United States Patent

Davies et al.

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[54] **SLUDGE INCINERATOR**

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[52] **U.S. Cl.** .....**110/8 R,** 110/18 R

[51] **Int. Cl.**.....**F23g 5/00**

[58] **Field of Search**.....110/7, 8, 18, 119

[56] **References Cited**

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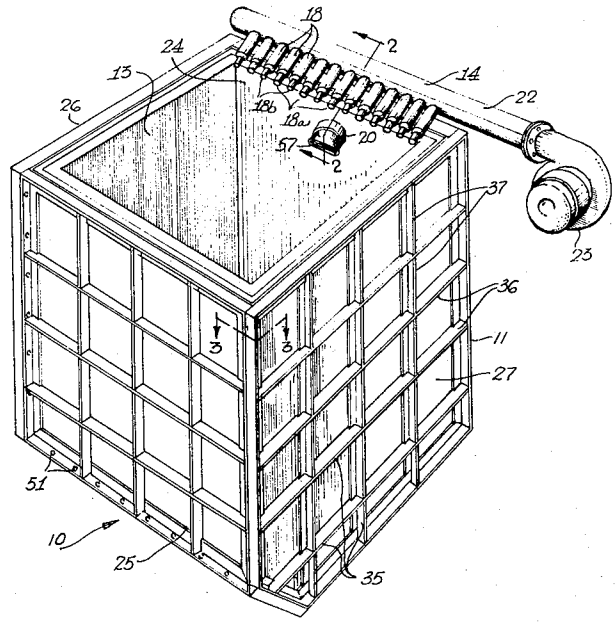
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[57] **ABSTRACT**

Method and apparatus for disposing of unwanted fluids having combustible constituents, such as petroleum wastes commonly collected in pits in oilfield operations. A screen or sheet of high velocity air is directed across an open-topped chamber of an incinerator, the air forming the sheet being directed downwardly at an angle relative to the horizontal so that it enters a combustion zone beneath the sheet. A mixture of air and waste is sprayed into the combustion zone from the same side as air which is supplied to form the sheet and in a direction substantially parallel to the direction of the travel of air in the sheet.

