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Tabak

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[54] **RECUPERATIVE FORM OF THERMAL-CATALYTIC INCINERATOR**

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[*] Notice: The portion of the term of this patent subsequent to Apr. 23, 1991, has been disclaimed.

[22] Filed: **Dec. 26, 1973**

[21] Appl. No.: **428,640**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 267,328, June 29, 1972, Pat. No. 3,806,322.

[52] **U.S. Cl.**..... **23/277 C;** 23/288 R; 110/8 A; 423/210; 431/5

[51] **Int. Cl.**..... **F23g 7/06;** B01j 9/04

[58] **Field of Search**..... 23/284, 288 R, 277 C; 60/299, 350; 110/8 A; 431/5; 423/210

[56] **References Cited**

UNITED STATES PATENTS

3,806,322 4/1974 Tabak..... 23/288 F

Primary Examiner—James H. Tayman, Jr.
Attorney, Agent, or Firm—James R. Hoatson, Jr.; Philip T. Liggett; William H. Page, II

[57] **ABSTRACT**

A special form of incinerator design provides for either a catalytic or thermal operation, or simultaneous conversions, in that burner means is provided for initiating catalytic oxidation or for discharging hot combustion gases into an elongated central combustion section to thermally oxidize the combustibles in the fume stream. The invention involves an elongated outer housing, internal cylindrical-form partitioning spaced inwardly thereof to define an annular gas flow space therein, an internal combustion section, burner means at one end of the housing with fume inlet means into said housing to the combustion section, gas pervious catalyst in at least a peripheral portion of the cylindrical-form partitioning, open passageway means at one face of the catalyst to permit the fume stream being treated to pass radially through the catalyst, and treated gas outlet means from the opposing face of the latter.

