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[54] **APPARATUS FOR IGNITING AND BURNING AIR-BORNE PARTICULATE COMBUSTIBLE MATERIAL**

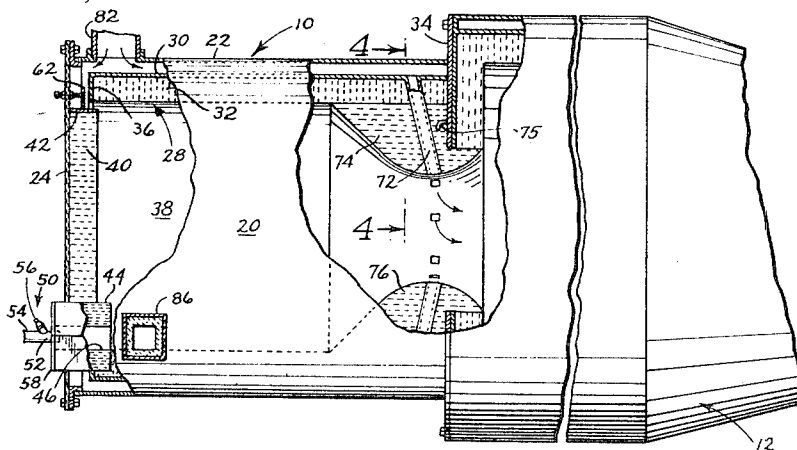
2 Claims, 5 Drawing Figs.

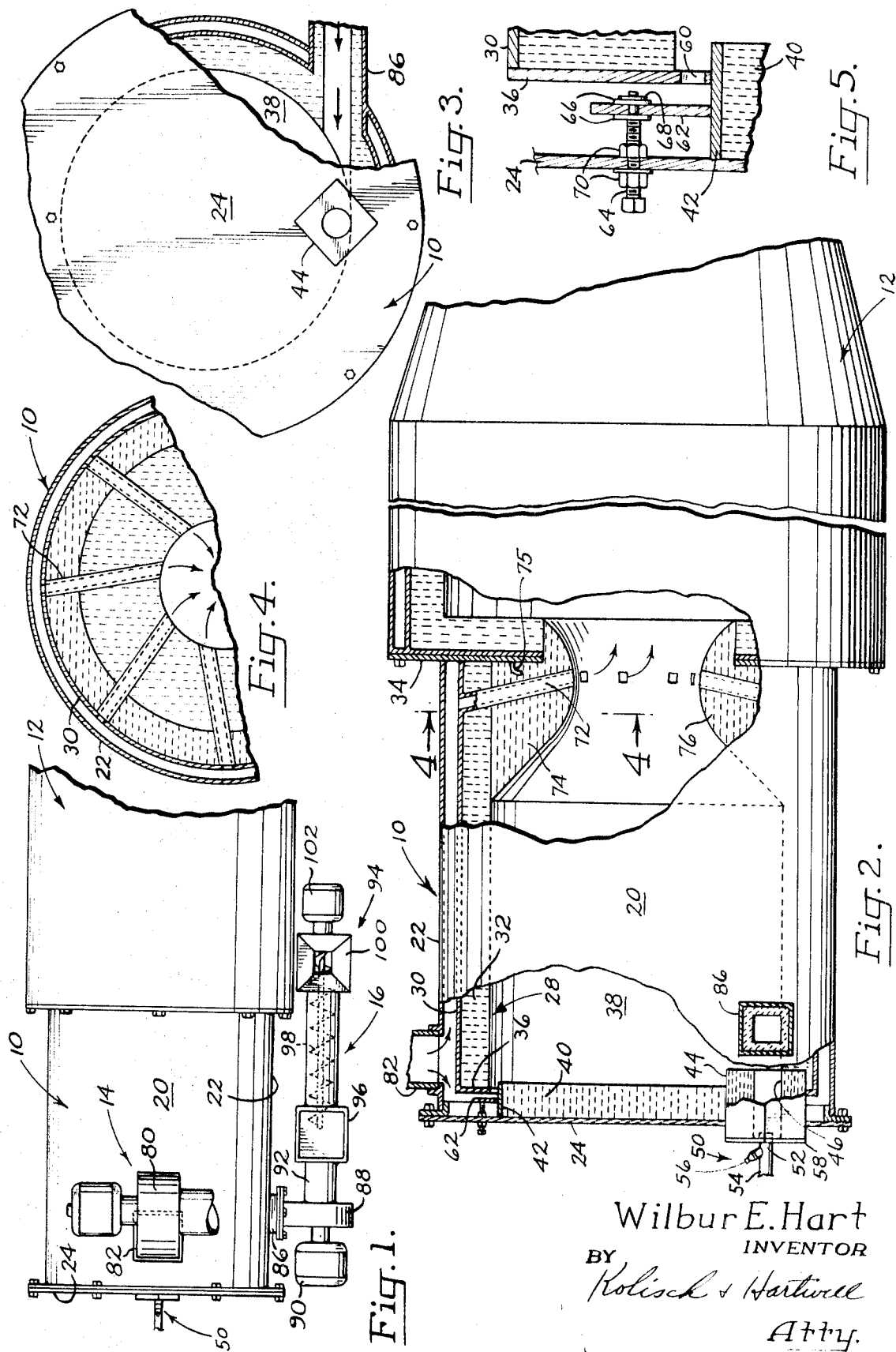
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ABSTRACT: Apparatus for igniting and burning airborne combustible material including a burner enclosure defining a substantially cylindrical internal burner chamber. A duct equipped with blower and connected to a supply of combustible material introduces such material into the chamber and produces flow of such material in a circumferential direction around the inside of said chamber. The burner enclosure adjacent the discharge end of the chamber includes a constricted throat section which leads to a discharge opening and which functions to restrict flow of material to outside the chamber. Means adjacent said throat section introduces air into the burner chamber with such traveling in a circumferential direction complementing the direction of movement of the airborne material introduced through the duct at the feed end of the chamber.





