May 26, 1964 W. J. KING 3,134,345

COMBINATION INCINERATOR AND DRAFT CONTROL APPARATUS

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FIG. 2

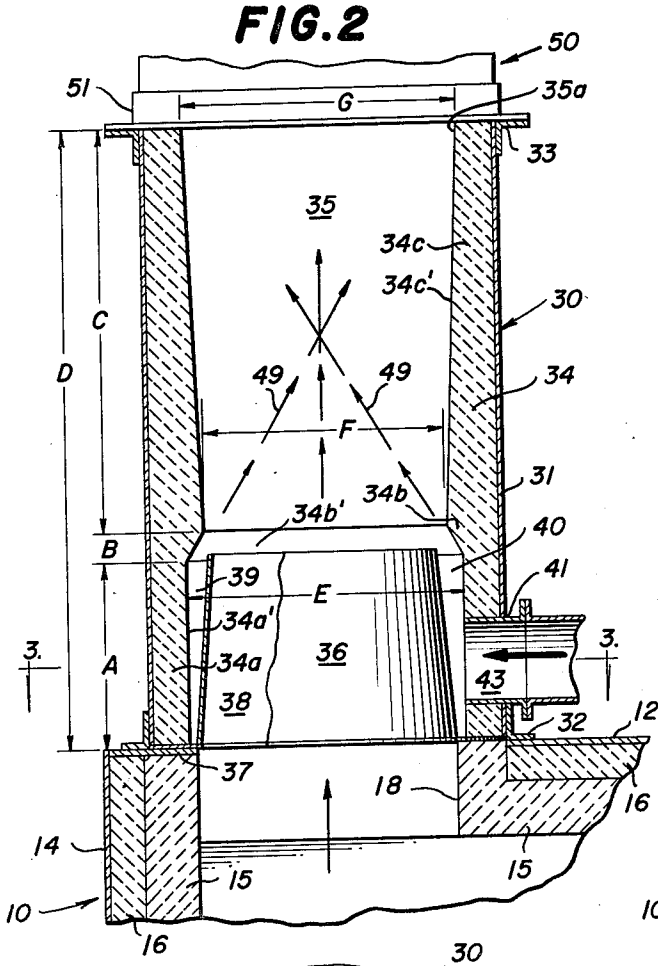


FIG. 1

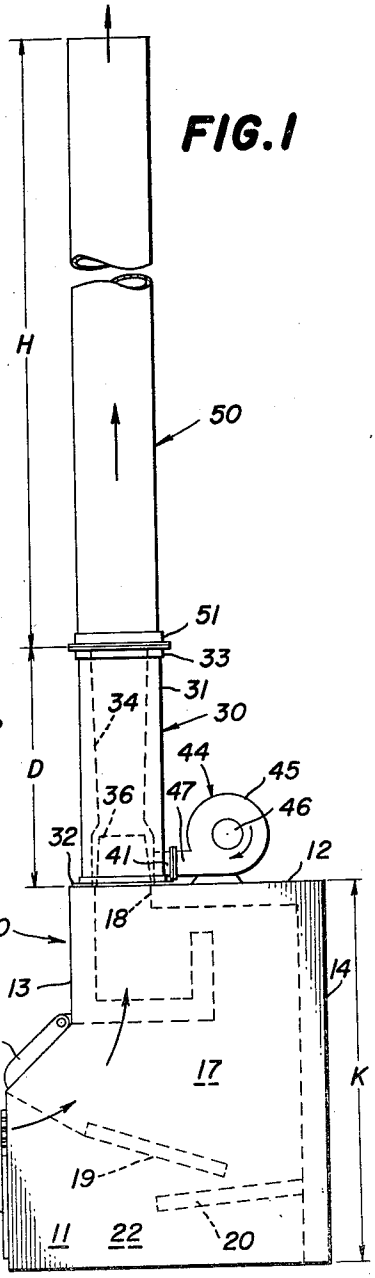
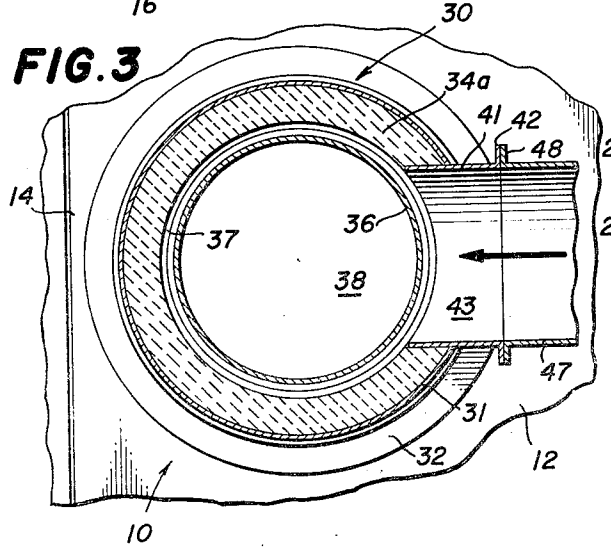