5 Claims, 4 Drawing Figures

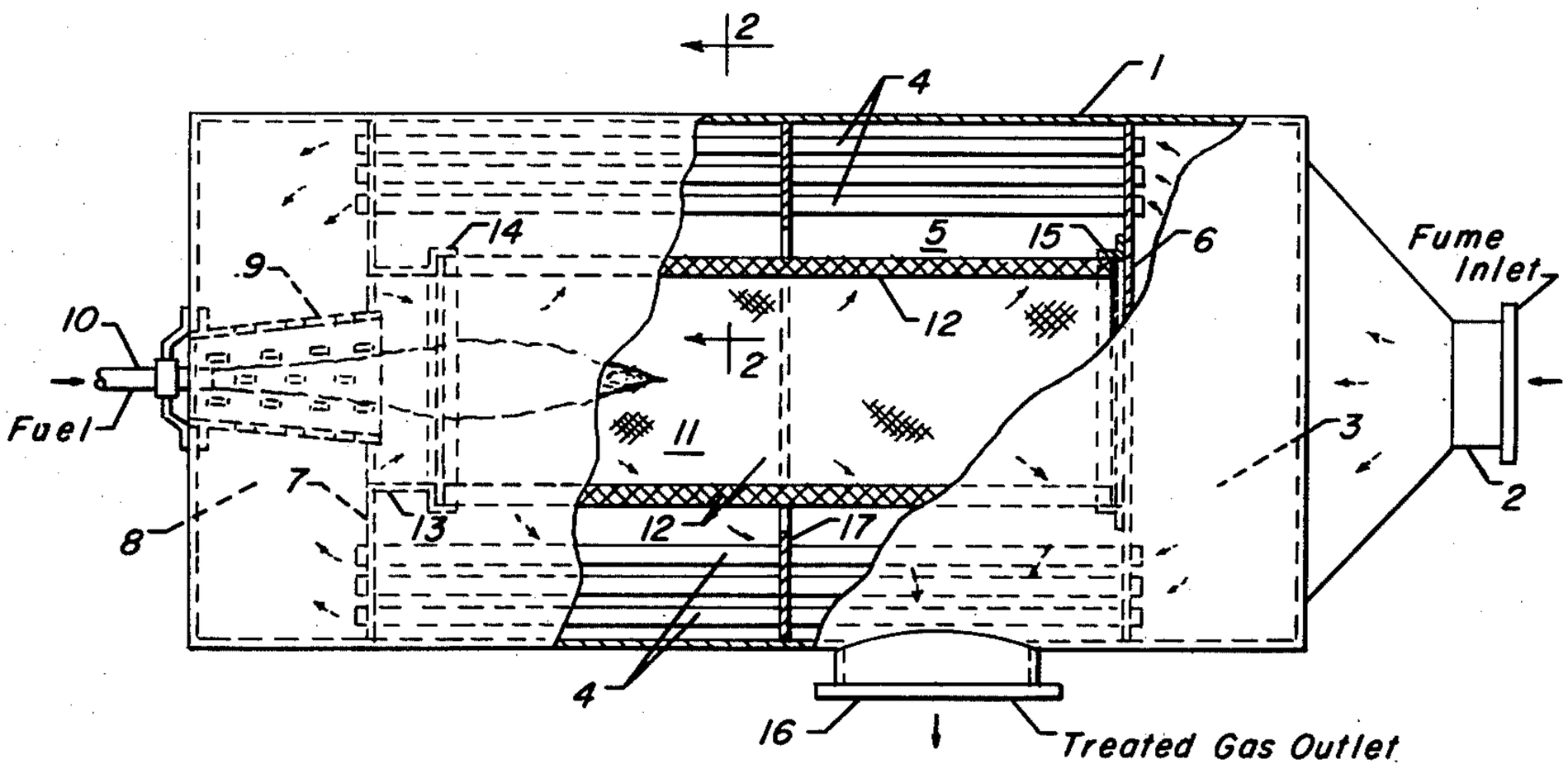


Figure 1