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APPARATUS FOR IGNITING AND BURNING AIR-BORNE PARTICULATE COMBUSTIBLE MATERIAL

This invention relates to apparatus for igniting and burning combustible material, and more particularly, to such apparatus which includes a burner chamber, and the combustible material comprises particulate solid material which is carried into the burner chamber in a stream of gas (air).

A need exists for apparatus for igniting and burning particulate solid material, either as part of a waste disposal system, or as a means for producing heat from such burning to be used in heating, drying or some other operation.

A general object of the invention is to provide improved apparatus for igniting and burning particulate combustible material, which in operation has been noted to be more effective in producing complete ignition and preliminary burning of the material.

A related object of the invention is to provide such apparatus which includes a burner chamber, and which can be operated to produce relatively high temperatures within the chamber to promote ignition and combustion of material.

A further feature and object of the invention is the provision of such apparatus where the combustible material enters a burner chamber within the apparatus while traveling in a path which extends transversely of, and is laterally offset from, the axis of the chamber. This initiates circumferential swirling movement of the material and air as the material travels toward the discharge end of the burner chamber. The material ignites on entering the chamber, and combustion proceeds as the material travels toward the chamber's discharge end. A throat section adjacent the discharge end of the burner chamber functions to restrict the flow of material from the chamber, thereby to tend to increase the retention time of particulate material in the chamber. Such has been noted to be effective in increasing the operating temperature of the apparatus, thus to promote ignition and burning of material which is difficult to process at a lower temperature. Additionally, according to the invention, further air is introduced adjacent this throat section which is directed in a path which also extends transversely of, and is laterally offset from, the axis of the burner chamber, to produce a circumferential whirling movement of such additional air complementing the movement produced in the material upon its entry into the burner chamber. Such air also functions to increase retention time of material within the burner chamber, and provides additional oxygen whereby further burning of already ignited material may better proceed.

These and other objects and advantages of the instant invention will become more fully apparent as the following description is read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a top plan view of apparatus as contemplated, such comprising a combustor including an outer casing assembly which houses a burner enclosure, means outside such combustor for introducing particulate material to be burned with such carried in a stream of air, and additional means outside the combustor for supplying the air or gas which supports combustion within the combustor;

FIG. 2 is a view, somewhat enlarged and with portions broken away, illustrating further details of the combustor;

FIG. 3 is a view, looking at the left end of the combustor in FIG. 2;

FIG. 4 is a cross-sectional view, taken generally along the line 4-4 in FIG. 2; and

FIG. 5 is a view, on an even larger scale, showing details of a mounting for a plate which is provided in the apparatus for controlling the flow of air into the feed end of a burner chamber in the apparatus.

