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[54] **THERMAL INCINERATION UNIT**
10 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **431/116,** 34/155, 263/3
[51] **Int. Cl.** **F23l 15/00**
[50] **Field of Search** 431/202, 115, 116, 5, 9; 263/3; 34/155

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ABSTRACT: A thermal incinerator unit with an improved design that provides a gas recycle passageway means around and in combination with the combustion section to thereby limit the temperature increase through such combustion section and provide a controlled burning of the incinerated portion of the fumes. The recycle arrangement within the incineration unit is particularly applicable to the handling of a high B.t.u. content contaminated gas stream which could normally result in an excessive temperature rise across the combustion zone.

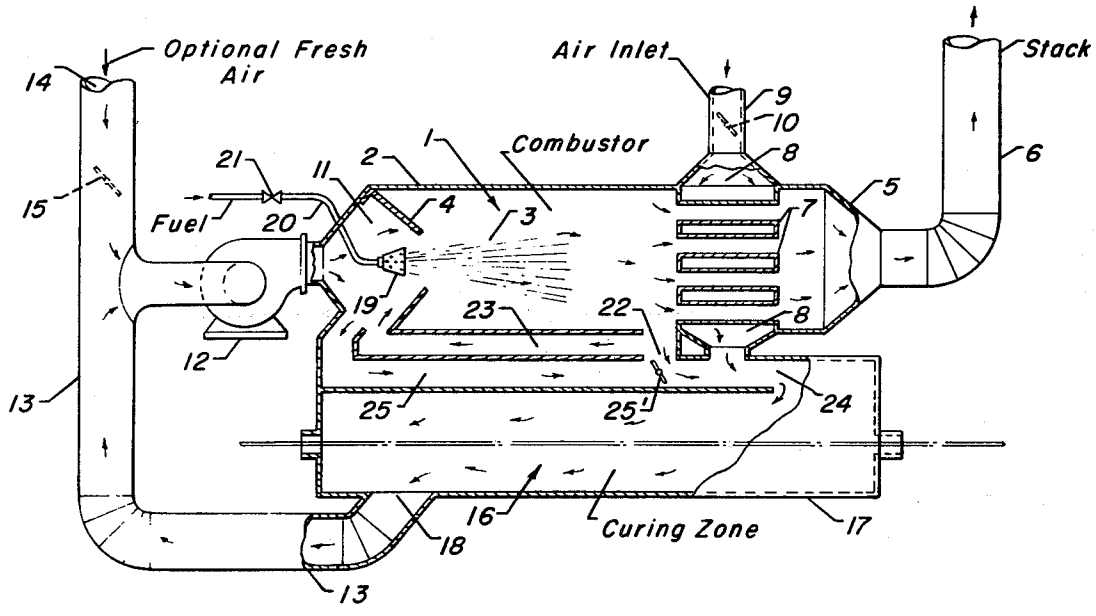


Figure 1

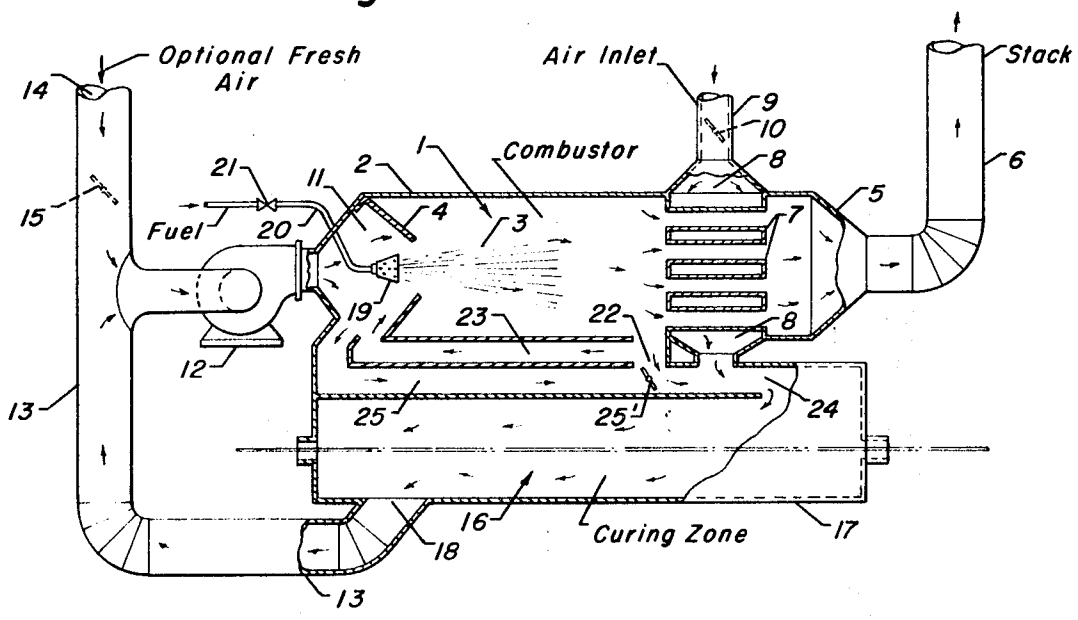


Figure 2

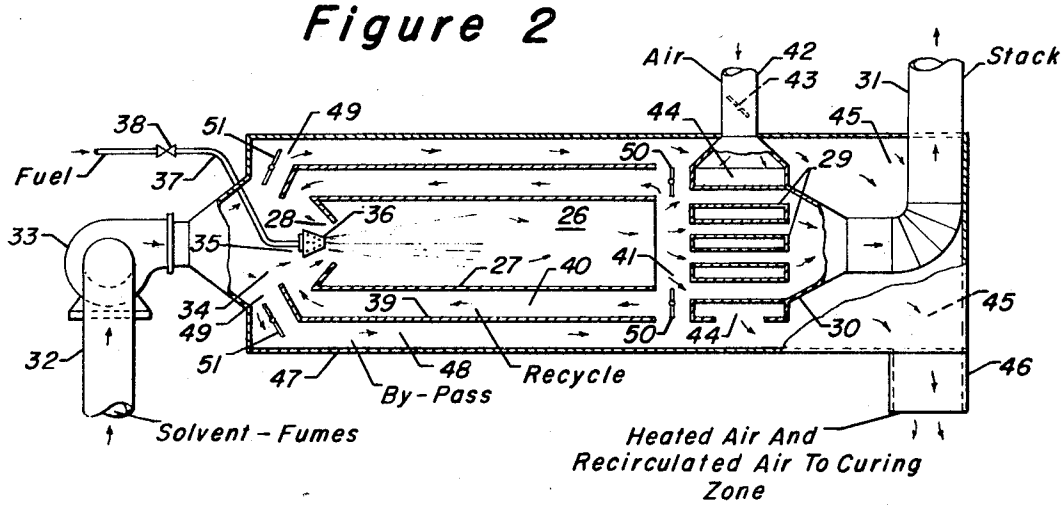
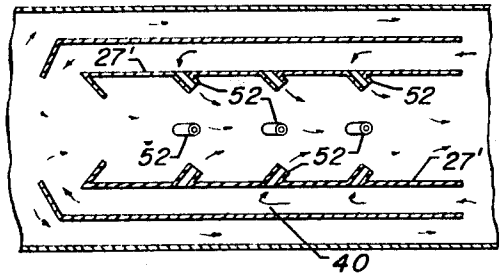


Figure 3



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THERMAL INCINERATION UNIT

The present invention relates to an improved form of thermal incinerator unit and in particular to a type adapted for use with a drying oven or a curing zone discharging an air-polluting gas stream containing combustible components of high B.t.u. content.

In accomplishing thermal incineration of combustible waste products there is generally provided the direct emission of flame and hot gases into the waste gas stream. In addition, there should be provided the customary three elements of good combustion, i.e., time, temperature and turbulence. For high-efficiency incineration systems, there have been various "recouperative"d designs which embody heat exchange means that will transfer heat from the hot combustion gases to the incoming waste gas stream; however, such designs are not necessarily adaptable to drying oven systems where it is desired to reheat and recycle a portion of the waste gas stream to the oven zone. Also, there may be a problem in the handling of the high B.t.u. content gas stream in many of the conventional incinerator units by reason of producing an excessive temperature rise through the length of the combustor section of the unit.

It may, therefore, be considered an object of the present invention to provide a thermal incineration unit, particularly for combination with a drying oven, such that there is provided means to dilute the incoming combustible material in the contaminated stream and thereby increase the effective "inlet temperature" of such stream while, at the same time, reducing the temperature rise through the combustor section to thereby hold to a given maximum temperature at the outlet of the incinerator.