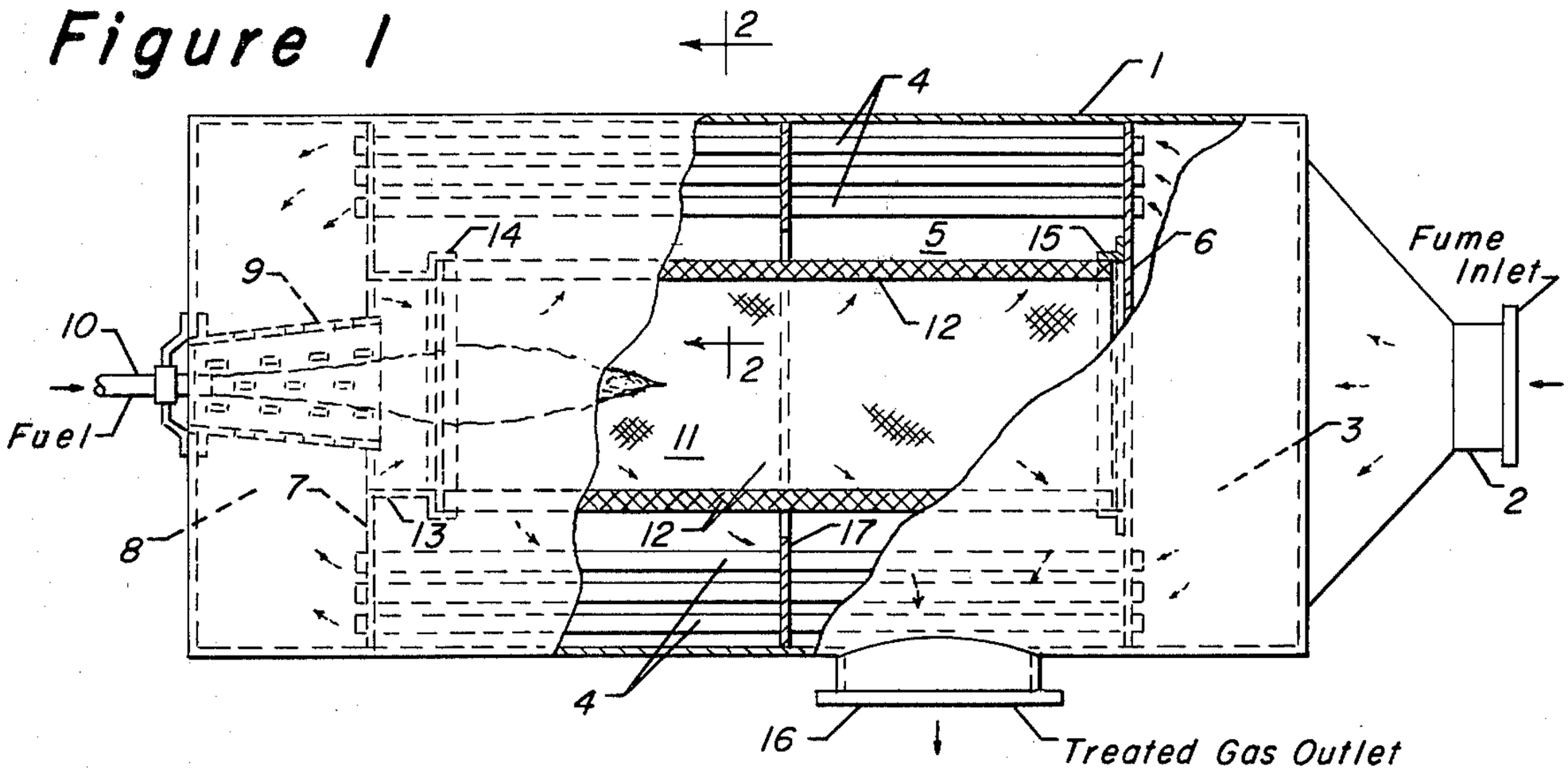
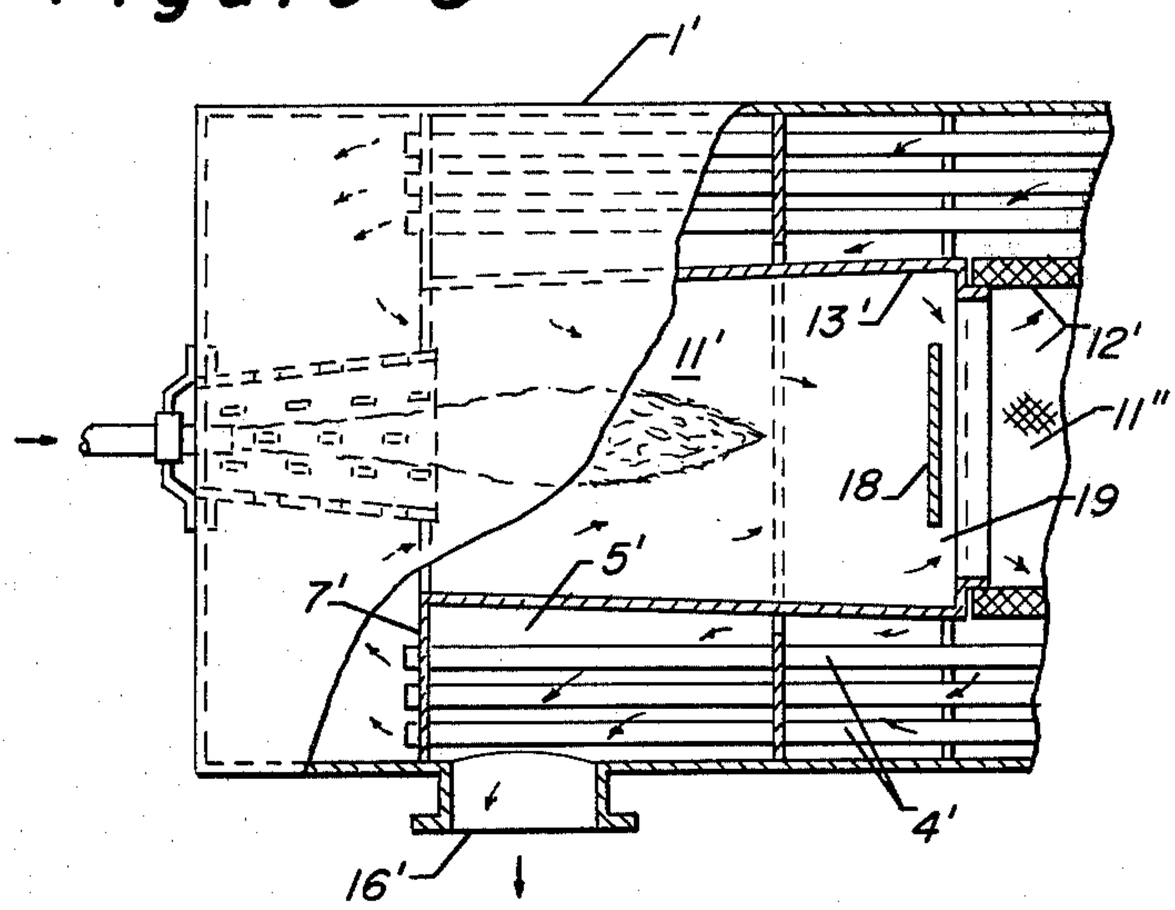


