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METHOD AND MEANS FOR THERMAL INCINERATION
OF A CONTAMINATED AIR STREAM
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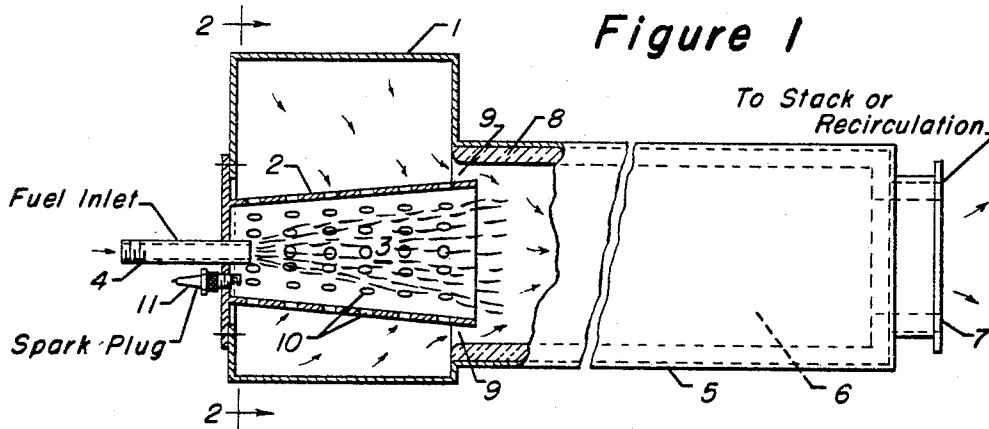
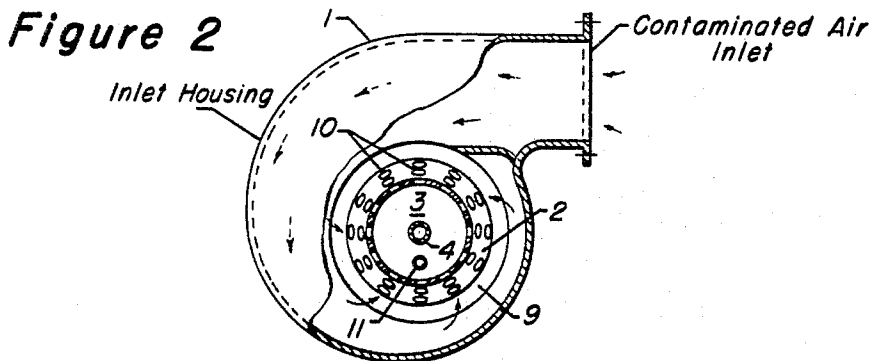
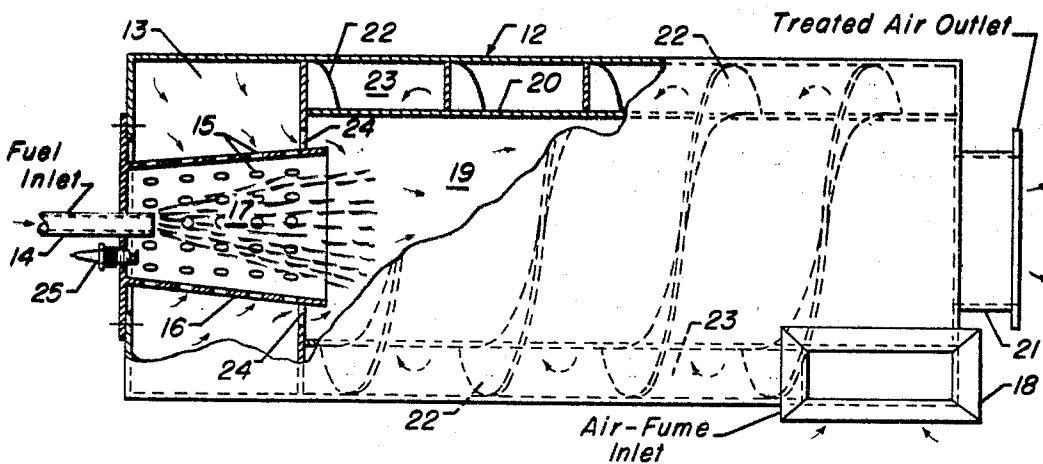


