

[54] **INCINERATORS FOR POLLUTION FREE BURNING OF SOLID WASTE MATERIALS AT LOW COST AND WITH REDUCED POSSIBILITY OF ACCIDENTAL FIRE SETTING, OFTEN, TRANSPORTABLE, PORTABLE, AND/OR SEMI PERMANENTLY LOCATED**

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

[58] Field of Search 110/8 R, 8 C, 18 R, 110/18 C, 19, 119

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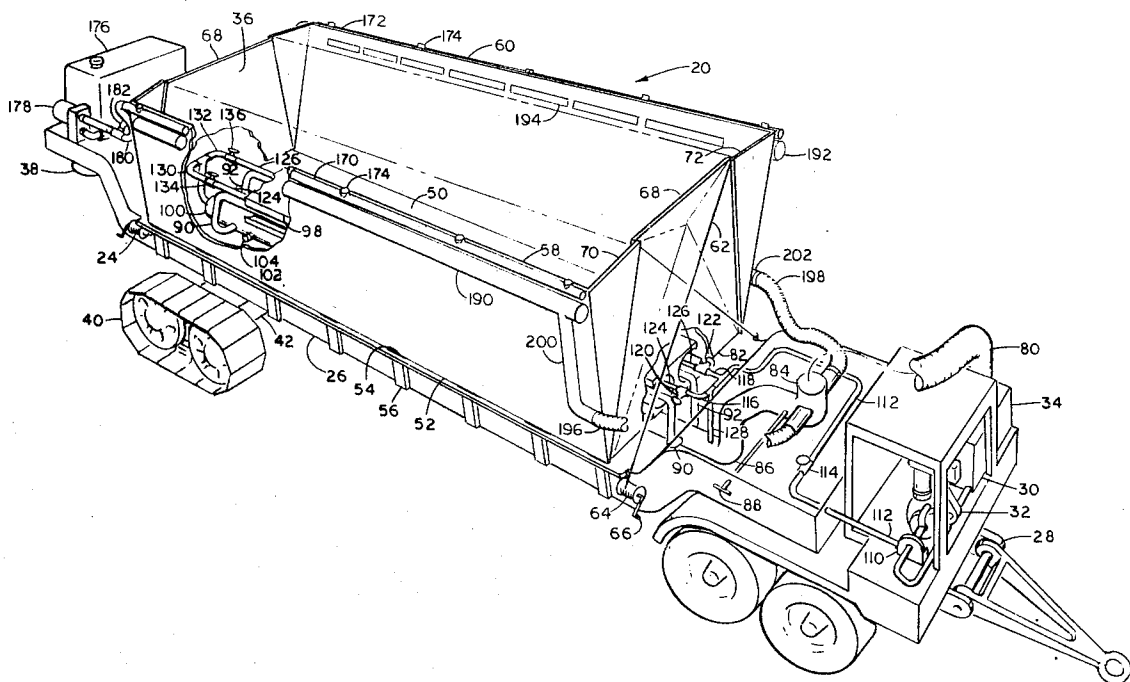
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[57]

ABSTRACT

Burning of solid waste material such as: slash and small growth, resulting from logging operations to acquire merchantable timber and wood products and/or to clear right of ways for vehicles or power lines; selected debris from demolition operations; selected debris taken from transfer stations and/or deposit areas where city wastes are received; and selected debris from wastes created at dwellings; is accomplished in a manner whereby controlling the burning process in an incinerator eliminates completely or in varying degrees the amount of pollutants discharged into the atmosphere. At the same time this method reduces the direct operating costs, possibilities of setting ancillary fires and the need for extended tending and/or dousing of several fires. In some embodiments, this incinerator is completely transportable to the general area over public roads and then after arrival to specific multiple locations off public roads it is conveniently moved over unimproved land to places where the incinerator is needed.