Generally describing the apparatus as contemplated by a preferred embodiment of the invention, and referring more particularly to FIG. 1, indicated generally at 10 is what is referred to herein as a combustor in the apparatus, within which ignition and preliminary burning of material takes

place. The combustor is shown attached to a furnace 12, which receives material leaving the combustor. This material ordinarily will comprise final and intermediate combustion products produced by the action which occurs in the combustor. Final burning of the material takes place in the furnace. Material leaving the furnace may be exhausted into the atmosphere, in the case of a disposal operation, or suitably channeled through heater or dryer apparatus and the like, when it is desired to utilize the heat obtained from the burning.

Shown adjacent the combustor in FIG. 1 is supply means 14 for supplying combustion supporting gas, i.e., air, to the combustor, and supply means 16 for supplying solid particulate material to the combustor with such carried in a stream of air.

Considering now in more detail the construction of the combustor, and referring now also to FIGS. 2, 3, 4 and 5, the combustor includes a casing assembly 20 which may be made of metal and comprises a cylindrical shell 22 and an end plate 24 fastened as by the detachable nut and bolts shown to the shell, the end plate closing off the left end of the shell in FIG. 2.

Suitably supported concentrically within the interior of the casing assembly is what is referred to herein as a burner tube 28. Making up the burner tube is a metal shell 30 and a refractory liner for the shell, such as the firebrick shown at 32. At the right end of the burner tube an annular plate 34 is provided, which is joined to shells 22 and 30, which has its outer peripheral margin outside of casing assembly 20. This outer peripheral margin may be utilized in securing the casing assembly to the furnace. Joined to the left end of shell 30 in FIG. 2 is an annular plate 36 which bounds the refractory liner adjacent this left end. The burner tube, which is part of what is referred to as a burner enclosure provided within the casing assembly, defines within its interior a substantially cylindrical burner chamber, designated generally at 38. The feed and discharge ends of this burner chamber are adjacent axially opposite extremities of the tube, with the feed end being at the left end of the casing assembly in FIG. 2 and the discharge end being adjacent the right end of the casing assembly.

Joined to end plate 24 of the casing assembly, and shown fitted within annular plate 36, is an end or wall or plug for the burner enclosure comprising refractory material (firebrick) 40 enclosed within a cylindrical metallic member band 42 which bounds the refractory material. Adjacent the base of this end wall, a block 44 of refractory material, such as a refractory ceramic, is provided, which has extending therethrough an internal passage 46. This block is joined to the end wall, and refractory material 40 as well as end plate 24 are suitably cut away to receive the block with the block extending through the end plate. Annular plate 36 and refractory liner 32 are also notched to provide a recessed region which snugly receives the right end of the block in FIG. 2 with the parts assembled as shown. With the parts assembled, passage 46 opens up to burner chamber 38 with such directly adjacent the bottom of the burner chamber.

An ignitor is shown at 50 which is provided to initiate combustion of material introduced to the combustor. As illustrated, such comprises a gas-fueled nozzle device 52 supplied with gas fuel through conduit 54 and having a sparkplug 56 which is operated to light the stream of gas ejected from the nozzle device. Such gas stream flows into passage 46, and with such ignited a flame is produced within the combustor at the feed end of the combustor and adjacent the base of the burner chamber. A plate 58 is shown which mounts the nozzle device and also closes off the end of block 44.

It will be noted that the inner peripheral margin of annular plate 36 projects radially inwardly of refractory liner 32 in all regions extending about the inner circumference of burner chamber 38 save for the region where such is notched to receive the block 44. Multiple bores are provided distributed circumferentially about this marginal portion of the annular plate, as exemplified by bore 60 shown best in FIG. 5. These bores collectively constitute a passage means joining the space

which exists between end plate 24 and annular plate 36 with burner chamber 38. During operation of the combustor, this passage means is utilized as an air inlet means adjacent the feed end of the burner chamber for introducing combustion supporting gas, i.e., air, into the burner chamber and for producing a pressure of such gas adjacent the feed end of the combustor which promotes axial movement of burning material toward the discharge end of the combustor.