Figure 3



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METHOD AND MEANS FOR THERMAL INCINERATION OF A CONTAMINATED AIR STREAM

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6 Claims 10

ABSTRACT OF THE DISCLOSURE

An improved thermal incinerating system for contaminated air streams is provided which uses the air content of said stream to provide all the oxygen requirements for the burning of the fuel. In this way handling and heating the primary air for the burner is eliminated.

The present invention relates to a thermal incinerating system utilizing only secondary air in the burning-mixing arrangement such that there is elimination of both the heating and handling of large quantities of primary air.

The usual or conventional thermal incinerating system provide primary air for the burner means from a combustion air blower or other suitable source. This stream of air is, of course, finally added to the fume stream as products of combustion at the incinerator operating temperature. As a result, substantial additional fuel must be continuously added to a unit to heat this primary air stream. Stated another way, by operating a system with 100% secondary air, there is far more efficiency or economy, particularly in connection with a large unit, where there can be substantial savings by way of first cost of the installation as well as in every day fuel and power requirements.

Burners that operate with secondary air only are known to be available and are not alleged to be new per se; however, it does not seem that 100% secondary air burner means have been heretofore utilized in an efficient manner to effect the thermal treating of a contaminated air stream to oxidize the noxious fumes or other contaminating components being carried by the air stream. Thus, it may be considered a principal object of the present invention to provide an improved thermal incinerating system for contaminated air streams which uses the air content of such stream to provide all of the oxygen requirements for the burning of the fuel and thus an elimination of the handling and heating of primary air for the burner.

It may also be considered an object of the present invention to provide an improved system which effects the channeling of the contaminated air stream into a relatively high velocity spiral flow at the zone of the fuel inlet and at the incinerator inlet such that there is an efficient mixing of the air stream with the fuel stream and with the flame from secondary air burner arrangement to thus provide for the high temperature thermal incineration of the entrained contaminants flowing with the air stream.

In carrying out the effective elimination of obnoxious fumes and combustibles in a waste gas stream there is required the customary three elements of combustion; i.e., time, temperature and turbulence. For complete combustion, it is necessary that contact with the combustible molecule of the stream be at a sufficient temperature and for a sufficient length of time in order that the reaction be completed. Incomplete reactions may result in the generation of aldehydes, organic acids, carbon or carbon monoxide and an overall undesirable result.

In a broad aspect, the present invention provides an improved method for thermally treating an air stream con-

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taining objectionable contaminating components in a manner which comprises, channeling such stream into a spiral flow and passing a portion thereof into a defined open-ended mixing zone, introducing a stream of combustible fuel without primary air into admixture with that portion of the contaminated stream entering the mixing zone whereby to sustain combustion of the fuel, passing the resulting high temperature flame and gases from the mixing zone into a combustion zone and into admixture with that portion of the contaminated air stream which is not needed to sustain combustion of the fuel stream, and subsequently discharging a thermally treated air stream with unobjectionable combustion gases from the combustion zone.

In carrying out the improved 100% secondary air burning system, there are of course various apparatus arrangements which may be utilized to advantage. Specifically, there is a suitable mixing section adjacent the fuel inlet nozzle such that a portion of the contaminated air stream becomes rapidly and intimately mixed with the fuel to provide the oxygen requirements to sustain a full and complete combustion of the fuel being introduced into the system. This may be accomplished by suitable baffle means, perforate cone means, or the like, which in turn will cause the rapid introduction of air jets into admixture with the fuel stream. A simplified apparatus arrangement will permit the high temperature flame and high temperature gases from the burner or mixing zone to pass along with the remaining portion of the contaminated air stream into an elongated combustion zone so as to provide the necessary time and turbulence to complete the oxidation of the combustible contaminants in such air stream. A spark plug or other suitable ignition means is also provided at the zone of the fuel inlet, i.e. in the mixing zone, such that there may be initial ignition between the fuel and the secondary air being supplied to the system.