15 Claims, 4 Drawing Figures



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SHEET 1 OF 2

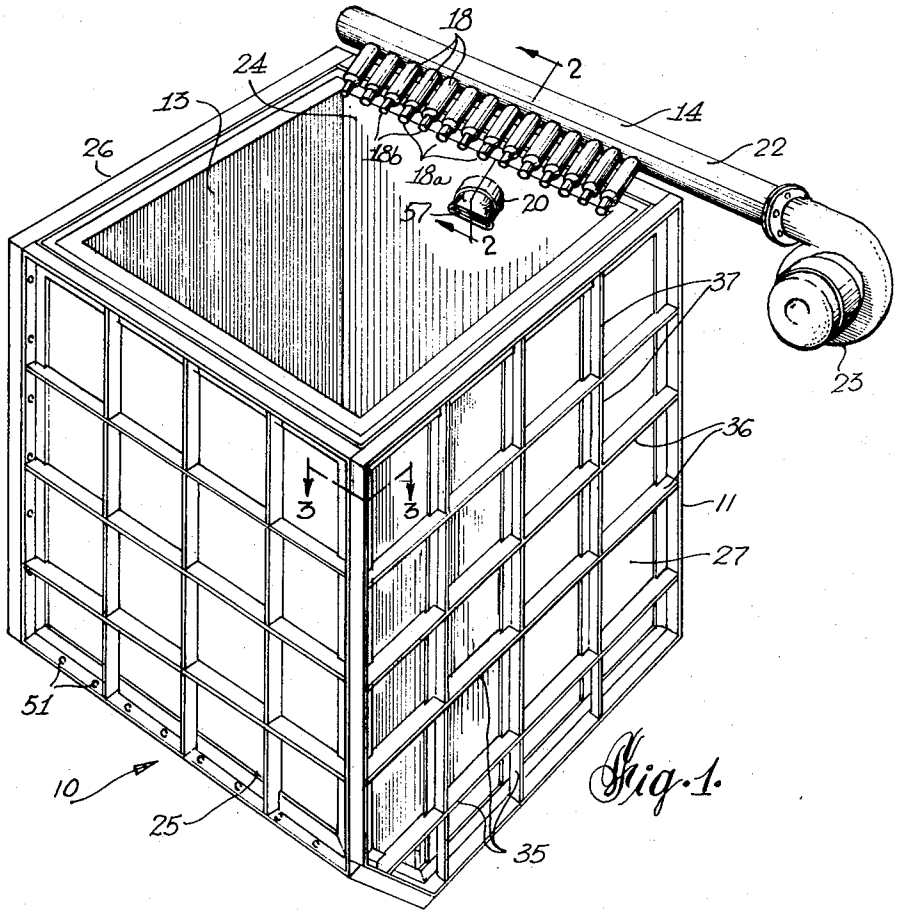


Fig. 1.

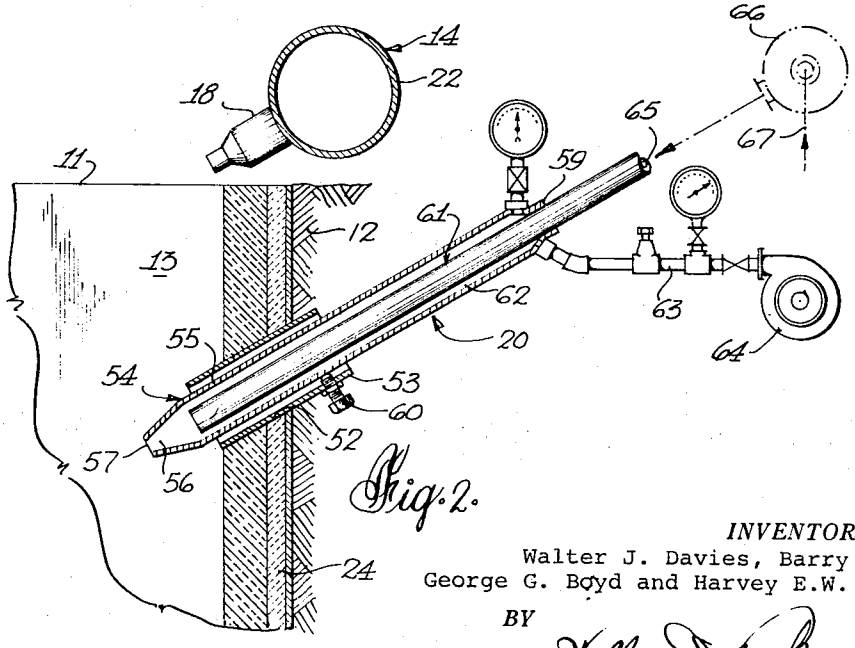


Fig. 2.

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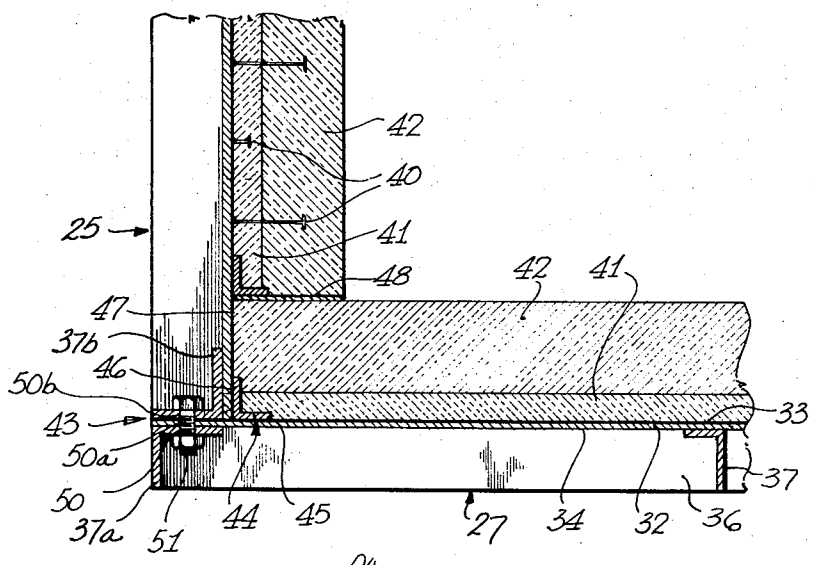


Fig. 3.

