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APPARATUS FOR BURNING WASTE MATERIAL

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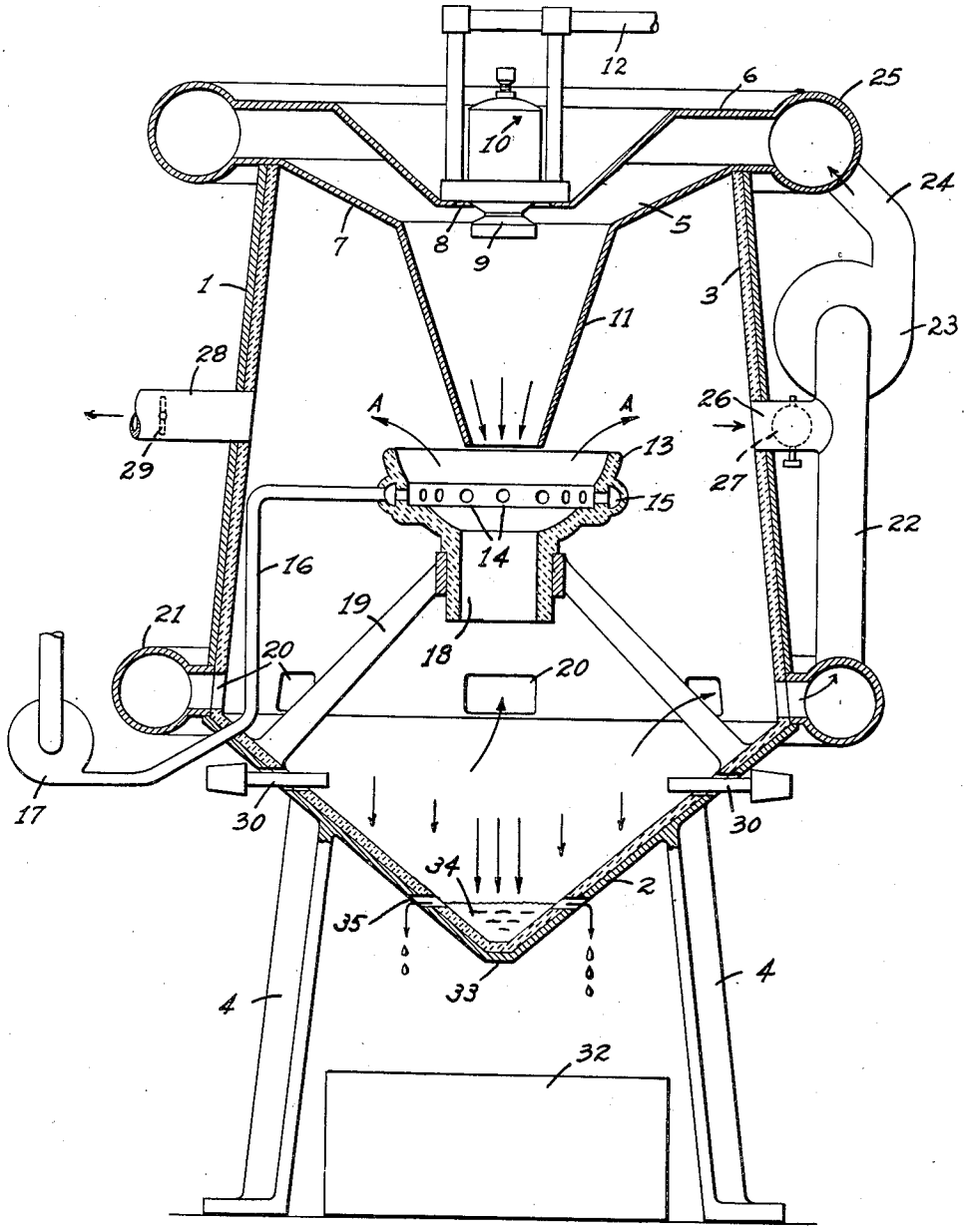

FIG. 1.