Figure 3



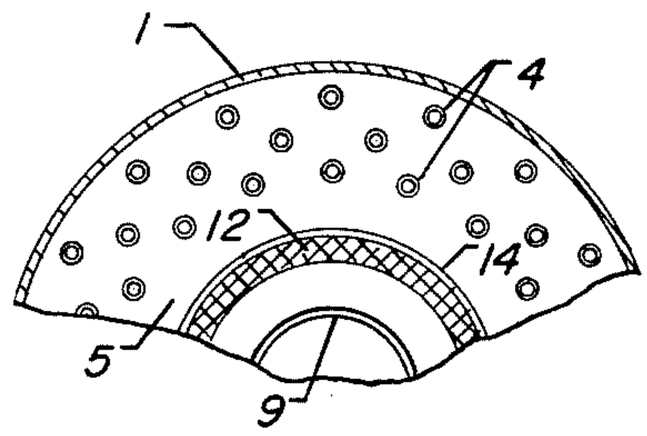
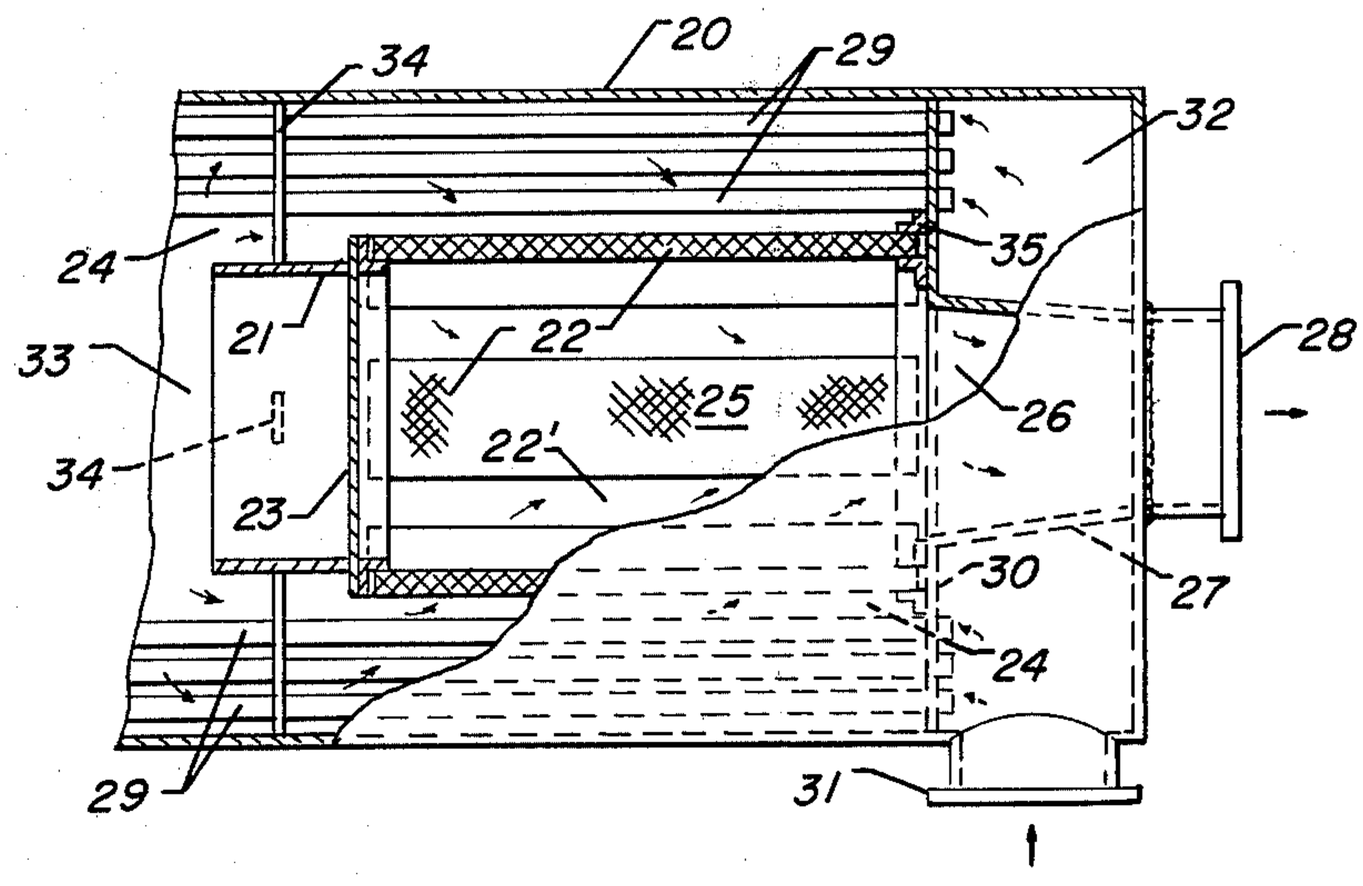


