotated. Thus air entering the passage 15 through the register passes into the trough 14 and is heated somewhat by contact with the sleeve 12 so that it may be mixed with the gases in the body 1 and ignited easily. Due to the temperature of the air being low relative to the temperature of the products of combustion, and also due to the stack pull, this air tends to flow around the lower end of the sleeve 12 and downwardly through the passage 4, thus forming a downwardly traveling annular stream of air closely adjacent the side walls of the passage 4 and body 1. In order to effect better admixture of this air and products of combustion, it is desirable to maintain this stream somewhat confined and fixed in shape so that it will not readily be destroyed upon contact with the exhaust products entering the body 1. Furthermore it is desirable to maintain the air as a swirling stream so as to more effectively separate suspended matter from the products of combustion coming into contact with the stream. For this purpose, a plurality of radial baffles 17 are provided in the lower portion of the shell 10 extending from the side walls thereof outwardly to the sleeve 12. These baffles are curved, as illustrated in Fig. 4, for imparting a swirling motion to the air. The baffles extend upwardly in the trough beyond the innermost end of the sleeve 12 so that all air admitted from the trough 14 must pass through the baffles. Since the air so admitted is, as stated, relatively cool and is discharged with a rotary motion, it forms a swirling stream flowing downwardly through the passage 4 and through the interior of the body 1 close to the side walls.

This swirling annular stream, indicated by the arrows 18, extends across the normal path of travel of the products of combustion, indicated by the arrows 3, entering the passage 2 so as to impinge thereon. The products, due to their heated condition, tend to rise and thus move in a direction opposite to the stream 18 but to do so must pass through or into contact with this stream so as to enter and be discharged from the passage 4. The swirling motion of the air stream imparts to the incoming products a similar swirling motion and, in turn, is heated by the products. The resultant heated mixture, being prevented from rising near the side walls of the body by the downwardly swirling air, passes toward the center of the body 1 and rises

within the annular swirling stream, forming a funnel-shaped swirling rising stream within the annular stream usually tapered in the direction of flow. The products are thoroughly aerated during this passage and likewise are swirled with sufficient force to effect separation of any suspended matter therefrom by centrifugal force. Due to the temperature of the products, secondary combustion is effected when they are aerated and recirculated along the comparatively long path of travel in the body 1 and shell 10 so as to burn any combustible gases therein and part of the suspended matter.

In order to effect more thorough aeration of the products of combustion and to direct the same more effectively into the stream 18, an opening is provided in the upper wall of the body 1 in a position to admit air thereinto onto the upper surface of the incoming stream of products of combustion, this opening being controlled by a damper 19. The relatively cooler air stream, indicated by the arrows 20, entering this opening, tends to force the incoming products downwardly, as indicated by the arrows 3a, so that they come into contact with the stream 18 well down in the body 1. The stream 18 passes rapidly downwardly toward the hopper 6 and reverses abruptly just above the hopper, when mixed with the products and all soot thrown out of the rising stream by centrifugal force is caught in the downwardly travelling stream and thrown out of this stream as it turns to rise, thus falling into the hopper 6.

In order to vary the volume of air admitted through the passage 15, a thermostatically operable device is provided within the shell 10 so as to be more directly responsive to the temperature of the products passing through the shell and of the heat of secondary combustion. A simple and effective device for effecting this operation may comprise a horizontal rod or lever 24 fixedly secured at its ends in the rotary damper 16, suitable notches or passages 25 being provided in the walls of the shell 10 to permit passage of the rod or lever 24 and permit a limited rotation of the lever 24 relative to the shell 10 about an upright axis. Secured to the shell 10 is a boss 26 to one end of which is fastened the end of a coil 27 of bi-metallic thermostatic metal. The thermostatic coil 27 is coaxial with the lever 24 and is secured thereto at its inner end. For so securing the one end of the coil to the lever 24, a lug 28 is provided, the end of the thermostatic coil being secured to the lug and the lug, in turn, being secured on the lever 24. The lug is movable to different rotated and longitudinal positions on the lever so that it may be turned or moved longitudinally to effect predetermined torsion or stress of the bi-metallic coil 27 so that it will operate at the predetermined temperature desired. A suitable set screw 29 is provided for securing the lug 28 in the position desired. Slots 30 are formed in the lower end of the sleeve 12 to permit relative passage of the lever 24 thereacross. The thermostatic coil 27 is preferably arranged so as to rotate the damper 16 to an open position for admitting a larger quantity of air consequent upon heating of the thermostat to a higher degree of temperature by the products and heat of secondary combustion. Thus, when the thermostat is heated, it reacts against the boss 26, and since this is fixed in position a reactionary thrust is effected on the lever 24, thus causing the lever