It may be considered a further object of the invention to provide a unitary oven-incinerator design which provides for the special blending in of heated gas at the inlet or burner and of the incinerator section such that combustion of fumes in the gas stream will be initiated with a minimum of fuel from a burner.

A still further object of the present invention is to provide an overall unitary oven-incinerator design which will provide a gas recirculation flow from and back to the oven as well as gas flows through the incinerator section and to gas bypass sections.

In a broad aspect, the present invention provides a thermal incinerator unit for use in combination with a curing zone discharging combustible fumes, which comprises in combination, an elongated combustion section with a fume inlet opening at one end and a hot gas outlet from the opposite end thereof, an axial-positioned burner means directed into said inlet opening and adjustable fuel supply means to said burner means, gas passageway means from said hot gas outlet to said fume inlet opening to effect a hot gas recycle to the latter at said burner means, additional gas passageway means from said hot gas outlet to the curing zone, and a gas outlet conduit from said hot gas outlet to effect a cleaned gas discharge to the atmosphere, at least one adjustable fresh air inlet means to said unit, and fan means connective with said unit providing flow of fumes into said combustion section and through said passageway and conduit means to maintain gas and fume flows therethrough.

As noted hereinbefore, the present improved design is particularly adapted to accommodate high B.t.u. content fumes so as to effect an efficient incineration of the fumes while precluding an excessive temperature rise through the combustion zone. For example, because of the limitations of the metal enclosure comprising the combustion section, it may be undesirable to have a temperature which is greater than about 1,350° to 1400° F. As a result, the present design and arrangement provides for a recycle of hot combustion gases from the outlet zone of the combustor section back along the latter and into its inlet end in admixture with the fume stream being introduced thereto. Where the fume stream is at relatively low temperature, of the order of about 500° F., there can be

burner means to effect a preheating of this stream; however, unless a large quantity of burner fuel is utilized, it is difficult to effect the initiation of the incineration of the fumes, and even with preheat to effect oxidation, there will be a temperature rise of some 800° F. to reach a 1,350° F. temperature at the outlet end of the unit. Thus, by providing recycle gases, which are at the 1,350° F. temperature level, into admixture with the fume-laden stream, there can be a resulting mixture of the order of at least about 1,050° F., whereby incineration can be started and there will be a lessened temperature differential through the combustion section with better operating efficiency.

In a preferred design of the incinerator section, the hot recycle gases which are to be brought into admixture with the fume stream will be returned through an annular-form passageway which is in an indirect heat exchange relationship with the outer wall of the combustion section so that there is a maximum retention of heat in the system. Also, preferably, there will be utilized a heat exchange zone at the downstream end of the combustion section so that fresh air may be heated by indirect heat exchange means from the incinerated fumes leaving the combustion section. The heated fresh air together with a portion of the incinerated gas stream and, where desired, a portion bypassed fume stream, may be passed through suitable conduit means to the curing zone or drying oven from which the fume stream is withdrawn.

In a simplified construction and design arrangement, there may be utilized a single fan to effect the withdrawal of fumes from a curing zone and the introduction of the fumes into the combustor zone, as well as induce hot gas flow trough the recycle passageway and combined heated gas flow back into the curing zone or oven. Of course, where desired, additional fan means may be brought into use in connection with the introduction of fresh air or to effect increase flow rates with respect to recycle and gas bypass passageway means.

In a more elaborate construction and design arrangement, there may be incorporated a fume bypass passageway around or in a heat exchange relationship with the hot recycle stream passing back around the combustor zone such that recirculated gas may be carried back to the oven or curing zone in admixture with a portion of the oxidized gas stream. The bypass arrangement permits a controlled portion of the fume-laden gas stream to be introduced into the combustor zone such that there may be a short residence period in such zone, say of the order of 0.1 to 0.2 seconds to produce of the order of 80 percent conversion. However, an extended passageway from the combustor zone can permit a greater residence time for the net oxidized gas stream carrying to the discharge stack such that there is at least about 0.5 to 0.6 seconds of residence time to produce a greater than 90 percent conversion and an efficient air-pollution control arrangement.