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APPARATUS FOR BURNING WASTE MATERIAL

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16 Claims. (Cl. 110—8)

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This application is a continuation-in-part of my application Ser. No. 540,819, filed June 17, 1944, for Sludge Burner, which has now been abandoned.

This invention relates to apparatus for and method of burning waste material. Its object is to provide a means and way for incinerating sewage sludge or other similar waste matter. More particularly, the purpose of the invention is to incinerate such material as a continuous process, utilizing the resultant heat and gases of combustion in a normally closed cycle to heat and dry following material prior to the combustion of the latter. This operation is based upon the fact that material like sewage sludge, which includes up to 70% moisture content, contains combustible solids in a quantity having enough calorific value to support its own combustion.

An additional object is to provide a structure which comprises, in combination with a chamber, a centrifugal atomizer, a funnel-shaped feed spout into which the atomizer discharges finely comminuted sludge or the like, means to withdraw hot gases of combustion from the chamber and to discharge such gases into the feed spout for heat interchange with the sprayed sludge, and to force-feed the resulting mixture through the feed spout as a high-velocity stream, an instrumentality located intermediate the ends of the chamber adjacent the discharge end of the feed spout which is arranged to deflect the lighter constituents of the stream, including the major portion of the spent gases which have been used for drying the material, which instrumentality includes a tuyère for introducing fresh air across the flow of the stream, and a heated portion through which the heavier constituents of the stream pass and are ignited.

Other objects of the invention are to produce a simple, inexpensive and practical device and a novel method of operation which is effective and efficient for the purposes for which it is designed. These objects are accomplished by means of such a structure and relative arrangement of parts as are fully described in the following specification, and the novel features of which are defined in claims.

The figure of the drawing is a sectional elevation of a burner which is made according to and embodies this invention.

This apparatus comprises a chamber having a substantially cylindrical body 1 having an inverted conical hopper 2 forming the lower end thereof. The body and hopper are provided with a refractory lining 3 and are supported in

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fixed position by a suitable means, such as legs 4.

At its upper end the body is closed by a structure which forms an annular passageway 5, generally in the form of an inverted truncated cone, which is formed between a top plate 6 and a bottom plate 7. A centrifugal atomizer 10 is mounted on the top plate 6, which has a central opening 8, through which the distributor 9 of the atomizer 10 projects into the lower end of the passageway 5. This centrifugal atomizer is shown in detail in my U. S. Patent No. 2,292,572, issued August 11, 1942, and the specific construction of this device forms no part of the present invention.

The distributor 9 in the lower part of the passageway 5 extends downwardly into the upper end of a funnel-shaped feed spout 11, which communicates at its upper end with the passageway 5, centrally through the bottom plate 7. The upper end of this feed spout is of a considerably larger diameter than that of the distributor 9. Sludge is fed to the centrifugal atomizer 10 through a feed pipe 12. Immediately below the funnel-shaped feed spout 11 is an instrumentality which includes an upwardly-opening bowl 13 having an outwardly-flaring curved deflecting surface and has a tuyère embedded in it, which discharges into the bowl through jets 14. Air under pressure is fed to the jets through an annular manifold 15 included in the bowl, and a conduit 16 which leads from an air pump 17 outside of the chamber. The length of the conduit within the chamber is such that the air passing through it is heated before its discharge into the bowl.

The lower end of the bowl is in open communication with a cylindrical ignition tube 18, which may be an integral part of the bowl, and the bowl and tube may be made of refractory material. They are supported from the bottom of the heater by a spider 19. The distributor 9, feed spout 11, bowl 13 and tube 18 are relatively concentric, with the bowl 13 being substantially larger at its upper end than the adjacent lower end of the feed spout 11.

Intermediate the ignition tube 18 and the hopper 2, the chamber is provided with a horizontal row of circumferentially spaced ports 20, which communicate with an annular manifold 21 surrounding the lower end of the body 1. A suction conduit 22 leads upwardly from the manifold 21 to a high-temperature fan or air-pressure pump 23. A discharge conduit 24 leads from this pressure pump to an annular manifold 25, which surrounds the passageway 5 and commu-

nicates therewith. 26 is a conduit, which forms a communication between the interior of the body 1 intermediate its ends, and the conduit 22 intermediate the manifold 21 and the pressure pump 23. A valve 27 in conduit 26 is provided for controlling the gaseous flow therethrough. Opposite the conduit 26 is another lateral conduit 28, which likewise includes a flow-control valve 29.

