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Stribling

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[54] **FURNACES**

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[52] **U.S. Cl.** ..... **110/7 R,** 431/330

[51] **Int. Cl.** **F23g 7/00**

[58] **Field of Search** ..... 110/7 R, 7 S, 13; 431/117, 431/330

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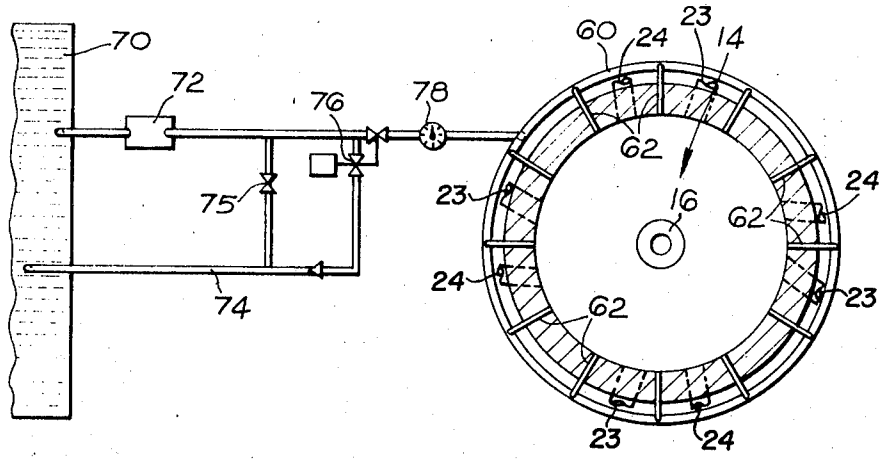
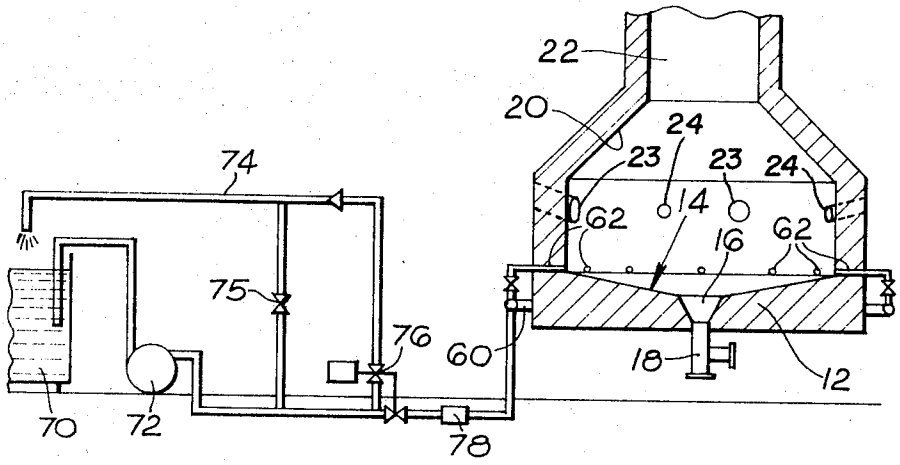
[57] **ABSTRACT**

A furnace for burning liquid sewage and other wastes has a shallow dished heart which is fed with the liquid so as to keep most of the hearth area wet and downwardly directed fuel burners evaporate and burn the material and create a vortex within the furnace interior so that combustion products pass upwardly to an outlet flue through the burner flame to ensure complete combustion.

3 Claims, 2 Drawing Figures




22
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74
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62
62
16
75
76
60
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12
70
72
78

Fig. 1.

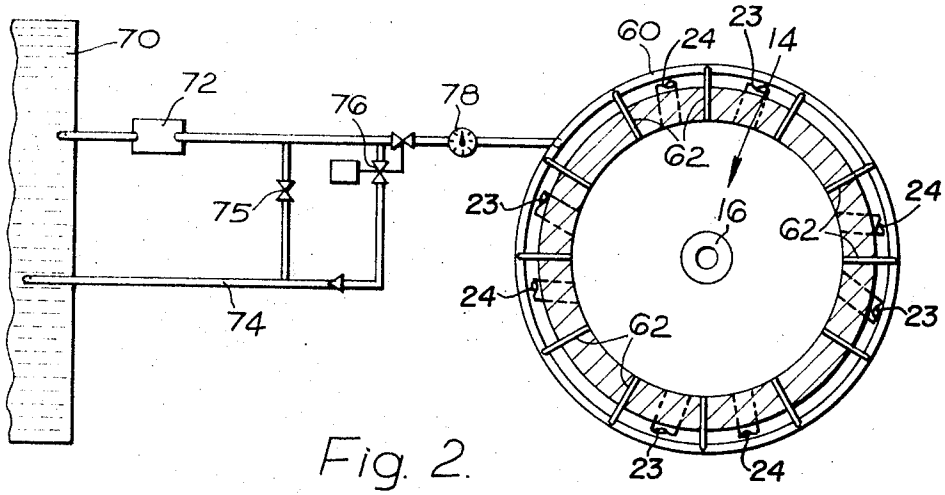
70
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Fig. 2.