The recycle of a portion of the hot combustion gases from the end of the combustor zone has the effect of increasing the effective "inlet temperature" at a substantially constant outlet temperature operation and, of course, this reduces the fuel requirements for the burner means at the inlet means of combustor zone. In still another aspect, the recycle arrangement provides for the admixture with the combustible fume stream being introduced to the incineration zone to effect an increased temperature for such stream and a reduction in the temperature rise of the gas stream carrying through the length of the combustion zone. Stated another way, the practical result of the incinerator design is to provide a unit that can provide high efficiency and a controlled maximum outlet temperature which is particularly adapted for use in combination with a drying oven or other type curing zone which discharges a fume stream with a high B.t.u. content.

Reference to the accompanying drawing and the following description thereof will serve to set forth the improved incinerator design and construction, as well as point out additional advantageous features which may be obtained from the use thereof in connection with the incineration of high B.t.u. content gases.

FIG. 1 of the drawing is a schematic elevational view indicating a thermal incinerator system providing for hot gas recycle in combination with a curing zone.

FIG. 2 of the drawing is a diagrammatic side elevational view of an alternate form of a thermal incinerator unit providing for both recycle gas passageway and fume bypass passageway means which encompass the combustor section of the unit in a heat exchange manner.

FIG. 3 of the drawing is a partial elevational view indicating a modified system for effecting the stagewise introduction of the hot recycle gases into the combustor section of the unit.

Referring now particularly to FIG. 1 of the drawing, there is indicated a thermal incinerator unit having a combustor zone which is encompasses by shell means **2** with an inlet opening **3**, formed from baffle plate means **4**, and an outlet section **5** connecting with a stack means **6**. There is also indicated the use of a gas passageway tubes **7** providing a heat exchange zone **8** therearound to accommodate the heating of a fresh airstream that is introduced by way of inlet means **9**. The latter, in turn, has a damper means **10** therein to control fresh airflow into the system. Upstream of the inlet portion of the combustor section there is also provided a mixing section **11** which is in communication with fan means **12** that, in turn, receive a fume-laden stream from duct means **13** and fresh air from duct means **14**. The latter is provided with a damper or valving means **15** to effect the control of the quantity of fresh air being introduced into the system at this zone.

There is also indicated diagrammatically in FIG 1 of the drawing a small drying oven or curing zone **16** encompassed by housing means **17** adapted to accommodate the movement of wires or other coated items that are passed through such curing zone. A fume-laden gas outlet passageway from the curing zone is provided at outlet means **18** to connect to duct means **13** and thence pass by way of fan **12** around the burner means **19** and into the thermal incinerator section of the unit. The burner **19** is indicated as being supplied with fuel by way of line **20** and control valve means **21**.

The downstream end of the combustor section **1** is provided with a sidewall hot gas opening **22** which is connective with a recycle passageway **23** as well as with a recirculation passageway **24** which connects with and discharges into curing zone **16**. The recirculation passageway **24** also is in open communication with the heat exchange zone **8** for the fresh air being introduced by way of inlet means **9**, whereby a resulting mixed gas stream of combustion products are preheated air will be introduced back into the curing zone.

As a still further feature of the present design, there is indicated a bypass passageway **25** connective with the fume or combustor inlet zone **11** whereby a portion of the fume-laden gas stream from fan means **12** can carry around combustor **1** and directly back to the curing zone in admixture with preheated fresh air and hot combustion gases from outlet means **22**. In other words, the bypass arrangement precludes having to pass all of the fume stream through the combustor zone **1** and permits a controlled incineration operation with only a desired portion of the total gas stream having to be discharged as net gas through the stack means **6**. Further advantages of the bypass arrangement provide for the present improved system of having a controlled temperature rise in the incinerator section, while also providing for the blending of the various gas stream, particularly as to quantity and temperature, for recirculation into the curing zone. A damper **25'** can assist in flow control.

Referring now to FIG. 2 of the drawing, there is indicated a modified form of incineration unit providing for an encompassing arrangement of recycle and gas bypass passageways around an internal combustion zone. Specifically, the is indicated an internal combustion zone **26** defined by shell **27** which has a gas inlet opening **28** and a downstream open end discharge arrangement into tubular means **29** and into an outlet section **30** connecting to stack means **31**. A contaminated gas conduit **32** is indicated as connecting to fan means **33** and the latter discharging into an inlet section **34** which in turn is in open communication with a mixing zone **35** leading to the combustion section inlet **28**. A burner **36** is also shown as being positioned within the inlet passageway **28** so as to provide controlled heat for the mixed gas stream entering combustor zone **26**, so as to ensure ignition of the fume-laden gas stream. In addition, burner **36** is provided with a fuel line **37** and valve means **38** so as to provide controlled quantities of fuel thereto.