to rotate the damper a sufficient amount to vary the effective size of the passages 15.

Within the combustion chamber "C" is a Venturi grate of the general nature disclosed in my United States Reissue Letters Patent No. 19,317, issued September 18, 1934, with certain improvements thereon to effect proper cooperation with the cleaning and aerating device above described for obtaining the desired results.

In the form illustrated the grate comprises a hollow shell body, indicated generally as 31, disposed in upright position in the combustion chamber "C" and preferably resting on the grate "G". This shell is contracted from both ends toward an intermediate portion to form an upwardly contracted heating chamber 32 surmounted by an upwardly expanded expansion chamber 33 communicating at its lower end with the upper end of the heating chamber. The chambers are connected by a very short throat portion 34, the shell being open at the bottom to receive air through the grate "G" into the interior thereof. At the upper end of the expansion chamber is a cap 35 supported in slightly spaced relation to the upper margin of the expansion chamber so as to define therewith a peripheral discharge passage for discharging air from the interior of the Venturi grate into the combustion chamber and across the upper surface of the fuel bed.

In the side wall of the expansion chamber 33 are a plurality of discharge vents 59, the effective size of which is controlled by a register within the head 33, the register being rotatable to different adjusted positions by suitable levers 62.

If the damper "D" is suddenly closed while only the lower strata of the fuel bed is burning at a high rate, a large amount of volatile gases is driven off from the upper strata than is consumed in the combustion chamber. These gases are aerated and burned in the body 1 and shell 10, this secondary combustion heating the thermostatic coil in the latter and additionally opening the register 16. This operation of the register 16 additionally checks the passage of air through the fuel bed and also, to a great extent, holds back the gases in the combustion chamber.

If the damper "D" is only considerably lowered, but not closed, the gases so held back eventually receive ample air through the venturi, as little additional gas is being evolved due to the fact that the venturi will by-pass most of the air directly into the combustion chamber under these conditions and not through the fuel bed. The gases, therefore, remain in the combustion chamber until burned. The more intense heat in the body 1 and shell 10 is reduced after most of the gases have been consumed and the register 16 is operated by the coil 27 to restrict the passage 20 additionally, and a greater stack pull is effected. Again a sufficiently large amount of air is drawn into the venturi so that part passes through the fuel bed again heating the venturi and causing the passages 59 to be opened somewhat and within a short interval, the proper rate of combustion and evolution of gases for a predetermined setting of the damper "D" is again effected.

Sufficient air to effect substantially complete combustion of these gases in the combustion chamber is normally provided through the peripheral passage in the venturi after the rate of combustion for a predetermined setting of the damper "D" has become steady.

When the fire is burning slowly, the vents 59 in the venturi will be closed or only slightly

opened by a thermostatic register damper contained therein and the greater portion of the air passing through the grate must discharge through the restricted peripheral passage and the side walls of the heating compartment, and air is again drawn through the fuel bed so as to increase the rate of evolution of the gases.

Referring again to Fig. 1, an economical and efficient means for controlling the various air currents and operation of the apparatus automatically is illustrated. When lowering or closing the damper "D" for reducing the amount of air entering the interior of the Venturi grate, the stack draft likewise should be checked and vice versa. Suddenly closing the damper "D" while the under stratum is in a highly incandescent state causes evolution of an amount of combustible gases in excess of the air provided for combustion of the same. Furthermore, more air is required for aerating and cleaning this excess of gases than is supplied initially through the register 16. This additional amount is supplied through the opening controlled by the damper 19.