Burners 30, 30, adapted to be connected with a source (not shown) of auxiliary fuel, project into the hopper 2 near the upper part thereof.

In operation of this apparatus, the sludge which is fed by pipe 12 into the centrifugal atomizer 10 is sprayed outwardly through the distributor 9 in a substantially horizontal plane in the form of a relatively fine mist or fog. The heavier constituents of the material, which are ignited as they pass through the ignition tube 18, burn in the area of the chamber at the lower end of the body 1 and in the hopper 2. These portions of the structure form its combustion space. Hot gases which are drawn from this combustion space through ports 20 and manifold 21 are discharged at high velocity and relatively great quantity by the pressure pump 23. These gases are the result of combustion and are comparatively inert. They flow inwardly from the manifold through the passageway 5 into the upper end of the funnel-shaped feed spout 11. When this occurs these hot gases are intermixed with the sprayed sludge from the distributor 9, and the mixture of sludge particles and gases pass downwardly through the feed spout 11. While passing through the feed spout a heat-interchange occurs between the hot gases and sprayed sludge, which materially reduces the moisture content of the latter. Thereafter, the mixture is discharged from the lower end of the feed spout 11 into the bowl 13. Due to the shape of the deflecting walls of the bowl 13 and the resistance offered by the transverse air streams from the tuyère as they are discharged into the bowl through the jets 14, the greater part of the gases and the lighter constituents of the matter carried by the gases from the feed spout 11 are deflected upwardly and outwardly from the bowl in the directions indicated by the arrows, AA, while substantially all of the sprayed dried sludge continues downwardly admixed with fresh heated air from the tuyère into and through the tube 18.

The burners 30, 30, which project into the hopper or lower portion of the chamber, are used to heat the ignition tube 18 to a temperature above the ignition temperature of the more volatile particles of the sludge to initiate their incineration. The continued combustion of the sludge as it passes through tube 18 maintains the temperature of the tube above this self-ignition temperature of the sludge. If the moisture content of the sludge requires auxiliary heat to assure continued combustion, it can be provided by the burners 30, 30. Incineration is completed in the combustion space in the lower part of the chamber.

The gases which escape upwardly and outwardly from the bowl 13, as previously described, are relatively cool and may be drawn through lateral conduit 26 into conduit 22 to temper the hot gases in the latter, if necessary. The flow of these gases may be controlled by the valve 27. The valve 29 in lateral conduit 28 may be open to the extent necessary to permit these relatively cool gases to be vented from the chamber.

The ash from the combustion in the chamber falls against the refractory lining 3 of the hopper 2, which is closed at its lower end, as shown at 33. This ash collects in the lower part of the hopper in the form of a molten slag, shown at 34. Such of the incinerated matter as falls onto the slag at 34 is cushioned thereby. A series of horizontally aligned ports 35 vertically spaced from the lower end of the hopper 2 are provided through the wall of the hopper and its lining, through which this slag escapes and falls onto a receiver or carry-off conveyor, indicated diagrammatically at 32.

In the operation of this device the re-circulation of the hot spent gases of combustion is one of the essential features, as it assures high temperature of the high-velocity stream of gases introduced in the passageway 5 and into the feed spout 11, into which the sludge is introduced as a spray from the distributor 9 to condition the sludge for subsequent combustion.

Previous attempts to dry and burn sludge and the like in one structure have been unsuccessful because of the fact that the volume of hot gases required for drying have been so great that they have interfered with the incineration of the dried material. I have found that it is necessary to remove the greater part of these drying gases from the mixture to be incinerated before it is ignited. Attempts to burn sewage sludge on a fuel bed have been unsuccessful, and I have found that such material can be more successfully incinerated if burned in suspension.