In accordance with the present invention, which provides for recycle of hot gases at and within the incineration section, there is utilized an additional housing or shell means **39** concentrically around shell **27** in order to form a recycle passageway **40**. Thus, hot gases from the outlet end of combustor zone **26** may pass through a regulated area passageway or zone **41** into recycle passageway **40** and be deflected from the latter into the mixing section **35** and to the combustor inlet **38** to therein become admixed with the combustible fumes entering from fan means **33**. As will hereinafter be more fully set forth, the recycle of hot combustion gases will provide an effective higher temperature mixed gas stream so as to in turn reduce the temperature rise across the length of the combustion section in zone **26**. For example, where the solvent or fume laden gas stream is of the order of 500° F. and below ignition temperature, the admixture of discharged hot gases at a temperature of the order of say 1,350° F. can provide, without particular aid from burner means **36**, a mixed gas stream temperature of the order of 1,050° F. whereby ignition will take place and the temperature rise through the length of the combustible zone be held to the order of only 300° F.

In a manner similar to that shown in FIG. **1**, there is a heat exchange zone built within the downstream end of the thermal incineration unit of FIG. **2**, by reason of a fresh air inlet duct means **42**, with damper means **43**, leading into an encompassing heat exchange section **44** around gas passageway tubes **29**. Thus, a preheated fresh airstream may be admixed into the hot gas steam entering a recirculating gas passageway **45** to in turn be transferred to a drying oven or curing zone by way of outlet means **46**.

The present embodiment also indicates the use of shell means **47** at a spaced distance around the combustor shell **27** and the recycle shell **39** to provide a gas bypass passageway **48**. The latter has an inlet opening **49** communicating with the fan discharge section **34** and a downstream section which is an open communication with the recirculating gas passageway **45** whereby a portion of the fume-laden gas stream can entirely bypass the incineration zone and be recirculated into the curing zone, drying oven, etc., in admixture with at least a portion of the resulting combustion gases and controlled quantities of preheated air.

Various types of flow control means or dampers may be used in connection with the various gas passageways of the thermal incinerator section and for the recirculation to the gas bypass passageway. However, it is not intended to limit the control means to any one type valving, dampers, or regulating apparatus, or to any specific location. Diagrammatically, the present drawing indicates movable damper means **50** at the passageway **41** so as to regulate the quantity of hot gases that may be recycled in passageway **40** and at the same time divert a portion thereof as a hot gas stream passing into the curing zone from the incinerator secton. There are also indicated damper means **51** at the inlet section **49** for the fume bypass **48** so as to control the quantity of gas being directly recirculated to the curing zone without passage into the combustor zone. As hereinbefore noted, under certain operating conditions, it may be desirable to only pass a small portion of the fume-laden gas stream into the combustor zone **26** and also pass a relatively small portion of the resulting hot combust gases to stack means **31**.

FIG. **2**, as also provided by the construction of FIG. **1**, effects an extended residence chamber for the combustion section by virtue of the hot gas stream from the combustor zone **26** being connective through tube means **29** to an outlet section **30** which, in turn, connects with the discharge stack,

whereby adequate time for thermal conversion of entrained fumes will be obtained to preclude air-pollution. Still further, other damper or control valve means may be embodied within the design of FIG. 2, as for example, within outlet section **30** or upstream of the heat exchange tubes **29**, whereby a more closely controlled gas flow can be obtained.

Actually, it is not intended to limit the present thermal incinerator unit to any predetermined volumes of gas flows within the various passageways and within the central combustion section inasmuch as the volume through the incinerator or combustor zone may comprise an amount substantially equivalent to that for bypass passageway **48** or a quantity which is greater or lesser than the amount in the bypass passageway. However, in all cases, a substantial quantity of the hot combustion gases leaving the combustor zone **26** shall be recycled by way of passageway **40** back to the combustor inlet so as to provide the higher inlet temperature to such zone to result the desired low-temperature drop in the unit as well as sustain an ignition temperature for the system. It is also to be noted that variations may be made with respect to heat exchange section or to the positioning of certain of the gas passageways, inasmuch as the drawings may be merely diagrammatic in this aspect. A preferred unit, however, provide for the heat exchange relationship between the recycle passageway and the combustion section **26**, as well as a heat exchange relationship between the recycle passageway **40** and the bypass passageway **48**.