FIG. 3



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COMBINATION INCINERATOR AND DRAFT CONTROL APPARATUS

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The present invention relates to combination incinerator and draft control apparatus, and more particularly to such apparatus of improved and simplified construction and arrangement.

It is a general object of the invention to provide the combination of an incinerator including a housing provided with a top wall and enclosing a combustion chamber and a communicating flue extending upwardly through the top wall and of a draft control unit carried by the top wall and including an upstanding tubular metal casing surrounding the top end of the flue and an upstanding tubular refractory liner arranged in supported position within the casing and also surrounding the top end of the flue and incorporating therein venturi structure and a blower operatively connected to the venturi structure to supply air thereto so as to produce an updraft from the combustion chamber through the flue and thence through the liner to the exterior.

Another object of the invention is to provide a draft control unit of the character described, wherein the venturi structure is formed fundamentally by the inner surfaces of lower and intermediate and upper sections of the liner, the inner surfaces mentioned having the required coordinate configurations for the purpose noted.

A further object of the invention is to provide a draft control unit of the character described, wherein the liner is of prefabricated monolithic structure and the required configurations of the inner surfaces of the sections thereof are obtained incident to casting and to subsequent setting-up of the refractory materials of which the liner is composed.

A still further object of the invention is to provide a draft control unit of the character described, wherein the total venturi structure consists of a single metal tube in addition to the prefabricated liner, and wherein the venturi structure is produced by the mere assembly of the tube within the liner.

Further features of the invention pertain to the particular construction and arrangement of the elements of the combination incinerator and draft control apparatus, whereby the above-outlined and additional operating features thereof are attained.

The invention, both as to organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification, taken in connection with the accompanying drawing, in which:

FIGURE 1 is a side elevational view of combination incinerator and draft control apparatus embodying the present invention and including an incinerator proper and a draft control unit carried by the incinerator proper;

FIG. 2 is an enlarged vertical sectional view of the principal portion of the draft control unit; and

FIG. 3 is an enlarged horizontal sectional view of the principal portion of the draft control unit, this view being taken in the direction of the arrows along the line 3—3 in FIG. 2.

Referring now to FIG. 1 of the drawing, there is shown combination incinerator and draft control apparatus embodying the features of the present invention and comprising an incinerator **10**, a draft control unit **30** and a stack **50**.

The incinerator **10** is of conventional construction and arrangement, and essentially comprises, as shown in FIGS. 1 to 3, inclusive, an upstanding housing **11** formed of

steel and having a substantially box-like configuration and including a top wall **12**, a front wall **13** and a rear wall **14**. The housing **11** encloses refractory wall structure **15** and heat-insulating wall structure **16** cooperating to define therein a combustion chamber **17** and a communicating flue **18**, the flue **18** extending upwardly through the wall structures **14** and **15** and thence through an opening provided in the top wall **12**. The bottom of the combustion chamber **17** is defined by the usual grates, indicated at **19** and **20**; and the front wall **13** is provided with the usual front charging opening communicating with the front of the combustion chamber **17** and selectively opened and closed by an associated front charging door **21**. Also, the usual primary air intake opening is provided in the front wall **13** and communicating with the top of the usual ash pit **22** disposed below the grates **19** and **20**; which primary air intake opening is selectively opened and closed, and otherwise regulated, by an associated intake air control device, indicated at **23**. Finally, the usual ash pit opening is provided in the front wall **13** and communicating with the bottom of the ash pit **22**; which ash pit opening is selectively opened and closed by an associated front ash pit door, indicated at **24**.