Figure 2

Figure 4



RECUPERATIVE FORM OF THERMAL-CATALYTIC INCINERATOR

This application is a continuation-in-part of my earlier application, Ser. No. **267,328,** filed June **29, 1972,** now Pat. No. **3,806,322.**

The present invention relates to a special form of fume incinerator which provides for either a thermal or catalytic type of operation, or both at the same time. An improved and preferred embodiment of the present invention also provides for a heat recuperative operation by having the incoming fume stream pass through an annular form heat exchange zone in heat exchange relationship with the resulting purified high temperature discharge stream.

It is recognized that many forms of thermal and catalytic incinerators have been designed and are in commercial usage to effect the oxidation and purification of noxious waste gas streams; however, the present design provides a compact and novel design and arrangement which permits the insertion, or removal, of catalyst elements to switch from one type of operation to the other. In fact, in the event that the catalyst operation for some reason fails to perform properly, the burner means can be readily operated at a sufficiently high temperature to have a thermal incinerator type operation while the catalyst elements remain in place or are removed.

A preferred form of incineration unit will also use a **100%** secondary air burner, such that no primary air need be supplied, to thereby provide a high efficiency operation. As for the burner means and the gas flow arrangements, the present design is related to that disclosed in my earlier application, Ser. No. **267,328,** and also somewhat related to my now issued U.S. Pat. No. **3,549,333;** however, in this instance, the inner cylindrical partitioning is comprised in part of gas pervious catalyst means such that a preheated gas stream can flow radially through the catalyst and be catalytically oxidized to remove noxious components. The catalyst may be a thin bed of impregnated refractory particles or pellets; a catalytic agent impregnated onto a "honeycomb" type ceramic support; or, preferably, will be of an all-metal construction such as may be provided by catalytically coated ribbon or wire in mat form between retaining screens.

Actually, it may be considered a principal object of the present invention to provide a thermal-catalytic fume incinerator unit with burner means and catalyst elements being suitably placed such that the unit can readily operate either thermally or catalytically without any necessary modification.

As another object of the improved design, there is provided an arrangement where the fume stream will be in heat recuperative, heat exchange relationship with the oxidized stream and also be subjected to an elongated passage through the burner section and catalyst means to provide a greater overall length of combustion section for reaping the benefits of time, temperature and turbulence in carrying out the fume incineration.

In a broad aspect, the present invention provides a thermal-catalytic fume incineration unit, which comprises in combination, an elongated outer housing, internal cylindrical-form partitioning spaced inwardly from the wall of said housing and extending for at least a portion of the internal length thereof to define an annular gas flow space therebetween and an internal combustion section, burner means positioned at the end of said housing and means to discharge hot burner gases axially into said combustion section, fume inlet means into said housing and to said combustion section with passageway means to the latter entirely surrounding said means discharging the hot burner gases, gas pervious catalyst means in at least a peripheral portion of the downstream section of said cylindrical-form partitioning, and open passageway means to one face of the catalyst means from the combustion section whereby the fume stream being treated may be passed in a radial type flow through said catalyst means, and treated gas outlet means from the opposing face of the latter and from said housing.

In a more specific aspect, the present invention provides a recuperative form of fume incineration unit, which comprises in combination, an elongated outer housing, inner partitioning spaced from the outer housing and terminating short of one end of said housing to provide an external annular heat exchange section and a central gas combustion section, a transverse partition positioned across the internal end of said inner partitioning to provide a preheated gas inlet section in the end of said housing and an end closure for said annular heat exchange section, a burner means connective with the end of said housing at the preheated gas inlet section and burner gas passageway means therefrom for discharging of hot flames and gases into said combustion section, additional transverse partitioning that is positioned a spaced distance from the other end of said housing to provide a gas inlet section and a second end closure for said annular heat exchange section, a plurality of open-ended tubular members extending between and through said transversely positioned partitions to define inlet gas passageway means through said heat exchange section from said gas inlet section to said preheated gas section, open passageway means from the latter section to said central gas combustion section which encompasses said burner gas passageway means, gas permeable catalyst means positioned in at least a downstream portion of said inner partitioning to thereby permit catalyst-gas contact and gas flow into said heat exchange section from said combustion section, a gas stream inlet to said housing and to said gas inlet section, and a treated gas outlet from said heat exchange section and from said housing.