A preferred flow system, as hereinbefore noted, utilizes a scroll shaped air stream distribution section at the zone of the fuel inlet and into the combustion zone, whereby there is a spiral flow of at least a portion of the air stream into admixture with the fuel stream and an annular shaped spiral flow in an annular passageway which encompasses the fuel mixing and flame section whereby the remaining portion of the contaminated air stream will become mixed with the hot combustion gases for thermal incineration of the noxious components in the air stream. The scroll shaped inlet section for the contaminated air stream may be formed in a manner similar to that for a centrifugal fan or blower, except that it is used in a reverse arrangement with the enlarged tangential portion accommodating the air inlet and the eye of the volute arranged to surround or encompass the fuel inlet nozzle. Thus, by the use of a perforate cone or other suitable baffle means, there can be the rapid and intimate mixing of a portion of the air stream with the fuel stream issuing from a nozzle into the inlet end of the incinerator system and a resulting high temperature burning of fuel with hot combustible gases to sustain the thermal treating of the entire air stream.

Reference to the accompanying drawing and the following descriptive material relating thereto will serve to further amplify the operation and the advantages in connection with utilizing 100% secondary air for the thermal treating of an air stream.

FIGURE 1 of the drawing is an elevational view, partially in section, showing a simplified incinerating system where there is a spiral flow of the contaminated air stream into the burner and into the inlet zone of the unit.

FIGURE 2 of the drawing is a cross-sectional view of the fuel inlet and mixing zone of the incinerating system

shown in FIGURE 1, as indicated by the line 2—2 in the latter.

FIGURE 3 of the drawing shows a modified and preferred air stream incinerating system where there is a spiral flow of the air stream at the zone with the fuel and into the inlet end of the unit, as well as a countercurrent spiral flow in a heat exchange section encompassing the combustion zone of the system.

Referring now specifically to FIGURES 1 and 2 of the drawing, there is provided a scroll or volute shaped contaminated air inlet section 1 which encompasses an internally positioned perforate frustra-conically shaped member 2. The latter is located within the eye portion of the inlet chamber 1 and encompasses a fuel inlet area or mixing zone 3 that is directly downstream from a fuel inlet nozzle 4. Downstream from the end of the perforate conically shaped member 2 and connective with the wall of the air stream inlet section 1 is an elongated housing section 5 which provides for an internal combustion zone 6 leading to a treated gas outlet port 7. The inner peripheral wall of the housing 5 is indicated as having a suitable insulating material 8 such that the combustion zone may withstand high temperature conditions, generally above 800° F. and up to 1500° F. or more. At the same time there is indicated a suitable annular passageway space 9 around the downstream end of the conical member 2 and within the upstream inner face of the liner 8 such that the major portion of the air stream entering scroll housing 1, but not entering the fuel inlet zone 3, can mix with the resulting flame and hot combustion gases being discharged from the latter.

The particular embodiments illustrated utilize a multiplicity of spaced holes 10 over the entire wall area of conical section 2 which will result in a corresponding multiplicity at small jet-like air streams entering the mixing zone 3 for admixture with the fuel from inlet 4 as secondary air. There shall be sufficient apertures 10 to insure an excess of oxygen into the mixing zone 3 and into admixture with the fuel stream to sustain a highly efficient complete burning of all of the fuel being introduced to the unit. The fuel introduction will, of course, be predetermined to provide sufficient B.t.u. output to in turn effect complete oxidation of the fumes or other components being entrained with the air stream entering housing 1. In order to insure jet-like streams of air through the apertures 10, the latter may be designed, for example, to provide from 2" to 3" of water column pressure drop. Also, in order to have initial combustion of fuel and air, a spark plug or other suitable ignitor means 11 is shown adjacent the burner nozzle 4 and within the confines of the inlet to mixing section 3. During normal or continuous incinerator operation, the spark plug means 11 need not be energized.