From the foregoing description it will be readily seen that this device fulfills the objects of the invention as set forth herein. The specific apparatus illustrated and described is disposed vertically, but this is not a necessary limitation.

Various modifications in construction, mode of operation, method and use of an invention may and do occur to others, especially after benefiting from knowledge of such a disclosure as that herein presented, of the principles involved, but the invention itself is not confined to the present showing.

I claim:

1. A burner comprising a structure forming a substantially closed chamber of circular cross section with a combustion space formed therein, an axially disposed feed spout projecting into a part of the chamber remote from the combustion space, means for withdrawing hot gases of combustion from one part of the chamber near the combustion space and forcing said gases as a stream through the feed spout into the chamber, means for introducing finely comminuted material into the stream, an axially disposed separating instrumentality between the discharge end of the feed spout and the combustion space for deflecting lighter constituents of the stream outwardly, and means for heating the undeflected constituents of the stream to a temperature above their ignition temperature.

2. A burner comprising a structure forming a substantially closed chamber of circular cross section with a combustion space formed therein, an axially disposed feed spout projecting into the part of the chamber remote from the combustion space, means for withdrawing hot gases of combustion from one part of the chamber near the combustion space and forcing said gases as a stream through the feed spout into the chamber, and means for introducing finely comminuted material into the stream, an axially disposed separating instrumentality between the discharge end of the feed spout and the combustion space for

deflecting lighter constituents of the stream outwardly, said instrumentality comprising means for heating the undeflected constituents of the stream to a temperature above their ignition temperature.

3. A burner comprising a structure forming a substantially closed chamber of circular cross section with a combustion space formed therein, an axially disposed feed spout projecting into a part of the chamber remote from the combustion space, means for withdrawing hot gases of combustion from one part of the chamber near the combustion space and forcing said gases as a stream through the feed spout into the chamber, means for venting the chamber, means for introducing finely comminuted material into the stream, an axially disposed open-ended circular bowl adjacent the discharge end of the feed spout, with the end of the bowl nearest the feed spout wider than the discharge end of the feed spout and with the sides of the bowl converging toward its other end, means for introducing gas containing oxygen into the stream beyond the discharge end of the spout in directions substantially transverse to the flow of the stream through the feed spout to cooperate with said sides of the bowl to deflect lighter constituents of the stream outwardly, and means for heating a part of the bowl through which undeflected constituents of the stream pass, to a temperature above the ignition temperature of said undeflected constituents.

4. A burner comprising a structure forming a substantially closed chamber of circular cross section with a combustion space formed therein, an axially disposed feed spout projecting into a part of the chamber remote from the combustion space, means for withdrawing hot gases of combustion from one part of the chamber near the combustion space and forcing said gases as a stream through the feed spout into the chamber, means for venting the chamber, means for introducing finely comminuted material into the stream, an axially disposed open-ended circular bowl adjacent the discharge end of the feed spout, with the end of the bowl nearest the feed spout wider than the discharge end of the feed spout and with the sides of the bowl converging toward its other end, means for introducing gas containing oxygen into the stream through the sides of the bowl in directions substantially transverse to the flow of the stream through the feed spout to cooperate with said sides of the bowl to deflect lighter constituents of the stream outwardly, and means for heating a part of the bowl through which undeflected constituents of the stream pass, to a temperature above the ignition temperature of said undeflected constituents.

5. A burner comprising a structure forming a substantially closed chamber of circular cross section with a combustion space formed therein, an axially disposed feed spout projecting into a part of the chamber remote from the combustion space, means for withdrawing hot gases of combustion from one part of the chamber near the combustion space and forcing said gases as a stream through the feed spout into the chamber, means for venting the chamber, means for introducing finely comminuted material into the stream, an axially disposed open-ended circular bowl adjacent the discharge end of the feed spout, with the end of the bowl nearest the feed spout wider than the discharge end of the feed spout and with the sides of the bowl converging toward its other end and terminating in an ignition tube, means for introducing gas containing oxygen into the stream beyond the discharge end of the spout in directions substantially transverse to the flow of the stream through the feed spout to cooperate with said sides of the bowl to deflect lighter constituents of the stream outwardly, and means for heating the ignition tube through which undeflected constituents of the stream pass, to a temperature above the ignition temperature of said undeflected constituents.