The draft control unit **30** is carried by the top wall **12** of the housing **11** of the incinerator **10** and essentially comprises an upstanding substantially cylindrical casing **31** formed of steel and rigidly carrying substantially ring-like steel collars **32** and **33** respectively surrounding the bottom and top ends thereof. The bottom end of the casing **31** is arranged in surrounding relation with the top end of the flue **18**, and the bottom collar **32** is supported upon an adjacent annular section of the top wall **12** and suitably securely fastened thereto. An upstanding tubular refractory liner **34** is arranged in supported position within the casing **31** and also in surrounding relation with the top end of the flue **18**. Preferably, the liner **34** is of monolithic structure and is fixedly secured in place within the casing **31**. For example, the liner **34** may be cast in situ with respect to the casing **31**; and in this case, the refractory materials of which the liner **34** is composed are mixed together, with water as a vehicle, to produce a plastic mass, a suitable collapsible core, not shown, is inserted into the interior of the casing **31** to produce a form, and then the plastic mass is poured into the form to define the basic configuration of the liner **34**. After the plastic mass sets-up, the core mentioned is collapsed and removed from the interior of the green liner **34**; whereupon the casing **31** and the green liner **34** are subjected to the usual firing step to cure the green liner **34**; all in a conventional manner well-known in the ceramic art. Alternatively, the liner **34** may be prefabricated in any suitable manner and then suitably cemented in place within the casing **31**.

The particular composition of the liner **34** forms no part of the present invention, and the same may comprise any one of the many compositions that are commercially available for the present purpose. For example, any one of the porcelain-like refractory compositions that are conventionally employed to line blast furnaces, incinerators, etc., may be employed. For example, such refractory materials usually contain two or more of the ingredients: SiO_2, Fe_2O_3, FeO, Al_2O_3, TiO_2, CaO, MgO, Cr_2O_3 and SiC; and one or more fluxes such as: alkali metal and alkali earth metal borates, silicates, carbonates and oxides.

The liner **34** comprises a lower section **34***a* having a height "A," an intermediate section **34***b* having a height "B," and an upper section **34***c* having a height "C," as shown in FIG. 2. The lower liner section **34***a* has an inner surface **34***a'* that is substantially cylindrical, having a diameter "E." The intermediate liner section **34***b* has an inner surface **34***b'* that is substantially frusto-conical,

having a bottom diameter "E" and a top diameter "F," and extending upwardly and inwardly from the top of the inner surface 34*a'* of the lower liner section 34*a*. The upper liner section 34*c* has an inner surface 34*c'* that is substantially frusto-conical, having a bottom diameter "F" and a top diameter "G," and extending upwardly and outwardly from the top of the inner surface 34*b'* of the intermediate liner section 34*b*. The inner surface 34*c'* of the upper liner section 34*c* defines in the upper liner section 34*c* an upwardly diverging exhaust chamber 35 having an outlet opening 35*a* therefrom at the top end of the upper liner section 34*c*.

An upstanding steel tube 36 is arranged in the lower portion of the liner 34 in surrounding relation with the top end of the flue 18; which tube 36 carries in surrounding relation with the bottom end thereof an outwardly directed annular steel flange 37. The flange 37 is arranged in the extreme lower end of the collar 32 and below the extreme lower ends of the casing 31 and the lower liner section 34*a*; and the periphery of the flange 37 is rigidly secured, as by welding, not shown, to the adjacent annular portion of the bottom collar 32. Also, the flange 37 engages the adjacent annular portion of the top wall 12 surrounding the opening therein at the top end of the flue 18. Thus, the bottom end of the tube 36 is sealed by the collar 37 mutually to the bottom end of the casing 31, to the top end of the flue 18 and to the bottom of the inner surface 34*a'* of the lower liner section 34. The tube 36 has a frusto-conical configuration extending upwardly and inwardly from the bottom end thereof to the top end thereof, the bottom end of the tube 36 being open and communicating with the top end of the flue 18 and the top end of the tube 36 being open and terminating within the intermediate liner section 34*b*, whereby the tube 36 defines an upwardly converging passage 38 therethrough between the bottom and top ends thereof.