For properly correlating the operation of the damper "D" and damper 19, a motor 80 is provided. This motor is operably connected by a lever mechanism 81 to the damper 19 and by a lever 82 to a suitable chain 83 operably connected to the damper "D" for lifting the same. The levers 81 and 82 are so disposed relative to each other that upon rotation of the motor in one direction they operate concurrently to close the damper 19 and to open the damper "D" and, upon reversal of the motor, to open the damper 19 and close the damper "D". Consequently, the air introduced through the grate and that introduced into the body 1 are in inverse proportional relation to each other. If the damper "D" is fully opened, sufficient air is normally supplied through the peripheral passage of the venturi to effect substantially complete combustion of the evolved gases while in the combustion chamber. If the heat unduly increases, the vents 59 may be opened to supply more air and also reduce the rate of evolution until a balance is again reached.

It is apparent that when a large amount of air is mixed with the products of combustion in the combustion chamber less is needed in the body 1, and consequently these volumes of air are maintained in inverse relation to each other. To control operation of the apparatus in response to temperatures in the rooms to be heated, a thermostat 85 is provided. The thermostat is of the double contact type, that is, one having a common movable contactor and two stationary contactors, one of the latter being associated with the common contactor when the thermostat is cool and the other being so associated when the thermostat is heated. Separate wires lead from the stationary contactors to the device to be operated and a wire, common to the two other wires for completing circuits therewith respectively, leads to the device from the movable contactor. Thus a dual electric circuit is provided. The thermostat is connected in the dual electrical circuit in series with the motor 80 and operates when moved in one direction to close the circuit for operating the motor in one direction and when operating in the opposite direction to break the first circuit and to close the other circuit for operating the motor in the opposite direction and vice versa. The motor and thermostat circuit may be connected in series to 110 volt or other household circuit, but preferably are connected in series with a transformer 86 which in

turn is connected to the high voltage household circuit through the usual wall plug 87. It often happens that a particular room may require more heat than is supplied even though the furnace is operating at capacity or at overload due to the lag in heat being conveyed from the furnace to the room. In order to protect the furnace in such instances a thermostat 88 is provided, this thermostat being normally connected in series with the thermostat 85 and the motor 80 and closing the circuit operable to cause the motor to open the damper 19 consequent upon heating of the thermostat 88 above a predetermined degree. Thus the furnace and the Venturi grate are both protected from excessive temperatures.

Assuming the apparatus to be operating with the working parts in the relative position shown in Fig. 1 only a small amount of air is introduced at the damper "D". This air passes through the ash pit and grates "G" into the interior of the Venturi grate. At the same time, the damper 19 is open so as to check the stack pull. Consequently, a comparatively small amount of air is drawn through the venturi and the stack pull is not sufficiently strong to draw any material amount of air out through the side walls of the heating compartment and through the fire bed. Therefore slow surface combustion of the fuel bed is maintained and very little volatile gases driven off. This air passed through the venturi is preheated on passing therethrough, thus assisting in maintaining the Venturi grate at a lower temperature and discharges over the fuel bed and mixes with the gases evolved. The resultant burning mixture remains for a considerable period within the combustion chamber due to the reduced stack pull and then passes through the flue "F" into the body 1. Though there may be an insufficient amount of air passing through the fuel bed and over the surface thereof with resulting imperfect combustion, since the damper 19 is open, a large quantity of air is mixed with these gases as they enter the body 1 thus aerating the same so that secondary combustion is effected and remaining volatile gases consumed. This heat causes the register 16 to be opened more widely and consequently the downwardly swirling stream is effective to swirl and aerate the incoming products of combustion, causing any suspended matter to be thrown out so that it falls into the hopper 6 and further reducing the stack pull. Upon additional reduction of gases passing into the body 1, the temperature therein is lowered and the register 16 closes or reduces the inflow of air, whereupon the stack pull in the combustion chamber is again increased and more gases are evolved.