FURNACES

BACKGROUND OF THE INVENTION

This invention relates to furnaces for burning liquid waste including, but without limitation, sewage and like residues.

During the treatment of sewage by certain processes, a liquid is obtained which is a mixture of filtrate and decantrate and has a solids content possibly as high as 10 percent, and the necessity for burning is due to the bacterial and biological characteristics of the liquid. This burning step is difficult both because of the low calorific value of the liquid/solids and also because, in evaporating water from the liquid, an extremely unpleasant smell is generated and there is a danger of contamination from escaping vapours. Similar difficulties arise with other waste liquids containing industrial solvents.

SUMMARY OF THE INVENTION

The object of the invention is to provide a furnace which overcomes these difficulties.

In accordance with the invention a furnace for burning liquid waste comprises a combustion chamber, a shallow dished hearth of said chamber being associated with an inlet for liquid to be burnt serving to deliver liquid to the periphery of said hearth, a plurality of fuel burners arranged around the said chamber and all directed generally tangentially and downwardly to direct flame and combustion products towards liquid on said hearth and set up cyclonic action of combustion products, an exhaust outlet disposed above said burners so that evaporated liquid waste and products of combustion pass through a hottest zone in travelling to the outlet when the burners are operating, and said chamber including a conical cyclone area located between said burners and outlet for creating a final combustion vortex.

Preferably, the hearth comprises a shallow frusto-conical area which may open to a steep frusto-conical area.

In general, there are two different possibilities provided by the invention. The liquid waste may be confined as a pool on the hearth, so that the surface area of the pool additional to the liquid trickling down the hearth is available for evaporation and for combustion of the liquid or alternatively, the liquid may be burnt substantially entirely as a thin film trickling down the slope of the hearth. In the second case the flow rate may be arranged so that the liquid is wholly combusted before it reaches the central area of the hearth and the latter may serve as an ash pit for incombustible residue.

The level may be controlled by supply from an external tank having a weir plate to control the height of liquid in the tank and with re-circulation of spill-over from the weir plate, to a second and annular weir plate around the hearth and hence the height of the liquid above the annular weir plate and the rate of flow may be maintained by gravity flow.

Alternatively, the flow may be under the control of pumps which may be adjusted either manually or automatically, the latter under the control of sensors reading the temperature of the exhaust gases from the furnace or the percentage of carbon dioxide present.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagrammatic part-sectional elevation of a typical furnace installation according to the invention;

FIG. **2** is a plan view of the arrangement of FIG. **1.**

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, the furnace comprises a combustion chamber which is generally cylindrical and has a hearth **12** at the lower end of the cylinder, the axis of the cylinder being vertically extending. The hearth includes a shallow frusto-conical area **14** opening to a steeper frusto-conical central portion or well **16** which communicates to an ash well **18.**

The upper end of the furnace combustion chamber is provided with a frusto-conical cyclone area **20** communicating with exhaust passage **22** connected to a flue, and possibly with a dust extractor or wet scrubber, the passage communicating with fan means before being connected to the final outlet flue or chimney.

The whole of the interior of the combustion chamber area of the furnace is lined with refractory such as silicon carbide, and a plurality of oil or gas burners **23** open into the combustion chamber, being downwardly directed and tangentially inclined to the periphery of the chamber, so as to induce cyclonic action of combustion products. A plurality of combustion air inlets **24** are provided, which may be combined with the burners or separate therefrom, which in the latter case will be similarly directed.

The burners may be adjustable in angle, to enable flame to be directed at the hearth.

A ring main or manifold **60** extends around the periphery of the hearth, but externally of the furnace structure, and a plurality of separate inlets **62** extend through the cylindrical wall to deliver liquid to (substantially) the periphery of the hearth so that the liquid trickles down towards the central point. The inlet **62** may be provided with divergent nozzles or apertures so as to spread the liquid over substantially the whole of the surface area of the hearth.