Encircling cylindrical member 42 and in confronting relation to the bore 60 and the passage means that they provide is an annular flow control plate 62. As best shown in FIG. 5, such is supported on end plate 24 through threaded studs such as stud 64 which have inner ends anchored to plate 62 with relative rotation permitted between the studs and the plate. Such an anchor mounting for the inner end of a stud may be provided through the use of washers 66 which encircle a reduced end of a stud with pin 68 passing through the extreme end of the stud functioning to hold the washers from axial displacement off the stud's reduced end. Each stud between its ends is screwed into nuts 70 which are suitably joined to end plate 24. From the construction described, it will be apparent that by turning the respective studs, annular plate 62 may be adjusted in an axial direction to change its spacing from the passage means provided by bore 60. Plate 62 provides a means for controlling the amount of air that passes through such bores, with a position close to the bores being effective to restrict air flow and a greater spacing being effective to permit greater air flow.

Adjacent the discharge end of the combustor a series of ducts 72 are shown which have their inner ends opening to the burner chamber and outer ends communicating with the space between shell 30 and shell 22. These ducts, collectively referred to as an air injection means, provide for the feeding of combustion supporting gas, i.e., air, into the burner chamber adjacent the discharge end of the chamber. As will be noted with reference to FIG. 4, each duct, where it communicates with the burner chamber, extends transversely of, and is laterally offset from, the axis of the burner chamber. As a consequence, air introduced through these various ducts tends to pass circumferentially around the interior of the burner chamber and produce a circumferential swirling of air adjacent the combustor's discharge end.

As perhaps best illustrated in FIG. 2, the various ducts also are inclined slightly with respect to a plane passing normal to the axis of the burner chamber, the inclination being toward the discharge end of the combustor. This promotes axial movement of material as well as circumferential movement.

Refractory material, such as a refractory ceramic, is built up about the inner extremities of the various ducts to cover these extremities where they protrude radially inwardly beyond firebrick 32. This refractory material, indicated at 74, and as best illustrated in FIG. 2, forms a constricted throat section adjacent the discharge end of the combustor leading to discharge opening 76 of the combustor. The refractory material is anchored in place by hooks 75.

Combustion supporting gas, i.e., air, is supplied to bores 60 and to ducts 72 through supply means 14 already generally described, which comprises a motor driven blower 80 with an exhaust duct 82 leading from the blower which connects with the annular space defined between shell 22 and shell 30. Duct 84 opening to the atmosphere permits air to flow into the blower. The annular space provided between shell 22 and shell 30 communicates with the outer ends of ducts 72 and also with the space between end plate 24 and annular plate 36.

Solid particulate material, for example shredded or powdered bark and other wood residue, such as might be burned in a disposal operation, is fed into the burner chamber through supply means 16. Referring to FIG. 1, such supply means includes a duct 86 having its exhaust end communicating with the interior of the burner chamber at the feed end of the combustor directly adjacent the location of block 44. Duct 86 is equipped with a blower 88 driven by motor 90. The duct is connected through the blower and blower inlet duct 92 to a

supply of particulate combustible material such as the wood residue mentioned, shown generally at 94. Such supply of combustible material in the embodiment of the invention illustrated comprises a hopper 96 which provides for the gravity feed of material into duct 92, a screw conveyor 98 which feeds particulate material to the hopper 96 at the rate prescribed for proper burning within the combustor, and a hopper 100 only partially shown which is maintained filled with such particulate material. The rate at which the material is fed from hopper 100 to hopper 96 is determined by the speed at which the conveyor screw 98 is operated through energizing of motor 102.

It will be noted, and with reference to FIG. 3, that the exhaust end of duct 86 is tangentially disposed with respect to the burner chamber. Thus, like ducts 72 described, duct 86 extends transversely of the axis of the burner chamber while being laterally offset from this axis. As a consequence, material introduced into the chamber through this duct travels in a circumferential direction on being introduced, to produce a swirling movement of material.