On the other hand when the damper "D" is open widely, the damper 19 is closed, thus increasing the effective stack pull in the combustion chamber and consequently drawing more air than will pass through the peripheral passage 58. Therefore a larger volume of air passes through the fuel bed. This evolves more gases than with a slow fire but at the same time more air is discharged through the top of the venturi to mix therewith. Also, the venturi is heated to a higher degree. As the venturi heats, the thermostat therein likewise heats but less rapidly owing to the air passing through the venturi. As the thermostat heats, however, it rotates the register damper and when it has become heated to a very high degree has moved the register damper to position to fully open the openings 59 in the

side wall of the chamber 33, thus furnishing an abundance of air over the surface for effecting combustion of the gases and also checking the passage of air through the fuel bed so as to reduce the rate of evolution of gases. Thus a large volume of the products of combustion results and these are well mixed with air before entering the body 1. These too are caught in the swirling stream within the body 1 and swirled rapidly so that the suspended matter is removed without requiring the addition of any large volume of air through the passage controlled by the damper 19. When very intense heat results in the body 1 which in turn heats the thermostatic coil 27 so that it opens the register 16 in the shell 10, the stack pull is reduced and a large amount of air is provided in the swirling stream for aerating the products of combustion. Thus a balance in the rate of evolution of gases and the rate of combustion is maintained for all settings of the damper "D".

It is apparent from the foregoing description that the apparatus herein described operates substantially automatically and the working parts thereof cooperate to produce effective combustion of the fuel and utilization of the resultant gases and uniform fire at various temperatures and to maintain the products of combustion free from volatile gases and suspended matter. In those instances in which the volatile gases continue burning in the body 1 this heat is effectively radiated within the house and does not escape through the flue, and the soot and suspended matter included in the products of combustion are entrapped in the hopper 6 and may readily be returned to the fire to be utilized.

Having thus described my invention, I claim:

1. A device for aerating and cleaning products of combustion from a combustion chamber comprising a hollow body having an inlet passage arranged for discharging products of combustion from said chamber into the body and an exhaust passage communicating the interior of the body with the atmosphere, said passages being angularly disposed to each other, an air vent for admitting outside air into the body from a position such that it flows thereinto in a direction away from and substantially coaxially of the exhaust passage and into contact with said products, and means to direct said air as a swirling stream.

2. A device for aerating and cleaning products of combustion from a combustion chamber comprising a hollow body having an inlet passage arranged for discharging said products of combustion into and across the body and an exhaust passage communicating the interior of the body with the atmosphere, said passages being angularly disposed to each other, means for admitting outside air into the body, so that it may flow longitudinally of the interior of the body substantially coaxially of and away from said exhaust passage, means to deflect said air spirally and means operable to introduce outside air into the products of combustion entering the body prior to passage of said products into said swirling stream.

3. A device for aerating and cleaning products of combustion from a combustion chamber comprising a hollow body having an inlet passage arranged for discharging said products into the body and an exhaust passage communicating the interior of the body with the atmosphere, said passages being angularly disposed with respect to each other, means for admitting outside air

into the body so that it may flow into the interior of the body substantially coaxially of the exhaust passage and away from said passage, means to deflect said air along a spiral path of travel, a passage for introducing outside air into the body from above downwardly onto the incoming products of combustion, and means operable to direct said incoming products and last mentioned air toward the end of said swirling air stream remote from the exhaust passage.

4. A device for aerating and cleaning products of combustion from a combustion chamber comprising a hollow body having a substantially horizontal inlet passage arranged for passing products of combustion from a combustion chamber into the body and a substantially upright exhaust passage communicating with the interior of the body above the level of the inlet passage and with the outside atmosphere, a passage for admitting a stream of outside air into the body substantially coaxially with the exhaust passage from a level above the inlet passage, means to deflect said air along a spiral path of travel, means within the body arranged to deflect the incoming products of combustion downwardly and into said swirling stream, an adjustable air inlet means for discharging air in predetermined volumes into the body onto the incoming stream of products of combustion, and means responsive to the heat of said products of combustion operable to vary the volume of said swirling stream.