The tube 36 is spaced radially inwardly with respect to the inner surfaces 34*a'* and 34*b'* of the respective lower and intermediate liner sections 34*a* and 34*b*. Specifically, the inner surface 34*a'* of the lower liner section 34*a* surrounds the tube 36 and is spaced radially outwardly therefrom and cooperates therewith to define therebetween an upwardly diverging plenum chamber 39; and the lower inner surface 34*b'* of the intermediate liner section 34*b* surrounds the top of the tube 36 and is spaced radially outwardly therefrom and cooperates therewith to define therebetween an upwardly converging nozzle 40 communicating at the bottom thereof with the top of the plenum chamber 39; which elements 39 and 40 have a generally annular configuration and are disposed substantially concentric with the upstanding longitudinal axis of the liner 34.

A pipe 41 extends from the outside radially through aligned openings respectively provided in the lower portion of the casing 31 and in the lower liner section 34*a*, the inner end of the pipe 41 being open and communicating with the adjacent portion of the plenum chamber 39 and the outer end of the pipe 41 carrying an outwardly directed surrounding flange 42. The pipe 41 is rigidly secured in place, as by welding to the adjacent annular portion of the casing 31; and the pipe 41 defines a duct 43 therethrough communicating with the plenum chamber 39. Further, a blower 44 is mounted upon the top wall 12 rearwardly of the casing 31; which blower 44 comprises a casing 45 having an air intake opening 46 therein and an air discharge opening therefrom that is surrounded by a forwardly directed conduit 47 terminating in an outwardly directed surrounding flange 48. The flanges 42 and 48 are suitably connected, so as to connect the conduit 47 to the pipe 41 for the air supply purpose. The blower 44 comprises a rotor, not shown, housed in the casing 45 and suitably rotated by a drive motor, not shown, all in a conventional manner. In passing it is mentioned that such a drive motor may conveniently comprise an electric drive motor of the variable speed type and provided with an associated electric control circuit

that accommodates the desired control of the speed of the connected electric drive motor, whereby the flow rate of the air supplied by the blower 44 may be selectively varied for the purpose of correspondingly varying the draft through the combustion chamber 17 of the incinerator 10 for a purpose more fully explained hereinafter.

In the unit 30 the tube 36 and the surrounding liner 34 comprise venturi structure; and before proceeding with the description of the operation thereof, it is advantageous to consider one constructional example of such venturi structure. In this example: the inner surface 34*a'* of the lower liner section 34*a* has a vertical height "A" of 9⅜" and a substantially uniform diameter "E" of 14". The inner surface 34*b'* of the intermediate liner section 34*b* has a vertical height "B" of 1⅝", a bottom end diameter "E" of 14" and a top end diameter "F" of 12¼", whereby the inner surface 34*b* extends upwardly and inwardly at an angle with respect to the vertical of 28° (about 30°). The inner surface 34*c* has a vertical height "C" of 20", a bottom end diameter "F" of 12¼" and a top end diameter "G" of 14", whereby the inner surface 34*c* extends upwardly and outwardly at an angle with respect to the vertical of 3° (several degrees). The tube 36 and the flange 37 are both fabricated of 3/16" sheet steel; the passage 38 through the tube 36 and through the associated opening in the flange 37 has an overall vertical height of 9 11/16"; the bottom end of the passage 38 in the associated opening in the flange 37 has an internal diameter of 13⅛"; the top end of the passage 38 in the top open end of the tube 36 has an internal diameter of 11⅝"; and, of course, the exterior surface of the tube 36 is spaced outwardly from the interior surface thereof by the 3/16" thickness of the sheet metal of which the tube 36 is fabricated. Thus, the tube 36 extends upwardly and inwardly at an angle with respect to the vertical of about 5°; and the nozzle 40 has a width between the inner surface 34*b'* of the intermediate liner section 34*b* and the adjacent corner of the top end of the tube 36 of somewhat less than 1".