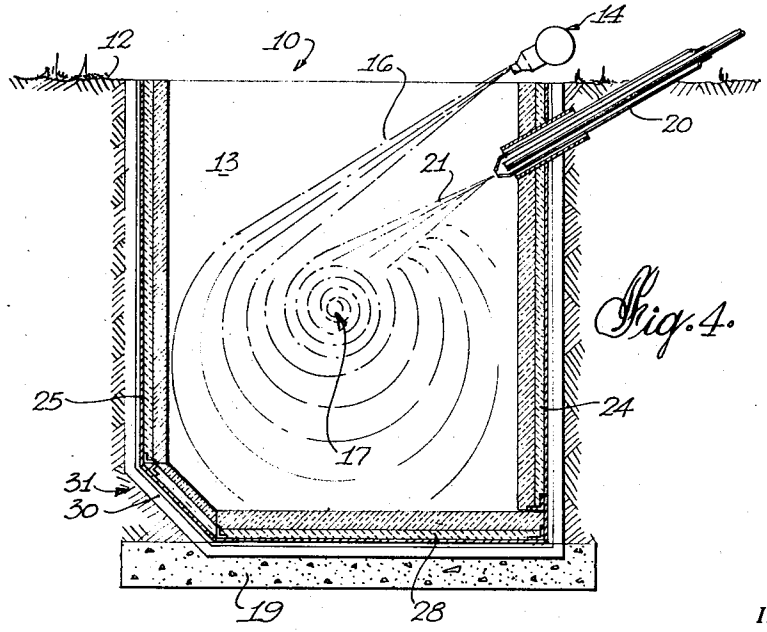


Fig. 4.

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SLUDGE INCINERATOR

This invention relates to a method and apparatus for burning fluid wastes, and more particularly to an incinerator for disposing of sludge collected in oilfield operations.

In the petroleum industry, and particularly in the oilfield operations, it is common practice to collect sludge and other wastes in an open hole or pit which eventually becomes full of the wastes, including crude oil, chunks of parafin, wood and other debris, water and sand. No economical manner of salvaging any of the waste or removing it from the pit has been found, and in the past the waste was set on fire when the pit became full. The fire resulted, of course, in large black plumes of smoke which are extremely displeasing to all inhabitants over large territories. As a result, government action has been taken in certain areas to prohibit any burning of such wastes which results in visible emissions. Thus, the problem of disposing of the collected wastes has become critical without any practical alternative to common burning practice having been found.

It is an object of the present invention to provide an incinerator capable of disposing of a mixture of sludge, water and debris, which normally collects in an open pit in an oilfield operation, without producing distasteful bellows of black smoke.

According to the present invention there is provided an incinerator having an open-topped chamber defining a combustion zone therein. Air supply means are arranged for feeding air into the chamber, the means being disposed for feeding a sheet of high velocity air over the combustion zone in a flow direction which is inclined downwardly from the top of one side of the chamber. Below the air supply means there is located a waste supply means for blowing an air-waste mixture into the combustion zone in a direction substantially parallel to the direction of travel of the sheet of air.

In the combustion zone a large ball of fire is established which is fed by the combustible constituents in the waste, and the ball of fire and the gases produced thereby are rolled at a very high speed by the high velocity air in the sheet which passes thereover. Because of the inclination of the sheet, the air, which forms the sheets, joins the tumbling ball of fire to provide a surplus of oxygen. The products of combustion cannot readily rise to escape the turbulent combustion zone since they are turned back by the sheet of moving air. Thus, the temperature within the combustion zone becomes extremely high, and clean and complete combustion is ensured.

Referring now to the accompanying drawings, which show a preferred embodiment of the invention:

FIG. 1 is a top perspective view of the incinerator of the present invention;

FIG. 2 is an enlarge section view as seen from the line 2—2 of FIG. 1, and shows the relationship of the air and the air-waste mixture nozzles.

FIG. 3 is an enlarge section view as seen from the line 3—3 of FIG. 1 and shows a corner joint of adjacent side walls; and

FIG. 4 is a sectional view through the middle of the incinerator, which view shows the interior of the combustion chamber and illustrates the flow of the air and air-waste mixture into the combustion zone.