After ignition takes place between the fuel being introduced by way of nozzle 4 and a part of the air through openings 10, there will be a sustained high temperature luminous flame and hot combustion gases which will be discharged from the downstream end of the mixing section 3 and into the combustion section 6. The annular passageway 9 to the latter also provides for the main portion of the contaminated air stream to spirally mix with the hot combustion gases and flame from section 3 for continued flow down through the elongated zone 6 to outlet 7.

The flame from a secondary air burning system is normally of a lean nature because of the excess air present; however, there is a great amount of adjustability available in the system, with flame turn down being such that it can be down to a point with very little flame showing.

At this point, it may be noted that there are at least three major advantages to using a secondary air burning system in comparison with incinerator arrangements which use premixed burners. Firstly, a combustion air blower is not required to supply the air stream which must be introduced under pressure for admixing with the fuel

stream ahead of the nozzle outlet. Secondly, the resulting burning and incinerating efficiency is much greater than when there is a premixed burner arrangement, particularly since all primary air being utilized with a premixed burner means has to be heated to the final incinerating temperature and there is a large portion of fuel introduction which must necessarily be given up to heating this additional combustion air. For example, the available heat for incinerating the fume stream at 1400° F. is increased from about 62% of the gross heat available, when using a premixed burner arrangement, to the theoretical ratio of about 90% of the available heat, when using 100% secondary air. Thirdly, the burner control arrangements may be greatly simplified for a secondary burner arrangement inasmuch as there are no controls needed to maintain a particular air-fuel ratio for a premix burner system.

In FIGURE 3 of the drawing, there is shown a preferred design and arrangement permitting a highly efficient thermal incinerating system operating without the use of primary air. Specifically, there is indicated an outer housing 12 with an internal scroll shaped air distributor section 13 at a fuel inlet end which has nozzle means 14. Within the air distributing zone 13, there is preferably provided a baffling means which will diminish in cross-sectional area in the manner of a scroll or volute to give a spiral flow to the air stream. Thus, there is provided a zone similar to that shown in FIGURE 2 whereby the contaminated air stream will in part be forced through a multiplicity of aperture means 15 in a frustra-conical section 16 to reach the mixing zone 17 whereby there will be oxygen to sustain 100% secondary air burning from the fuel introduced through inlet 14. The remaining portion of the air stream passes centrifugally or in a spiral flow past conical section 16. Actually, the design of this embodiment will only vary from that of FIGURE 2 in having the initial air-fume inlet to the incinerating system located at the downstream end portion of the unit at an inlet port 18, whereby the entire contaminated air stream can pass in heat exchange relationship with centrally positioned combustion zone 19. The latter being defined by an internal cylindrical wall section 20.

In order to provide the most efficient type of incinerating system, it is desirable to pass the incoming contaminated air stream in heat exchange relationship with the combustion zone and the hot gas stream being discharged from the unit at outlet port 21. This arrangement of course provides preheating of the air and a lessening of the overall fuel requirements for the system. The present embodiment indicates spaced spiral baffling means 22 positioned between the combustion chamber wall 20 and the outer housing wall 12 so as to define a continuous spiraling passageway zone 23 extending from the air inlet port 18 to the air distributing zone 13. The spiral passageway is of advantage in providing an elongated heat exchange path with the comparatively shorter combustion zone 19, as well as a design causing an initial spiral flow to enter the scroll form distribution section 13 whereby there is a continuing spiraling flow into the mixing zone 16 into the combustion zone 19 by way of the annular passageway 24. Spark plug means 25 are also indicated in the mixing zone 17, adjacent to the nozzle 14, so that there may be suitable fuel-air ignition at the time of starting up the system. Generally, after combustion is initiated and underway the spark or ignition means need no longer be activated.