Turning now to the joint mode of operation of the incinerator 10 and the draft control unit 30, the materials undergoing burning are supported upon the grates 19 and 20 in the combustion chamber 17 and intake air to support combustion is supplied from the atmosphere through the primary air intake opening provided in the front wall 13 and thence via the ash pit 22 into the combustion chamber 17. The flue gases resulting from the combustion of the materials in the combustion chamber 17 proceed therefrom and upwardly through the flue 18 and into the passage 38 formed through the tube 36. The blower 44 is operated by the associated electric drive motor, not shown, whereby air from the atmosphere is drawn into the intake opening 46 in the casing 45 and is blown therefrom via the conduit 47 and the duct 43 defined in the pipe 41 into the plenum chamber 39, whereby a substantial air pressure is built-up therein, and the air proceeds upwardly therefrom into the nozzle 40. The nozzle 40 is operative to convert the pressure head of the air therein into a velocity head and to project the resulting stream of air at high velocity upwardly and inwardly therefrom to produce a corresponding air cone, indicated generally by the upwardly and inwardly directed broken lines 49 in FIG. 2, proceeding over the open top end of the tube 36 so as to produce a venturi effect (a low pressure area disposed below the air cone and directly above the open top end of the tube 36) with the result that the flue gases in the passage 38 are drawn upwardly therethrough. In turn, the flue gases moving upwardly into the low pressure area disposed below the air cone are trapped therein and move upwardly and inwardly therewith, whereby the mixed gases thus produced are projected upwardly into the lower portion of the exhaust chamber 35 and proceed upwardly therethrough and from the outlet opening 35*a* therefrom. However, the upwardly and inwardly directed air stream in the air cone maintains the venturi effect, so that the suction of the flue gases through the passage 38 is con-

tinuous, with the result that the forced updraft through the combustion chamber **17** is continuous and very greatly increased with respect to the natural updraft through the combustion chamber **17**.

The magnitude of the forced updraft through the combustion chamber **17** may be selectively controlled, not only by adjusting the intake air control device **23** operatively associated with the primary air intake opening provided in the front wall **13**, but also by adjusting the venturi effect that is produced in the draft control unit **30**. The last-mentioned adjustment may be effected by governing of the electric control circuit for the electric drive motor, so as to control the speed thereof, and consequently, the air supply rate from the blower **44** to the plenum chamber **39**. In passing, it is mentioned that an increase in the speed of the electric drive motor increased the air supply rate of the blower **44**, and consequently the air pressure head in the plenum chamber **39**, with the result that the velocity head of the air stream in the nozzle **40** is increased, whereby the venturi effect is increased (the pressure is lowered in the low pressure area below the air cone). The increase in the venturi effect increases the forced updraft through the combustion chamber **17**.

A high forced updraft through the combustion chamber **17** is very advantageous, as it not only produces rapid burning of the materials in the combustion chamber **17**, but it causes more nearly complete combustion due to several factors, thereby substantially completely eliminating objectionable smoke in the flue gases that are expelled from the draft control unit **30**. Specifically, the temperature in the combustion chamber **17** is materially elevated, which tends to cause more nearly complete combustion; and also, the higher rate of oxygen supply reduces the amount of smoke that is produced and minimizes the production of carbon monoxide in the combustion process.

Furthermore, the exhaust chamber **35** that is defined in the upper liner section **34***c* constitutes, in effect, an auxiliary combustion chamber in which there is maintained a substantially high temperature and into which there is introduced the fresh air from the nozzle **40**. Thus, any smoke in the hot flue gases issuing from the combustion chamber **17** are burned in the exhaust chamber **35**, and any carbon monoxide in the flue gases in the exhaust chamber **35** are oxidized or burned to carbon dioxide. Also, this combination of burning and oxidizing conditions in the apparatus effects substantially complete destruction of amines and other noxious vapors and gases in the mixed gases issuing from the unit **30**. Further, any such residual products in the mixed gases mentioned are so highly dispersed and diluted that the issuing mixed gases are in no way objectionable.