6. A burner comprising a structure forming a substantially closed chamber of circular cross section with a combustion space formed therein, an axially disposed feed spout projecting into a part of the chamber remote from the combustion space, means for withdrawing hot gases of combustion from one part of the chamber near the combustion space and forcing said gases as a stream through the feed spout into the chamber, means for venting the chamber, means for introducing finely comminuted material into the stream, an axially disposed open-ended circular bowl adjacent the discharge end of the feed spout, with the end of the bowl nearest the feed spout wider than the discharge end of the feed spout and with the sides of the bowl converging toward its other end and terminating in an ignition tube, means for introducing gas containing oxygen into the stream through a plurality of angularly spaced orifices in the sides of the bowl in directions substantially transverse to the flow of the stream through the feed spout to cooperate with said sides of the bowl to deflect lighter constituents of the stream outwardly, and means for heating the ignition tube through which undeflected constituents of the stream pass, to a temperature above the ignition temperature of said undeflected constituents.

7. A burner comprising a structure forming a substantially closed chamber of circular cross section with a combustion space formed therein, an axially disposed funnel-shaped feed spout projecting into a part of the chamber remote from the combustion space with its larger end outermost, means for withdrawing hot gases of combustion from a part of the chamber near the combustion space and forcing said gases as a stream through the feed spout into the chamber, means for introducing finely comminuted material into the stream near the larger end of the spout, an axially disposed separating instrumentality between the discharge end of the feed spout and the combustion space for deflecting lighter constituents of the stream outwardly, and means for heating the undeflected constituents of the stream to a temperature above their ignition temperature.

8. A burner comprising a structure forming a substantially closed chamber of circular cross section with a combustion space formed therein, an axially disposed feed spout projecting into a part of the chamber remote from the combustion space, means for withdrawing hot gases of combustion from a part of the chamber near the combustion space and forcing said gases as a stream through the feed spout into the chamber, means for venting the chamber, means for introducing finely comminuted material into the stream, an axially disposed open-ended circular bowl adjacent the discharge end of the feed spout, with the end of the bowl nearest the feed spout wider than the discharge end of the feed spout and with the sides of the bowl converging toward its other end, means for introducing heated gas containing oxygen into the stream through orifices in the sides of the bowl in directions sub-

stantially transverse to the flow of the stream through the feed spout to cooperate with said sides of the bowl to deflect lighter constituents of the stream outwardly, said means comprising a pressure pump outside of the chamber, and a conduit passing through the chamber interconnecting the pump with the orifices in the bowl, and means for heating a part of the bowl through which undeflected constituents of the stream pass, to a temperature above the ignition temperature of said undeflected constituents.

9. A burner comprising a structure forming a substantially closed chamber of circular cross section with a combustion space formed therein, an axially disposed feed spout projecting into a part of the chamber remote from the combustion space, a manifold outside of the chamber in communication with the combustion space, a pressure pump, a suction conduit between the manifold and the pump, a pressure conduit between the pump and the feed spout, means for venting the chamber, means for introducing finely comminuted material into the stream, an axially disposed open-ended circular bowl adjacent the discharge end of the feed spout, with the end of the bowl nearest the feed spout wider than the discharge end of the feed spout and with the sides of the bowl converging toward its other end, means for introducing gas containing oxygen into the stream through the sides of the bowl in directions substantially transverse to the flow of the stream through the feed spout to cooperate with said sides of the bowl to deflect lighter constituents of the stream outwardly, and means for heating a part of the bowl through which undeflected constituents of the stream pass, to a temperature above the ignition temperature of said undeflected constituents.