As set forth briefly before, the catalyst elements or catalyst means may comprise an all-metal construction such as high temperature resistant wire or ribbon plated or otherwise coated with platinum, palladium, or other active metal, whereby there is an active oxidizing catalyst to effect the incineration of combustible fumes in the gas stream to be treated. Reference may be made to U.S. Pat. Nos. **2,685,742** and **2,720,494.** Alternatively, the catalyst section may comprise one or more elements utilizing coated refractory pills or other subdivided particles which have a catalytic coating suitable to effect the desired oxidation reactions. For example, spherical-form alumina particles may be impregnated or otherwise coated with a suitable oxidizing catalyst agent and such particles retained between perforate screens so that there is permeability for the radial inward or outward flow of the gas stream passing from the inlet and burner zones of the incinerator unit.

Reference to the accompanying drawing and the following description thereof will serve to illustrate various features and advantages of the present invention as

well as point out specific aspects of construction to obtain the desired optional thermal or catalytic fume incineration operations as well as heat recuperation.

FIG. 1 of the drawing is a longitudinal sectional elevational view of one embodiment of the present thermal-catalytic fume incineration unit.

FIG. 2 of the drawing shows a partial cross-sectional view, as indicated by the line 2—2 in FIG. 1.

FIG. 3 of the drawing is a diagrammatic partial longitudinal sectional view indicating radial outward flow through a catalyst section positioned primarily downstream in the combustion zone.

FIG. 4 of the drawing is also a partial longitudinal sectional view through an incinerator unit where there is radial inward flow through the catalyst section and also a modification in the gas outlet positioning.

Referring now particularly to the FIGS. 1 and 2 of the drawing, there is shown an outer shell or housing 1 arranged to have a contaminated gas stream inlet 2 connective with an internal gas distribution section 3, which in turn, passes the stream through a plurality of spaced open-ended tubular members 4 within a heat exchange section 5, hereinafter described in further detail. Positioned across the inlet end of the housing is a partitioning sheet or tube sheet 6 which defines the inlet section 3 as well as an end for the heat exchange section 5. At the opposing end of the housing 1, there is a second transverse partitioning sheet 7, also serving as a tube sheet, which defines the opposing end of the heat exchange section 5 as well as provide a preheated gas section 8 for the distribution of the heated fume stream into the combustion zone 11 of the incinerator unit.

Extending into and through a central portion of the preheated gas section 8 is a burner means defined by a perforated frusta-conical member 9 and a fuel inlet line 10. It is to be understood that various types of burner means may be utilized in connection with the present form of incinerator unit; however, a preferred type of burner will be of the 100% secondary air type having only fuel introduced into the interior of the burner cone means 9 from line 10 and the air, or oxygen content, required to sustain combustion will be supplied by way of the contaminated air stream entering the incinerator unit from inlet means 2 and the heat exchange tubes 4. Preferably the cone means 9 will have a plurality of holes in order to permit air and gases into the interior thereof and mix with the fuel being injected by way of line 10. At the same time, there will be passageway means around burner cone means 9 to provide for the flow of the entire fume stream into an internally positioned combustion zone 11.

In accordance with the present invention, an interiorly positioned cylindrical-form partitioning wall is provided longitudinally at a spaced distance from housing 1 so as to define the heat exchange section 5 as well as the internal combustion section 11. Such wall may be comprised primarily of one or more catalyst sections 12, such as shown in the drawing, along with a short cylindrical end portion 13 or, alternatively, as will be more fully explained hereinafter, there may be a longer non-perforate wall section 13 in combination with one or more catalyst sections which are of more shorter lengths. Various types of catalyst elements may be utilized in connection with the present incinerator unit as hereinbefore noted; however, the one or more catalyst sections will be of a gas pervious nature such that the fume stream and hot combustion gases leaving burner cone 9 and entering the axial portion of the unit can pass in an outward radial flow through catalyst means 12 into the encompassing heat exchange section 5. In the present diagrammatic drawing, catalyst element(s) 12 are supported at the burner end from suitable flange means 14 from wall cylindrical section 13 as well as from transverse tube sheet 6 at the opposing end of the incinerator unit. Support angles 15 or other suitable means that may be attached to partitioning wall 6 can be provided to removably hold the end of the catalyst unit. Although no detail is shown, the catalyst 12 is preferably constructed and mounted to be removable by utilizing a plurality of cylinder-like sections or a plurality of arcuate-like longitudinal pieces held by suitable support means, such that the catalyst can be removed or replaced in the event that it needs replacement or regeneration. Also, there may be an operation where the present form of convertible incinerator unit will be entirely thermal such that all or a part of the catalyst sections may be removed or, if desired, replaced with perforate partitioning to in turn permit a thermally incinerated fume stream to pass radially outwardly through such partitioning into the heat exchange section 5 and then be discharged from the housing by way of outlet means 16.