From the construction described for supply means 16, it should be obvious that material fed into the combustor is fed as particulate material carried in a stream of air. Such air thus acts as a conveying medium and also functions to support combustion within the combustor.

Explaining generally the operation of the combustor and associated equipment, and describing some of the advantages of the apparatus contemplated, during operation of the apparatus ignition of the combustible material is started utilizing ignitor 50. With air and the material to be burned being ejected into the burner chamber directly adjacent the outlet end of passage 46, initial combustion tends to occur immediately upon entry of the material into the burner chamber. The material and combustion supporting air swirls about the interior of the burner chamber. Air introduced through bores 60 additionally supports combustion and produces a pressure of air adjacent the feed end of the chamber promoting axial movement generally toward the discharge end of the combustor.

After a short period of operation of the combustor, high temperatures are reached within chamber 38, with the refractory material, i.e., firebrick, becoming white hot. Because of the tangential feed of material into the combustor, such material tends to slide across the hot refractory, with an abrading action resulting. This abrading action promotes disintegration of the material as well as ignition of the material.

The swirling movement of air produced by ducts 72 is in the same direction, i.e., complements, the swirling direction produced by duct 86 which feeds the material to be burned into the combustor. By providing the throat section described, a slight back pressure results within the burner chamber, resulting in higher operating temperatures within the combustor. All the air necessary to support complete combustion of the product is not introduced at the feed end of the combustor, as such would tend to produce too rapid movement of material through the burner chamber and tend to introduce a cooling action lowering the operating temperature of the combustor. The auxiliary stage for the feeding of air is provided by ducts 72. The product mixture which arrives at the location of ducts 72 is quite hot, and the air provided by these ducts promotes final combustion of such product mixture. Note also that these ducts, by producing a swirling movement complementing the swirling movement provided by supply means 16, ensures that the product mixture on traveling through the combustor will travel in a swirling path with maximum retention time obtained within the combustor.

Using the combustor as described, a flame results which is ejected from discharge opening 76 into the furnace. The material ejected into the furnace comprises material in near final stages of combustion, which within the confines of the furnace burns completely to produce ash, and the usual gaseous combustion products associated with burning.

I claim:

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1. Apparatus for igniting and burning airborne particulate material comprising:
 - an elongated burner tube having feed and discharge ends at axially opposite extremities,
 - a discharge opening at the discharge end of the tube accom- 5 modating the passage of airborne material from the interior of the tube,
 - means adjacent the feed end of the tube for introducing airborne material into the interior of the tube,
 - a casing assembly including a shell extending about said 10 burner tube defining an annular space surrounding the tube bounded by said shell, said assembly further including an end plate spaced axially outwardly of the feed end of the burner tube defining an end space between the end plate and said feed end of the tube which communicates 15 with said annular space,
 - means defining air inlet passage means distributed circumferentially about the axis of the tube connecting said end space and the interior of the tube, and
 - a flow control plate mounted on said casing assembly in 20 confronting spaced relation to said inlet passage means, air flowing into said passage from said end space flowing past said control plate with the amount of such air being controlled by the position of such plate.
2. Apparatus for igniting and burning airborne particulate 25 material comprising:

- an elongated burner tube including a shell and refractory material lining the interior of the shell, said tube having feed and discharge ends at axially opposite extremities,
- a casing assembly including a second shell extending about said burner tube and defining an annular space surrounding the tube bounded by said second shell, said casing assembly further including an end plate spaced axially outwardly of the feed end of the burner tube defining an end space between the end plate and the feed end of its tube which communicates with said annular space, said end plate being detachably fastened about the perimeter thereof to said second shell,
- an end plug inserted within the feed end of the burner tube comprising an expanse of refractory material bounded about the perimeter of the expanse by a band which fits at least partially within the interior of the tube, said end plug being mounted on said end plate of said casing assembly,
- air inlet passage means defined between the perimeter of the end plug and the interior of said tube at the tube's feed end connecting said end space with the interior of the tube, and
- a duct extending tangentially of and connecting with the interior of the burner tube adjacent its feed end for feeding airborne particulate material into the burner tube.

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