10. A burner comprising a structure forming a substantially closed chamber of circular cross section with a combustion space formed therein, an axially disposed feed spout projecting into a part of the chamber remote from the combustion space, a manifold outside of the chamber in communication with the combustion space, a pressure pump, a suction conduit between the manifold and the pump, a pressure conduit between the pump and the feed spout, a valve-controlled conduit between the chamber and the suction conduit, means for venting the chamber, means for introducing finely comminuted material into the stream, an axially disposed open-ended circular bowl adjacent the discharge end of the feed spout, with the end of the bowl nearest the feed spout wider than the discharge end of the feed spout and with the sides of the bowl converging toward its other end, means for introducing gas containing oxygen into the stream through the sides of the bowl in directions substantially transverse to the flow of the stream through the feed spout to cooperate with said sides of the bowl to deflect lighter constituents of the stream outwardly, and means for heating a part of the bowl through which undeflected constituents of the stream pass, to a temperature above the ignition temperature of said undeflected constituents.

11. A burner comprising a structure forming a substantially closed chamber of circular cross section with a combustion space formed therein, an axially disposed feed spout projecting into a part of the chamber remote from the combustion space, a manifold outside of the chamber in communication with the combustion space, a pressure pump, a suction conduit between the manifold and the pump, a pressure conduit between the pump and the feed spout, a valve-controlled conduit between the chamber and the suction conduit, a valve-controlled vent from the chamber, means for introducing finely comminuted material into the stream, an axially disposed open-ended circular bowl adjacent the discharge end of the feed spout, with the end of the bowl nearest the feed spout wider than the discharge end of the feed spout and with the sides of the bowl converging toward its other end, means for introducing gas containing oxygen into the stream through the sides of the bowl in directions substantially transverse to the flow of the stream through the feed spout to cooperate with said sides of the bowl to deflect lighter constituents of the stream outwardly, and means for heating a part of the bowl through which undeflected constituents of the stream pass, to a temperature above the ignition temperature of said undeflected constituents.

12. A burner comprising a structure forming a substantially cylindrical body with a cone-shaped portion at one of its ends together forming a closed chamber with a combustion space therein, an axially disposed funnel-shaped feed spout projecting into a part of the chamber remote from the combustion space, a manifold surrounding the structure in communication with the combustion space, means at the end of the structure opposite the cone-shaped portion thereof forming an annular passage in the form of a truncated cone axially alined with the body, the feed spout extending centrally from said passage with its smaller discharge end innermost, a pressure pump outside the structure, a suction conduit between the manifold and the pump, a pressure conduit between the pump and said passage, means for venting the chamber, means for introducing finely comminuted material into the feed spout near its larger end, an axially disposed open-ended circular bowl adjacent the discharge end of the feed spout, with the end of the bowl nearest the feed spout wider than the discharge end of the feed spout and with the sides of the bowl converging toward its other end, means for introducing gas containing oxygen into the stream beyond the discharge end of the spout in directions substantially transverse to the flow of the stream through the feed spout to cooperate with said sides of the bowl to deflect lighter constituents of the stream outwardly, and means for heating a part of the bowl through which undeflected constituents of the stream pass, to a temperature above the ignition temperature of said undeflected constituents.

13. A burner comprising a structure forming a substantially cylindrical body with a cone-shaped portion at one of its ends together forming a closed chamber with a combustion space therein, an axially disposed funnel-shaped feed spout projecting into a part of the chamber remote from the combustion space, a manifold surrounding the structure in communication with the combustion space, means at the end of the structure opposite the cone-shaped portion thereof forming an annular passage in the form of a truncated cone axially alined with the body, the feed spout extending centrally from said passage with its smaller discharge end innermost, a pressure pump outside the structure, a suction conduit between the manifold and the pump, a valve-controlled conduit between the suction conduit and the chamber, a pressure conduit between the pump and said passage, a valve-controlled vent for the chamber, means for introducing finely commi-

nuted material into the feed spout near its larger end, an axially disposed open-ended circular bowl adjacent the discharge end of the feed spout, with the end of the bowl nearest the feed spout wider than the discharge end of the feed spout and with the sides of the bowl converging toward its other end, means for introducing gas containing oxygen into the stream beyond the discharge end of the spout in directions substantially transverse to the flow of the stream through the feed spout to cooperate with said sides of the bowl to deflect lighter constituents of the stream outwardly, and means for heating a part of the bowl through which undeflected constituents of the stream pass, to a temperature above the ignition temperature of said undeflected constituents.