While the present incinerator unit will normally operate either thermally or catalytically, it is to be noted that the present embodiment also lends itself to a combination type of operation or the fume stream. Thus, the fumes can be primarily thermally converted from hot combustion gases supplied by the fuel and burner means at the preheated gas inlet end of the unit, and then there can be a further combustion and clean-up of the fume stream by the second stage catalytic contact of such stream prior to its leaving the incinerator unit. Where the unit is being operated primarily as a catalytic incinerator, the burner means will normally supply only sufficient heat input to insure that the contaminated gas stream is brought up to an oxidizing temperature for catalytic incineration as it passes through the one or more elements 12. Conversely, where the unit is operating primarily as a thermal incinerator then the burner means will supply sufficient fuel, flame, and hot combustion gases to insure substantially complete incineration of oxidizable components in the contaminated air stream. In the latter instance, the catalyst elements 12 will normally have been removed from the incinerator although, as heretofore noted, such elements may be left in the unit.

As heretofore noted, various types of catalyst support means, as well as catalyst element configurations, may be utilized to form the catalyst section in the cylindrical-form partitioning wall as well as the separating wall means between combustion zone 11 and heat annular-form heat exchange section 5. Also, various types of baffling and tube support means may be utilized in the latter section and it is not intended to limit the present invention to any one type of construction. In the present instance, there is diagrammatically indicated a baffle member 17 which will assist in providing turbulent flow and the channeling of the hot combustion gases around tubular members 4 after the outward radial gas flow through catalyst means 12.

In FIG. 3 of the drawing, there is indicated a slight modification to the incinerator unit design and construction in that a longer internal non-perforate parti-

tioning section 13' is provided at the burner end or fume inlet end to an internal combustion section 11' and a shorter overall length is provided for catalyst means 12' at the downstream end of the partitioning wall defining the wall means between combustion zone 11' and a heat exchange section 5'. There is also indicated the placement of a transverse partitioning member 18 within combustion section 11' so that hot flames and combustion gases will necessarily be caused to pass therearound and through an annular space 19 prior to reaching a downstream combustion section 11' prior to the radial outward flow of gases into the annular heat exchange section 5'. There is further indicated in the embodiment of FIG. 3, the placement of a treated gas stream outlet means 16' adjacent the downstream end of heat exchange section 5' and tube plate 7' such that there is a resulting reversal of flow in the hot treated gas stream with respect to gas flow within combustion zone 11'. The fume inlet end to the incinerator unit of FIG. 3 may well be similar to that shown in FIG. 1 of the drawing or, alternatively, may be into the side of housing to communicate with the internal gas distribution section.

In still another modification of the present form of incinerator unit, reference may be made to FIG. 4 of the drawing where an incinerator housing 20 is provided with only partial longitudinal internal partitioning wall means in the downstream end portion thereof with respect to combustion gases as defined by cylindrical-form partitioning means 21 and catalyst means 22. There is further provided a centrally positioned transverse partitioning member 23 at the juncture between internal wall means 21 and catalyst means 22 such that the gases leaving the burner means and the preheated gas inlet means at the burner end of the incinerator unit will be deflected initially to a heat exchange section 24 encompassing catalyst means 22 such that there is a resulting radial inward flow to a central gas collecting zone 25 and the discharge of a treated fume gas stream through passageway means 26, as defined by cylindrical wall means 27, to a gas outlet means at 28.

The embodiment of FIG. 4 also indicates that a plurality of tubular members 29 will be provided in the heat exchange section 24, with such tubes extending between a transverse tube sheet 30 at the fume inlet end of the incinerator and a similar transverse tube sheet (not shown) which will be at the opposing end of the incinerator in a means similar to the embodiments of FIGS. 1 and 3. The multiplicity of tubes 29 will serve to pass the contaminated air stream being introduced at inlet means 31 and from a gas distribution section 32 to the burner end of the incinerator unit to then pass in a reverse flow around a suitable burner means into a central combustion section 33, ahead of transverse partitioning 23, to then flow into the annular-form heat exchange section 24.