In the drawings, the incinerator of the present invention is generally denoted by the reference numeral **10**. The incinerator **10** includes box-like structure **11** which may be supported on a concrete pad **19**, and the structure **11** is preferably located in the main below ground level so as to in effect provide a pit in the ground **12**. The interior of the box-like structure **11** provides an open-topped combustion chamber **13**, and an air supply means **14**, which is located above the box-like structure **11** along one side thereof, is arranged to feed air into the chamber **13**. The air supply means **14** has a series of nozzles **18** which extend substantially along the length of one side of the combustion chamber **13**, the nozzles being closely spaced so that the air issuing therefrom will form a sheet **16** (FIG. **4**) which travels at a high velocity in a direction inclined downwardly relative to the horizontal. The sheet **16** thus contains within the chamber **13** a combustion zone **17**. Located below the air supply means **14** is a waste supply means **20** arranged to blow an air-waste mixture **21** (FIG. **4**) into the combustion zone **17** in a direction substantially parallel to the direction of travel of the sheet **16**.

The air supply means **14** includes a header pipe or manifold **22**, which may receive air from a compressed air system or directly from a separate air pump as illustrated at **23** in FIG. **1**. The manifold **22** is located slightly above one side of the box-like structure **11**. In direct communication with the interior of the manifold are the series of nozzles **18**. The nozzles **18** project downwardly towards the interior of the box-like structure and are preferably directed downwardly at an angle of about 30° relative to the horizontal. The nozzles **18** are closely spaced so that the air issuing from the series intermingles to form a screen or sheet of high velocity air rather than a series of separated streams. It has been found that mixing of the air from the individual nozzles is enhanced whereby a more uniform sheet is produced if the outlets **18*a*** are of a different area than outlets **18*b***, i.e., every second nozzle has a larger nozzle outlet than the one immediately preceding it in the series.

The box-like structure **11** includes four side walls **24**, **25**, **26** and **27**, and a bottom wall **28**. The side wall **25**, is opposite the side wall **24** over which the air supply means **14** is located, and the side wall **25** is of less depth than side wall **24** so that its bottom edge is located above the plane of the bottom wall **28**. An oblique wall section **30** (FIG. **4**) extends from the lower edge to the bottom wall **28** so as to provide a bevelled corner **31** opposite the air supply means **14**, it being found that improved combustion is provided by avoiding a sharp corner at the bottom of the side wall against which the air and air-waste mixture are directed.

Each of the side walls **24**, **25**, **26** and **27**, bottom wall **28**, and also the oblique wall section **30** are preferably prefabricated as separate units and are erected on the site to form the box-like structure **11**. Each of the walls includes a steel plate member **32** having an inner surface **33** and an outer surface **34**. Formed on the outer surface **34** of the plate member **32** is a network **35** of reinforcing members which may be in the form of a plurality of horizontal angle irons **36** between which are fastened vertical angle irons **37**, the angle irons being welded to the outer surface **34**. A plurality of tie mem-

bers 40, which may be of two different lengths are secured to and project from inner surface 33 of plate member 32. Fastened to the inner surface 33 by way of the tie members 40 is an insulating material 41, which is preferably of the rigid block type. Covering the insulating material 41 is a thicker layer of refactory material 42 which is anchored to the plate members 32 by the longer tie members 40.

As may be seen in FIG. 3, the adjacent walls are secured together at the corner of the box-like structure 11 by securing means 43. The plate member 32 of wall 27 has an angle iron 44 secured, as by welding, to its inner surface 53. The angle iron 44 is spaced inwardly from and extends parallel to the vertical edge of the plate member 32. A flange 45 of the angle iron abuts the inner surface 33, and upstanding flange 46 projects away from inner surface 33 a distance greater than the thickness of insulating material 41. Accordingly, by providing angle irons like 44 around the periphery of the plate member 32, the insulating material is closed from external exposure once the refractory material is cast to the outer surface of the insulating material. Edge 47 of refractory material is cast flush with the outer surface of flange 46. The same type of structure is utilized along the vertical edge of the plate 32 of wall 25, the angle iron 44 being located a distance away from the edge only slightly greater than the total thickness of the insulating material 41 and refractory material 42. Thus, when the side vertical edge of plate member 32 of wall 25 is brought towards the inner surface 33 of plate member 32 in wall 27, a gasket 48 may be located between the edge of the refractory material 42 of wall 25 and the outer surface of the refractory material 42 of wall 27.