14. A burner comprising a structure forming a vertically disposed substantially cylindrical body with a cone-shaped portion at its lower end forming a hopper, said body and hopper together forming a closed chamber with a combustion space therein, an axially disposed funnel-shaped feed spout projecting into the upper part of the body, a manifold surrounding the structure in communication with the combustion space, means near the upper end of the structure forming an annular passage in the form of a truncated cone axially alined with the body, the feed spout extending centrally from said passage with its smaller discharge end innermost, a pressure pump outside the structure, a suction conduit between the manifold and the pump, a pressure conduit between the pump and said passage, means for venting the chamber, means for introducing finely comminuted material into the feed spout near its larger end, an axially disposed open-ended circular bowl adjacent the discharge end of the feed spout, with the end of the bowl nearest the feed spout wider than the discharge end of the feed spout and with the sides of the bowl converging toward its other end, means for introducing gas containing oxygen into the stream beyond the discharge end of the spout in directions substantially transverse to the flow of the stream through the feed spout to cooperate with said sides of the bowl to deflect lighter constituents of the stream outwardly, and means for heating a part of the bowl through which undeflected constituents of the stream pass, to a temperature above the ignition temperature of said undeflected constituents.

15. A burner comprising a structure forming a vertically disposed substantially cylindrical body with a cone-shaped portion at its lower end forming a hopper, said body and hopper together forming a closed chamber with a combustion space therein, an axially disposed funnel-shaped feed spout projecting into the upper part of the body, a manifold surrounding the structure in communication with the combustion space, means near the upper end of the structure forming an annular passage in the form of a truncated cone axially alined with the body, the feed spout extending centrally from said passage with its smaller discharge end innermost, a pressure pump outside the structure, a suction conduit between the manifold and the pump, a valve-controlled conduit between the suction conduit and the chamber, a pressure conduit between the pump and said passage, a valve-controlled vent from the chamber, means for introducing finely comminuted material into the feed spout near its larger end, an axially disposed open-ended circular bowl adjacent the discharge end of the feed spout, with the end of the bowl nearest the feed spout wider than the discharge end of the feed spout and with the sides of the bowl converging toward its other end, means for introducing gas containing oxygen into the stream beyond the discharge end of the spout in directions substantially transverse to the flow of the stream through the feed spout to cooperate with said sides of the bowl to deflect lighter constituents of the stream outwardly, and means for heating a part of the bowl through which undeflected constituents of the stream pass, to a temperature above the ignition temperature of said undeflected constituents.

16. A burner comprising a structure forming a vertically disposed substantially cylindrical body with a cone-shaped portion at its lower end forming a hopper, said body and hopper together forming a closed chamber with a combustion space therein, an axially disposed funnel-shaped feed spout projecting into the upper part of the body, a manifold surrounding the structure in communication with the combustion space, means near the upper end of the structure forming an annular passage in the form of a truncated cone axially alined with the body, the feed spout extending centrally from said passage with its smaller discharge end innermost, a pressure pump outside the structure, a suction conduit between the manifold and the pump, a pressure conduit between the pump and said passage, means for venting the chamber, means for introducing finely comminuted material into the feed spout near its larger end, an axially disposed open-ended circular bowl adjacent the discharge end of the feed spout, with the end of the bowl nearest the feed spout wider than the discharge end of the feed spout and with the sides of the bowl converging toward its other end, means for introducing gas containing oxygen into the stream beyond the discharge end of the spout in directions substantially transverse to the flow of the stream through the feed spout to cooperate with said sides of the bowl to deflect lighter constituents of the stream outwardly, and means for heating a part of the bowl through which undeflected constituents of the stream pass, to a temperature above the ignition temperature of said undeflected constituents, said hopper being closed at its lower end and being provided with an outlet port vertically spaced from said closed end.

THOMAS R. KOMLINE.

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