In this arrangement there is illustrated a tank **70** connected to pump **72** which delivers to the main **60,** with a valve controlled by-pass **74,** enabling the pump to be run at constant rate, but for the delivery rate to be controlled in accordance with requirements.

The arrangement may be operated so that the liquid waste material delivered through the inlets **62** and trickling over the hearth is substantially all evaporated and burnt by the burners and combustion air via the inlets therefor before it reaches the central and steeper frusto-conical portion **16,** so that there is no true pool of liquid on the hearth. Alternatively, the same arrangement may be used to feed a pool of liquid, with the possibility of some fraction of the liquid waste material evaporating and/or burning off before it reaches the pool, that is to say providing a pool which is of smaller diameter than the hearth. Ash or other incombustible residue may be removed from the outlet **18** as and when required.

In general, if industrial wastes of substantial calorific value are being burnt, a pool of relatively small surface area will be maintained possibly confined within the steeper frusto-cone **16.** The rate of burning is then

likely to be limited only in order to prevent overheating of the furnace structure, and in such operation, the burners may be operated at low rate only in order to maintain the combustion and ensure that the combustion products pass through the burner flame on their way to the outlet, as more particularly explained hereinafter.

If the liquid waste being burnt is of a lower calorific value, in general it will be preferred to provide a pool or larger surface area. In such events, and particularly with very low calorific value materials, the burners will operate at a higher rating in order to maintain combustion at desired levels.

It is possible to vary the angles of the cones, from one design of furnace to another, and in order to suit particular needs, but it has been found experimentally that the use of the two cones of different angles substantially avoids the need for this, for the narrower angle portion is suitable for high fuel value wastes and the wider angle cone for low ones, and more critical and efficient control is possible by these means then would be the case if, for example, a single cone were provided.

In all cases, and even where the calorific value is sufficient to enable the burners to be shut off, combustion air continues to be supplied into the furnace in the tangential and downwardly directed manner which ensures a high efficiency vortex of flame and hence completion of combustion within the cylindrical area of the furnace, the final frusto-cone **20** also serving to maintain the vortex and complete the combustion.

In the cases of the low calorific value materials, for example watery wastes, the heat generated maintains evaporation, and particles entrained in the evaporating vapours are thoroughly mixed with flame in the vortex and essentially pass through the burner flames before reaching the final vortex, again for the purposes of ensuring thorough and complete combustion of the material.

Furnaces according to the invention may also be suitable for the combustion of liquids containing sodium or other materials which would normally attack the refractory lining of the hearth, and for such purposes the hearth may be composed of a metal, especially a high temperature alloy steel. In such event it is preferred to maintain the hearth surface wet with the liquid over its entire surface area, or substantially so. The waste liquid then has the supplementary purpose of maintaining the hearth cool.

Preferably for such purposes, an annular weir is provided as a vertical extension of the hearth periphery and the weir forms one wall of a channel or trough fed from an external reservoir e.g. by gravity so that the liquid spills over at a plurality of points to feed the pool on the hearth or burn on the surface of the hearth. The annular weir may be of saw-tooth formation or like to ensure that feeding occurs around the whole of the periphery of the hearth.

In any of the arrangements or systems described, the temperature of the gases leaving the furnace may be sensed and used to control motorized valves such as **75, 76, 78** in the feed system, and in general dropping temperature below a predetermined minimum or rising temperature above a predetermined maximum will be effective to cause reduction of the feed rate. Again, as an alternative, the carbon dioxide content of the exhaust gases may be sensed, and used to control feed rate, and the particular method selected (assuming that manual operation is not required) may depend upon the nature of the waste material to be burnt.

I claim:

1. A furnace for burning liquid waste, comprising a cylindrical combustion chamber having a conical upper end terminating in an exhaust outlet, a shallow frusto-conical hearth forming the lower end of the combustion chamber, and a plurality of fuel burners which extend into the combustion chamber and are downwardly and tangentially inclined to direct the flame at the hearth, and to induce cyclonic action of the combustion products so as to produce a vortex of flame in the combustion chamber, wherein the improvement comprises a conduit for conducting the liquid waste having a plurality of outlets distributed around the periphery of the hearth to cause the liquid waste to trickle down the hearth, where it is evaporated and burned to produce vapors which pass through the vortex of flame to complete the combustion, and an ash well at the center of the hearth for removal of incombustible residues.

2. A furnace as claimed in claim **1** wherein said hearth comprises a first shallow frusto-conical area and a central steeper-angle frusto-conical portion.

3. A furnace as claimed in claim **1** wherein a ring main surrounds the hearth and a plurality of inlets open to the periphery of the hearth from the main.

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