5. A device for aerating and cleaning products of combustion from a combustion chamber comprising a hollow shell, an inner sleeve of smaller diameter than the shell extending thereto from one end, an inlet passage at the opposite end of the shell aligned with said inner sleeve and arranged to receive said products of combustion and discharge the same into the shell, the walls of said passage and inner sleeve terminating in longitudinally spaced relation to each other, said inner sleeve and shell defining a peripheral trough opening at the innermost end of the inner sleeve into the interior of the shell, air inlet means operable to introduce air into said trough, an adjustable air register associated with said air inlet means operable to vary the flow of said air there-through, and thermostatically operable means responsive to the heat of said products of combustion to move said register to different adjusted positions.

6. A device for aerating and cleaning products of combustion comprising a hollow shell having an air inlet, an inner sleeve protruding within the shell arranged to discharge exhaust products therefrom and forming with the wall thereof an internal annular trough discharging radially inwardly of the shell and communicating with said air inlet, a passage in said shell for receiving products discharged from a combustion chamber and discharging the same into the shell, said passage having its discharge and in alignment with the inner shell and spaced longitudinally therefrom, and means associated with said trough to cause the air from said trough to discharge as an annular cyclonic stream toward and into the said incoming products.

7. A device for aerating and cleaning products of combustion from a combustion chamber comprising a hollow body, a hollow shell having an inlet passage at its lower end communicating with the upper end of the body, an inner sleeve of smaller diameter than the shell protruding thereinto from the upper end and communicating with a discharge flue, said inlet passage being aligned

with said inner sleeve and arranged to receive products of combustion from said body and to discharge the same into the said shell, the walls of said inlet passage and inner sleeve terminating in longitudinally spaced relation to each other and the walls of said inner sleeve and shell defining a peripheral trough discharging around the innermost end of the inner sleeve, air inlet means for admitting air into said trough, baffles arranged near the discharge end of said trough operable to impart to said air a spiral swirling motion around an axis parallel to the axis of the shell, whereby a swirling annular stream coaxial with the shell traveling away from the sleeve toward and extending into said body is formed, and an inlet passage in said body arranged to discharge products of combustion thereinto into contact with said swirling stream whereby said products and air become heated and swirl and rise within said annular stream.

8. A device for aerating and cleaning products of combustion comprising a hollow body having an inlet passage for receiving a stream of products of combustion from a combustion chamber and for discharging the same into and across the body, and an upright exhaust passage communicating with the body above the level of the inlet passage and in communication with an exhaust flue, an air inlet for admitting air into said body above the inlet passage whereby the air flows opposite to the flow of the products of combustion, means cooperable therewith to impart a swirling motion to said air and to direct said air as a swirling stream of annular cross section into contact with the products discharging into the body from said inlet passage, whereby said products are aerated and swirled and the mixture turns abruptly and rises within said annular stream and throws out suspended matter and the suspended matter passes into the outer downwardly swirling stream, a hopper communicating with the interior of the body below the confluence of said streams of air and products for receiving suspended matter dropping out from said swirling mixture.

9. A device for aerating and cleaning products of combustion from a combustion chamber comprising a hollow body having a substantially horizontal inlet passage for receiving products of combustion from a combustion chamber and for discharging the same into the body and having an upright discharge passage, a globular shell surmounting said body and communicating at its lower end with the discharge passage of the body, a sleeve protruding into said globular shell from the end remote from the body and forming an exhaust passage leading from said shell and defining with the walls of said shell an annular trough, means for admitting cool outside air into said trough whereby said air may flow toward the axis of said shell and downwardly around the lower end of said sleeve, spiral baffles cooperable with said trough to cause said air to swirl about a generally upright axis, whereby a swirling downwardly moving annular stream of air is formed extending from the lower end of said shell into the interior of said body, means for directing the incoming products of combustion generally downwardly and into contact with said swirling stream, an air inlet means for admitting air into said body onto the upper surface of the stream of incoming products of combustion whereby said products are aerated and caught in said swirling stream and cooled thereby and suspended matter may pass toward the bottom of said body.

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