In connection with the embodiment of FIG. 4, it is to be noted that various means may be provided for supporting the internal partitioning 21 as well as longitudinal cylinder form catalyst means 22 and that it is not intended to limit the incinerator unit to any one type of construction. In this instance, spaced support bars or rod means 34 are shown as supporting cylindrical partitioning 21 and thus the internal end portions of the catalyst elements 22 while suitable support angles at 35 and on transverse tube sheet 30 may be utilized to support the opposing ends of catalyst members 22. In FIG. 4 of the drawing, there is also an indication that catalyst 22 comprises a plurality of spaced segments which may be alternated with non-perforate segments 22'. In other words, it is not necessary that the catalyst means be one continuous cylindrical-form member as long as the catalyst is provided in a gas pervious form between suitable support plates and will, in turn, provide for the desired generally radial flow of gases therethrough in order to obtain substantially uniform flow through the entire internal portion of the incinerator unit.

Again, it is to be reiterated that the present improved form of thermal-catalytic incinerator unit is constructed and arranged such that the unit may be operated either as a thermal conversion unit, a catalytic conversion unit, or as a combination unit. In the latter instance, the catalyst will be utilized primarily as a second stage clean-up section while in a strictly thermal operation there can be the removal of the one or more catalyst elements making up the catalyst portion of the internal cylindrical-form partitioning wall.

It is to be recognized that each of the drawings are merely diagrammatic and that various modifications may be made with respect to the general shapes and configurations of the housings and inlets or outlets, as well as with respect to modifications in partitioning and baffling to effect the desired flow for the contaminated gas stream and a radial flow through one or more catalyst elements. Also, it is not intended to limit the invention to any one method of supporting, or positioning, for the one or more catalyst elements in combination with the internal cylinder-form partitioning means extending longitudinally to form the interior sections of the incinerator housing. Still further, although not shown in any of the drawings, there may be suitable insulation provided around critical portions of the outer housing or around the heat exchange sections such that there may be an efficient retention of heat within the entire incinerator unit. All of the burner means have been indicated as 100% secondary air burners; however, other forms of burner means may well be used within the scope of the present invention so long as there is a suitable location of the burner means in order to effect the proper mixing with the contaminated gas stream to be preheated, or to be thermally converted at such times as the incinerator will be operating as a purely thermal incinerating device.

As a still further aspect, the burner means may be arranged other than axially with respect to the outer housing as long as the hot combustion gases from the burner are baffled or otherwise channeled to eventually flow into the central portion of the incinerator unit and then permit the radial outward flow, or alternatively, the inward radial flow, with respect to the catalyst portion of the partition so as to provide for the uniform flow through the entire interior portion of the incinerator.

I claim as my invention:

1. A thermal-catalytic fume incineration unit, which comprises in combination, an elongated outer housing, internal cylindrical-form partitioning spaced inwardly from the wall of said housing and extending for at least a portion of the internal length thereof to define an annular gas flow space therebetween and an internal combustion section, burner means positioned at the end of said housing and means to discharge hot burner gases axially into said combustion section, fume inlet means into said housing and to said combustion section with

passageway means to the latter entirely surrounding said means discharging the hot burner gases, gas pervious catalyst means in at least a peripheral portion of the down-stream section of said cylindrical-form partitioning, and passageway means in interconnection with one face of the catalyst means from the combustion section whereby the fume stream being treated may be passed in a radial type flow through said catalyst means, and treated gas outlet means from the opposing face of the latter and from said housing.

2. The incineration unit of claim **1** further characterized in that an internal transverse partitioning means extends across said combustion section whereby the fume stream and hot combustion gases will be passed radially inward through the gas pervious catalyst means.

3. The incineration unit of claim **1** further characterized in that said internal combustion section is open and coextensive with the interior of said gas pervious catalyst means and the fume stream is passed radially outwardly through said catalyst means.

4. The incineration unit of claim **1** further characterized in that said treated gas outlet means is at the same end of said housing as said fume inlet means thereto whereby the treated gas stream from the internal combustion section passes in substantially the same direction as the gas stream flow within the internal combustion section.

5. The incineration unit of claim **4** further characterized in that said treated gas outlet means from said heat exchange section and from said housing is peripherally adjacent the preheated gas section of said housing and at the opposite end thereof with respect to the gas stream inlet to said housing whereby there is a flow of the treated gas stream within said heat exchange section which is substantially opposite to the gas flow within the internal combustion section of the unit.

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