In the present example, the flue gases passing through the tube **36** may have a temprature in the general range 800° F. to 1600° F. and the flow rate thereof may be as high as about 1,600 c.f.m. The blower **44** may deliver air at ambient temperature through the conduit **47** at a flow rate of about 850 c.f.m., when the electric drive motor for the blower **44** is delivering power thereto at about one horsepower.

Finally, the apparatus comprises the upstanding tubular steel stack **50** that is carried by the top end of the casing **31** of the draft control unit **30** and communicating therewith. Specifically the bottom end of the stack **50** carries a surrounding steel collar **51** of substantially ring-like form and rigidly secured thereto; which collar **51** is suitably fastened to the top collar **33** that is carried by the top end of the casing **31**. Ordinarily, it is not necessary to line the interior of the stack **50** with refractory material, since it is usually satisfactorily protected against damage by the liner **34** arranged in the casing **31** of the draft control unit **30**; however, the interior of the stack **50** may be so lined, if desired, all in a conventional manner. The provision of the stack **50** is very advantageous, since the same extends well above the unit **30**, so that the mixed gases proceeding from the unit **30** are released by the stack **50** at the open top end thereof at an elevation positioned substantially above the incinerator **10**.

In a constructional example of the apparatus, as indicated in FIG. 1, the incinerator **10** may have a height "K" of about 5 feet, the unit **30** may have the height "D" of 31 inches, as previously noted, and the stack **50** may have a height "H" of about 30 feet.

In view of the foregoing it is apparent that there has been provided combination incinerator and draft control apparatus comprising an incinerator proper and a draft control unit, each of modular construction, whereby the unit may be readily assembled with a wide variety of different incinerator types and constructions to produce the desired combination. Also, the draft control unit comprises a minimum number of simple parts, of economical construction and arrangement, that automatically produce upon mere assembly thereof venturi structure of predetermined dimensional configuration, so as efficiently to produce a wide range of updrafts through the cooperating incinerator in order substantially to eliminate from the gaseous output therefrom smoke and other products of incomplete combustion.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In combination: an incinerator comprsing an upstanding housing having a top wall, and structure defining a combustion chamber within said housing and a communicating flue extending upwardly through said top wall; and a draft control unit carried by said top wall and comprising an upstanding tubular metal casing surrounding the top end of said flue, an upstanding tubular refractory liner arranged in supported position within said casing and also surrounding the top end of said flue, said liner including a lower section having a substantially cylindical inner surface and an intermediate section having a substantially frusto-conical inner surface and an upper section also having a substantially frusto-conical inner surface, the inner surface of said intermediate liner section extending upwardly and inwardly from the top of the inner surface of said lower liner section, the inner surface of said upper liner section extending upwardly and outwardly from the top of the inner surface of said intermediate liner section and defining in said upper liner section an upwardly diverging exhaust chamber having an outlet opening therefrom at the top end of said upper liner section, an upstanding metal tube arranged in the lower portion of said liner and having an open bottom end sealed both to the top end of said flue and to the bottom of the inner surface of said lower liner section and having an open top end terminating within said intermediate liner section, said tube having a frusto-conical configuration and extending upwardly and inwardly from the bottom end thereof to the top end thereof, whereby said tube defines an upwardly converging passage therethrough communicating at the lower end thereof with the top end of said flue, the inner surface of said lower liner section surrounding said tube and spaced radially outwardly therefrom and cooperating therewith to define therebetween an upwardly diverging plenum chamber, the lower inner surface of said intermediate liner section surrounding the top of said tube and spaced radially outwardly therefrom and cooperating therewith to define therebetween an upwardly coverging nozzle communicating at the bottom thereof with the top of said plenum chamber, a pipe extending through aligned openings respectively provided in the lower portion of said casing and in said lower liner section and defining a duct communicating at the inner end thereof with said plenum chamber, and means including a blower for supplying atmospheric air under pressure through said duct into said plenum chamber to be supplied to said communicating