The vertical angle irons 37*a* which extend along the outer edges of plate members 32 in wall 27 is provided with bores 50 in the flange thereof which abuts the plate member 32, and the plate 32 is provided with aligned bore 50*a*. In the upstanding flange of angle iron 37*b* along the vertical edge of plate member 32 in wall 25, there are aligned bores 50*b*. The walls are thereby clamped together by a series of bolts 51 which extend through the aligned openings 50, 50*a* and 50*b*. When the walls are bolted together the exposed inner surface of plate member 32 in wall 25 is held against the edge 47 of the refractory material and the upstanding flange 46 of angle iron 44 in wall 27, and as explained above, the gasket 48 is squeezed between the edge of the refractory material 42 in wall 25 and the outer surface of the refractory material 42 in wall 27 so as to form a rigid gas-tight corner joint.

The manifold 14 is located above the upper edge of wall 24, and the series of nozzles 18 project at an inclined angle towards combustion zone 17. The wall 24 has an inclined opening 52 therethrough a short distance below its upper edge. The waste supply means 20 extends through the opening 52 which contains a sleeve 53. The waste supply means 20 includes a nozzle means 54 which also projects towards the combustion zone 17 at substantially the same inclination as the nozzles 18. The nozzle means 54 is formed by an outer casing 55 in the form of a pipe of circular cross-section which has the outlet end thereof flattened to form a restricted portion 56 terminating in a slot-like opening 57. The outer casing 55 projects through sleeve 53 and is held therein by way of a set screw 60. The casing 55 has a rear reduced portion 59 through which projects an inner casing or waste supply pipe 61. The outer diameter of pipe 61 is less than the inner diameter of outer casing 55 so as to define an air supply passage 62 of annular cross-section therebetween. A supply of pressurized air is continuously fed to the passage 62 by way of a conduit 63 which is supplied by an air pump 64. The pipe 61 defines a waste passage 65 which is supplied by a pump 66. The pump 66, which is preferably of a type which is capable of moving a heavy sludge including lumps of solids, such as paraffin, and sand, has an intake line 67 which may be placed directly in an open pit in the ground which has been filled with oilfield wastes. The discharge end of the pipe 61 terminates short of or at least at the larger end of the restricted portion 56 of nozzle means 54 so that the waste from passage 65 and the air from passage 62 are mixed in the restricted portion and sprayed from the opening 57 into the combustion zone 17.

In operation, some of the fluid waste can be pumped through passage 65 and allowed to flow out of the nozzle means 56 so as to collect in the bottom of combustion chamber 13. Gasoline may then be added to the waste on the bottom, and a lightly oily rag is then thrown into the chamber to start the flame within the chamber. Air is then supplied to manifold 22 and passage 62 as the waste is continually pumped to passage 65. The air issuing from the series of nozzles 18 provides the sheet 18 of high velocity air which travels at an inclined angle down into the combustion chamber 13. The spray of air waste mixture enters the chamber 13 under the sheet 16 and a large whirling ball of fire is formed in the combustion zone 17. Complete combustion of the waste occurs before the products of combustion rise through the sheet 16 so that no visible emissions occur above the incinerator. A major portion of the air which forms the sheet 16 curls under and enters the ball of fire, and the actual burning is retained entirely beneath the sheet 16.

In test runs, a box-like structure having an inside depth of about 10 ½ feet was used. The inside lengths of the walls were approximately 8 feet, and the insulating material and refractory material were 1 inch and 4 inches thick, respectively. The manifold 22, which was utilized, was 16 inches in diameter. The nozzles 18 were on 6 inches centers and the outlets of the nozzles were alternatively of 2 inches and 3 inches diameters. The air pump 23 was capable of delivering air at 10,000 c.f.m. at 15 in. water col. The nozzle means 54 was located about 18 inches below the manifold and the outer casing 55 was formed by a 2 inches pipe, the end of which was flattened to a width of 3 inches. A 1 inch pipe was used for pipe 61. The air pump 64 was capable of delivering 80 c.f.m. at 40 p.s.i., but it was found that the pressure within the passage 62 could be maintained at about 25 p.s.i. With such an arrangement the incinerator was capable of disposing of 2 to 4 barrels of waste per hour, the waste including crude oil, paraffin, sand and about 50 percent water, although during certain runs of the incinerator about 15 barrels of waste have been burned per hour. Under normal operating conditions the operating temperature within the combustion zone stabilized at about 2000° – 2200° F. At no time during the operation of the test runs, have any visi-

ble exhaust appeared above the incinerator, and although the wastes have contained significant amounts of sand, cleaning of the interior of the chamber 13 after many hours of continuous operation has not been required.