In the present embodiment, as set forth in connection with FIGURES 1 and 2, there is provided an efficient thermal incineration of all of the contaminants entrained with the air stream by virtue of the latter entering spirally through passageway 24 into the combustion zone 19 to become mixed with the flame and hot combustion gases from the fuel-air mixture and flame issuing downstream from zone 17. The resulting combustion products and the treated air stream is subsequently discharged

from the downstream end of the system by way of the outlet 21. It may also be noted that all of the advantages for the 100% secondary air burning arrangement heretofore set forth apply to the present embodiment, while in addition, there is a further advantage obtained through the use of the spiral heat exchange passageway 23 around combustion zone 19 for conserving heat in the overall system and permitting the elimination of internal refractory means along the inside wall of a combustion chamber. Generally, it has been found that the incoming air stream at a conventional low temperature range, is sufficient to maintain cooling of the cylindrical combustion chamber wall 20 and preclude the necessity for any internal insulation therein.

Various types of baffle means or perforate wall means may be utilized at the center of the air distributing scroll section 13; however, generally a conical form perforate member, such as 16, appears to provide quite satisfactory distributing and mixing means to effect good burning of the fuel and the resulting highly efficient secondary air burning arrangement whereby the fuel requirements for the entire system is minimized. Suitable blower means may be incorporated directly in association with the air inlet port or at the volute form air distributing end portion of the unit to insure adequate velocity for the air stream through the spiral flow air distributing section. However, generally the air blower means may be upstream from the fume incinerating system and therefore has not been shown in either of the embodiments in the present drawing.

It may be further pointed out that in connection with a large unit, or in an alternative design arrangement, more than one fuel inlet means, with accompanying scroll shaped gas distributing means in combination with each inlet, may be used to effect the handling and mixing of a large volume air stream with fuel inlet means. In such an instance, each of the resulting burner arrangements may discharge into a common combustion chamber having a single treated air outlet.

We claim as our invention:

1. The improved method for thermally treating an air stream containing objectionable contaminating components which comprises, channeling such stream into a spiral flow and passing a portion thereof into a defined open-ended mixing zone, simultaneously introducing a stream of combustible fuel without primary air into admixture with the portion of said contaminated air stream in said mixing zone whereby to sustain combustion of the fuel, passing the resulting high temperature flame and gases from the mixing zone into a combustion zone and into admixture with that portion of the contaminated air stream which is not needed to sustain combustion of the fuel stream, and subsequently discharging a thermally treated air stream and unobjectionable combustion gases from said combustion zone.

2. The method of claim 1 further characterized in that said air stream to be treated is initially passed in heat exchange relationship with the combustion zone of the system to effect preheating of the air stream.

3. The method of claim 2 still further characterized in that said air stream to be treated passes in a spiral path in indirect heat exchange relationship with the combustion zone, with such path beginning at the downstream end of the combustion zone and ending in a continuing spiral flow with a decreasing cross-section area being distributed into the mixing zone at the upstream end of the combustion zone and into the latter zone.

4. An improved thermal incinerating system eliminating the heating of primary air, which comprises in combination, a confined combustion chamber, fuel inlet means into said chamber, a contaminated air inlet means to said combustion chamber, mixing means associated directly with the discharge portion of said fuel inlet means and with said contaminated air inlet means providing distribution of a part of the air from the latter as secondary air for said fuel inlet means whereby combustion of fuel to the combustion chamber will be sustained, fuel-air ignition means in said mixing means at the zone of said fuel inlet means, and a treated gas-air outlet from said combustion chamber.

5. The incinerating system of claim 4 further characterized in that a scroll shaped contaminated air inlet section circumscribes said mixing means and discharges in part into the latter and into the upstream end of said combustion chamber.

6. The incinerating system of claim 4 further characterized in that perforate frusto-conical baffle means is provided within the contaminated air inlet means whereby a multiplicity of air inlet streams are introduced into admixture with the fuel stream from said fuel inlet means, and an annular space is provided around the downstream end of the frusto-conical means and within the interior upstream wall portion of said combustion chamber, whereby the contaminated air stream not being mixed directly with the fuel is introduced spirally into the combustion chamber for admixture with the resulting flame and hot gases issuing from the mixing means.

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