nozzle, whereby said nozzle is operative to project a corresponding stream of air at high velocity therefrom upwardly and inwardly over the open top end of said tube and thence into the lower portion of said exhaust chamber so that flue gases from said combustion chamber are drawn through said flue and proceed through said passage into the air stream that is projected from said nozzle upwardly into the lower portion of said exhaust chamber, with the result that the mixed gases thus produced in the lower portion of said exhaust chamber are projected therethrough and through the outlet opening therefrom at the top end of said upper liner section.

2. The combination set forth in claim 1, and further comprising an upstanding tubular metal stack carried by the top end of said casing and communicating at the bottom end thereof with the outlet opening at the top end of said upper liner section and communicating at the top end thereof with the atmosphere, said stack extending upwardly well above said draft contrl apparatus so as to release the mixed gases to the atmosphere at an elevation positioned substantially above said incinerator.

3. A draft control unit comprising an upstanding tubular metal casing adapted to be supported above and in surrounding relation with the top end of a cooperating flue, an upstanding tubular refractory liner arranged in supported position within said casing and also adapted to surround the top end of the cooperating flue, said liner including a lower section having a substantially cylindrical inner surface and an intermediate section having a substantially frusto-conical inner surface and an upper section also having a substantially frusto-conical inner surface, the inner surface of said intermediate liner section extending upwardly and inwardly from the top of the inner surface of said lower liner setcion, the inner surface of said upper liner section extending upwardly and outwardly from the top of theinner surface of said intermediate liner section and defining in said upper liner section an upwardly diverging exhaust chamber having an outlet opening therefrom at the top end of said upper liner section, an upstanding metal tube supported in the lower portion of said liner and having an open bottom end sealed to the bottom of the inner surface of said lower liner section and adapted also to be sealed to the top end of the cooperating flue and having an open top end terminating within said intermediate liner section, said tube having a frusto-conical configuration and extending upwardly and inwardly from the bottom end thereof to the top end thereof, whereby said tube defines an upwardly converging passage therethrough adapted to communicate at the lower end thereof with the top end of the cooperating flue, the inner surface of said lower liner section surrounding said tube

and spaced radially outwardly therefrom and cooperating therewith to define therebetween an upwardly diverging plenum chamber, the lower inner surface of said intermediate liner section surrounding the top of said tube and spaced radially outwardly therefrom and cooperating therewith to define therebetween an upwardly converging nozzle communicating at the bottom thereof with the top of said plenum chamber, a pipe extending through aligned openings respectively provided in the lower portion of said casing and in said lower liner section and defining a duct communicating at the inner end thereof with said plenum chamber, and means including a blower for supplying atmospheric air under pressure through said duct into said plenum chamber to be supplied to said communicating nozzle, whereby said nozzle is operative to project a corresponding stream of air at high velocity therefrom upwardly and inwardly over the open top end of said said tube and thence into the lower portion of said exhaust chamber so that flue gases are drawn through the cooperating flue and proceed through said passage into the air stream that is projected from said nozzle upwardly into the lower portion of said exhaust chamber, with the result that the mixed gases thus produced in the lower portion of said exhaust chamber are projected therethrough and through the outlet opening therefrom at the top end of said upper liner section.

4. The draft control unit set forth in claim 3, wherein said lower liner section has a length that is several times that of said intermediate liner section, and said upper liner section has a length that is several times that of the combined lengths of said lower liner section and said intermediate liner section.

5. The draft control unit set forth in claim 3, wherein the inner surface of said intermediate liner section extends upwardly and inwardly at an angle with respect to the vertical of about 30°, and the inner surface of said upper liner section extends upwardly and outwardly at an angle with respect to the vertical of only several degrees.

6. The draft control unit set forth in claim 3, wherein said refractory liner is of monolithic structure.

7. The draft control unit set forth in claim 3, wherein said refractory liner is of monolithic structure and is cast in situ within said casing.

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