We claim:

1. An incinerator for the burning of fluid wastes having combustible constituents, said incinerator comprising an open-topped chamber defining a combustion zone therein, air supply means for feeding air into said chamber, said air supply means being disposed for feeding a sheet of high velocity air over said combustion zone in a flow direction inclined downwardly from the top of one side of said chamber, and waste supply means for blowing an air-waste mixture into said combustion zone below said air supply means in a direction substantially parallel to the direction of travel of said sheet of air.

2. An incinerator as defined in claim 1, wherein said chamber is formed by a box-like structure including four side walls and a bottom wall, said air supply means including an elongated manifold member extending substantially parallel to and above an upper edge one of said side walls.

3. An incinerator as defined in claim 2, wherein said one side wall has an opening below said manifold member, and wherein said waste supply means includes a nozzle means projecting said opening.

4. An incinerator as defined in claim 3, wherein said manifold member has a series of closely spaced nozzles thereon, said series extending substantially the length of said one side wall, said nozzles projecting downwardly at an angle to the horizontal for forming the inclined sheet of high velocity air.

5. An incinerator as defined in claim 4, wherein said plurality of nozzles and said nozzle means projects towards said combustion chamber in substantially parallel relationship.

6. An incinerator as defined in claim 4, wherein said plurality of nozzles and said nozzle means project towards said combustion chamber at an angle substantially 30° relative to the horizontal.

7. An incinerator as defined in claim 1, wherein said waste supply means includes a nozzle means projecting into said chamber towards said combustion zone.

8. An incinerator as defined in claim 3, wherein said nozzle means includes an outer casing terminating in an injector nozzle outlet, an inner waste supply pipe disposed within said casing and having an open end terminating short of said injector nozzle outlet, said outer casing and inner pipe defining an air passage therebetween, wherein means is provided for supplying pressurized air to said passage, and wherein means is provided for feeding fluid waste to said pipe to be discharged through said open end thereof.

9. An incinerator as defined in claim 7, wherein said nozzle means includes an outer casing having a restricted portion terminating in a nozzle outlet at one end, an inner casing providing a waste supply passage therethrough and being concentrically disposed within said outer casing, and inner and outer casing defining an air supply passage therebetween, said inner casing terminating inwardly of said restricted nozzle outlet whereby mixing of air and waste is achieved within said restricted portion.

10. An incinerator as defined in claim 9, wherein said inner and outer casings are of circular cross-section whereby said air supply passage is of annular cross-section, and wherein said outer casing is flattened at one end to form said restricted portion and an elongated slot-like nozzle outlet.

11. An incinerator as defined in claim 2, wherein the side wall opposite said one wall is of less depth than said one wall whereby the lower edge thereof is located above said bottom wall, and further comprising an oblique wall section extending from said lower edge to said bottom wall, said oblique wall section providing a bevelled lower corner opposite said air and air-waste mixture supply means.

12. An incinerator as defined in claim 2, wherein said walls are each prefabricated units and include securing means for holding said box-like structure in an erected condition.

13. An incinerator as defined in claim 12, wherein each wall unit includes a metal plate member having inside and outside surfaces, a network of reinforcing members secured to said outside surface, a rigid insulating material overlying said inside surface, and a layer of refractory material covering said insulating material.

14. An incinerator as defined in claim 13, and further including tie members secured to said inside surface of said plate member and projecting therefrom, said tie members extending into said insulating material and refractory layer for anchoring said insulating material and refractory layer to said plate member.

15. A method of burning fluid having combustible constituents, the method comprising the steps of continuously feeding a first supply of air in the form of a high velocity sheet across the top of an open-topped combustion chamber, the sheet being directed at an incline downwardly into said chamber so that air from said sheet enters a combustion zone formed within said chamber beneath said sheet and in which combustion has been initiated, continuously feeding a second supply of air to a mixing and injection nozzle below said first supply, continuously feeding the fluid waste to said nozzle for mixing with said second supply of air, and injecting the mixed air and waste through said nozzle and into the combustion zone in a direction substantially parallel the direction of travel of said sheet.

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