With reference to FIG. 3 of the drawing, there is indicated a modification within the shell defining the combustor zone by reason of shell **27'** providing a plurality of spaced-apart, angularly positioned gas inlet means **52** which will permit small portions of the recycle gas stream from passageway **48** to be introduced at spaced points in the combustor zone **26** and, in effect, reduce the output from the burner means as well as keep the temperature rise in the combustor zone to a low differential. The openings **52** as shown are, of course, diagrammatic and can be varied as to number and as to angular relationship with the wall of the combustion zone and still be within the scope of the present invention.

I claim as my invention:

1. A thermal incinerator unit for use in combination with a curing zone discharging combustible fumes, which comprises in combination, an elongated combustion section with a fume inlet opening at one end and a hot gas outlet from the opposite end thereof, an axial-positioned burner means directed into said inlet opening and adjustable fuel supply means to said burner means, gas passageway means from said hot gas outlet to said fume inlet opening to effect a hot gas recycle to the latter at said burner means, additional gas passageway means from said hot gas outlet to the curing zone, and a gas outlet conduit from said hot gas outlet to effect a cleaned gas discharge to the atmosphere, at least one adjustable fresh air inlet means to said unit, and fan means connective with said unit providing flow of fumes into said combustion section and through said passageway and conduit means to maintain gas and fume flows therethrough.

2. The thermal incinerator unit of claim **1** further characterized that said gas passageway means for effecting hot gas recycle is provided annularly around said elongated combustion section and in heat exchange relationship therewith.

3. The thermal incinerator unit of claim **1** further characterized in that a gas bypass passageway extends longitudinally coextensive with said combustion section and is connective between said fan means and said additional gas passageway means from said hot gas outlet, whereby there may be a recirculation of a fume containing stream to the curing zone without passage through said combustion section.

4. The thermal incinerator unit of claim **3** still further characterized in that said bypass passageway is in heat exchange relationship with said hot gas recycle passageway means.

5. The thermal incinerator unit of claim **1** further characterized in that a heat exchange section is provided in communication with the hot gas outlet from said combustion section and air inlet means to said heat exchange means provides for preheating air thereto, and an outlet from said heat exchange section is in communication with said additional gas passageway means to the curing zone whereby heated fresh air may be admixed with gas from said hot gas outlet.

6. The thermal incinerator unit of claim **1** further characterized in that flow control means are provided in combination with the hot gas outlet from said combustion section whereby there may be regulation of the flow gases to said gas passageway means for hot gas recycle and control of gas flow to said additional gas passageway from said hot gas outlet.

7. The thermal incinerator unit of claim **1** further characterized in that said gas passageway means from said hot gas outlet to said fume inlet opening is of an annular form around said elongated combustion section and a gas bypass passageway is provided in an annular form around said annular form recycle gas passageway, whereby there is a resulting heat exchange relationship between said gas passageways.

8. The thermal incinerator unit of claim **7** still further characterized in that flow control means are provided in said bypass gas passageway whereby to control fume flow from said fan means to said combustion section and to said gas bypass passageway.

9. In combination with an oven of the type recirculating at least a portion of the contaminated gas stream, a thermal incineration section, comprising in combination, an elongated open-ended inner shell defining a combustion section with a fume inlet and a hot gas outlet means therefor, an elongated outer shell spaced around said inner shell and providing a recycle passageway for recycle of hot gases, a fume-laden inlet at one end of said outer shell in alignment with the open gas inlet to said inner combustion sections, a fume passageway from said oven to said fume inlet of said combustion section, a burner with fuel supply means thereto positioned centrally within said fume inlet to the latter, an incinerated gas outlet from said outer shell, additional wall means spaced adjacent said outer shell to provide a gas bypass section therearound which is in heat exchange relationship with said outer shell, a return passageway means from said bypass section to said oven, and a blower means within said fume passageway to maintain gas flow and gas recirculation within said incineration section and said gas bypass section.

10. The combined oven-thermal incineration section of claim **9** further characterized in that adjustable flow control means is provided within each of said gas passageways and said gas bypass sections, whereby the volume of gas flow can be regulated within each portion of said incineration section.