16 Claims, 13 Drawing Figures



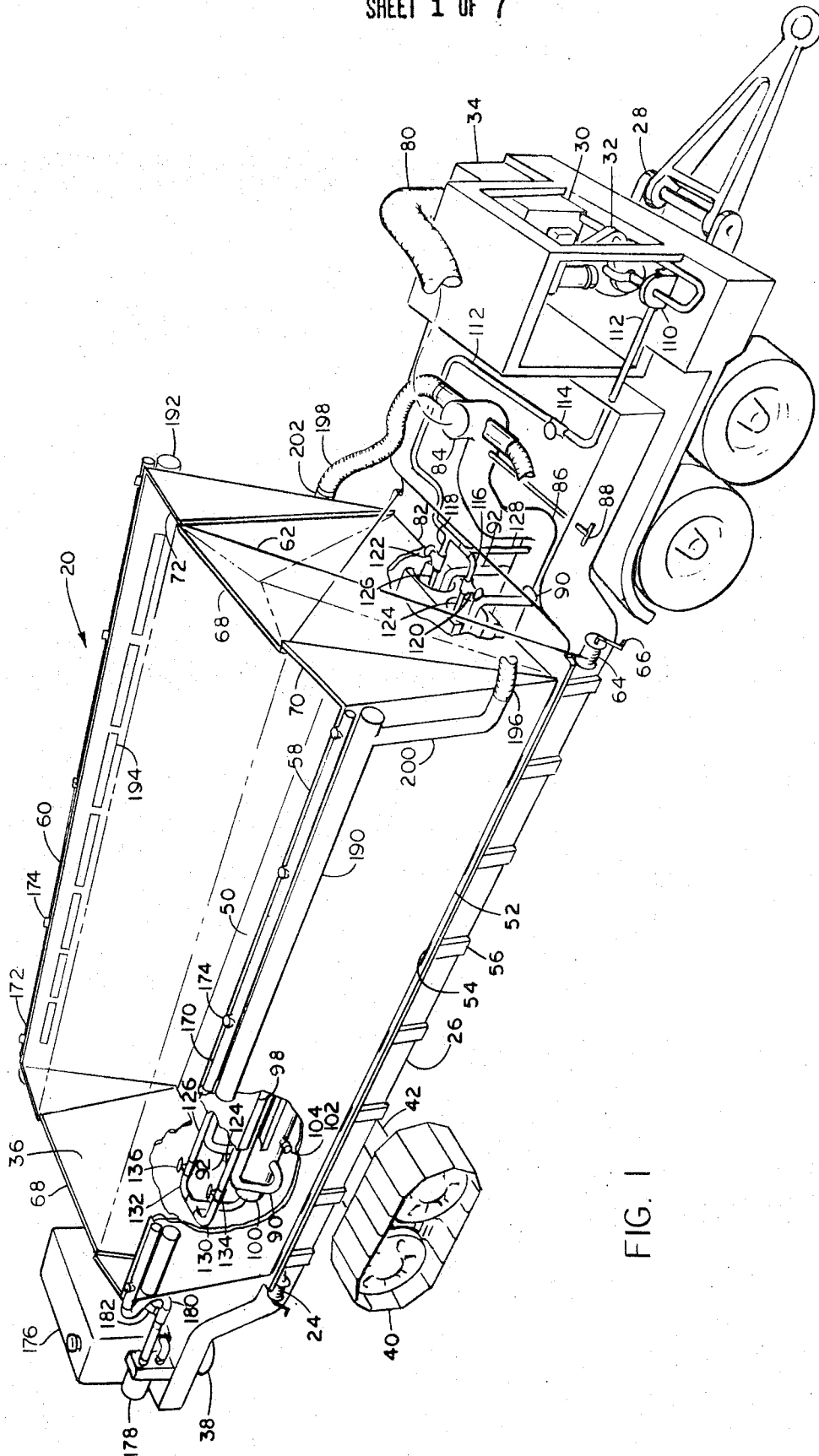


FIG. 1

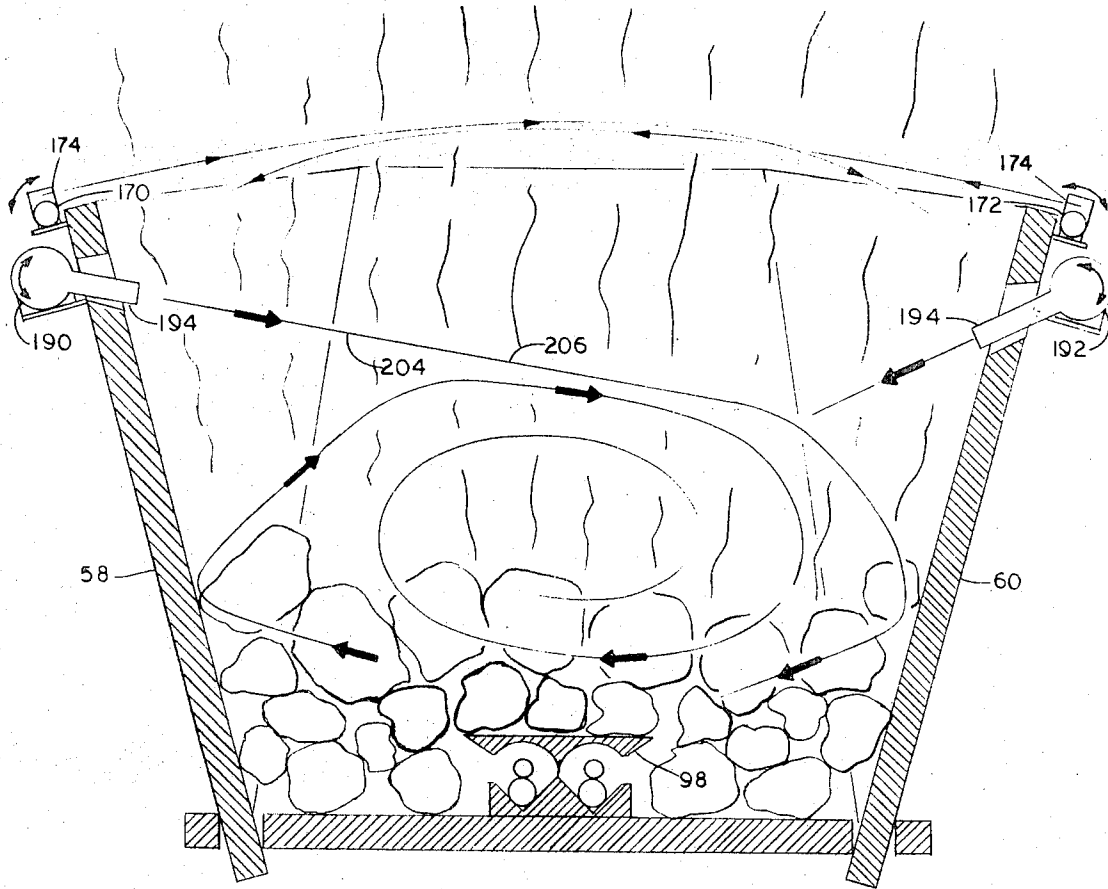


FIG. 2

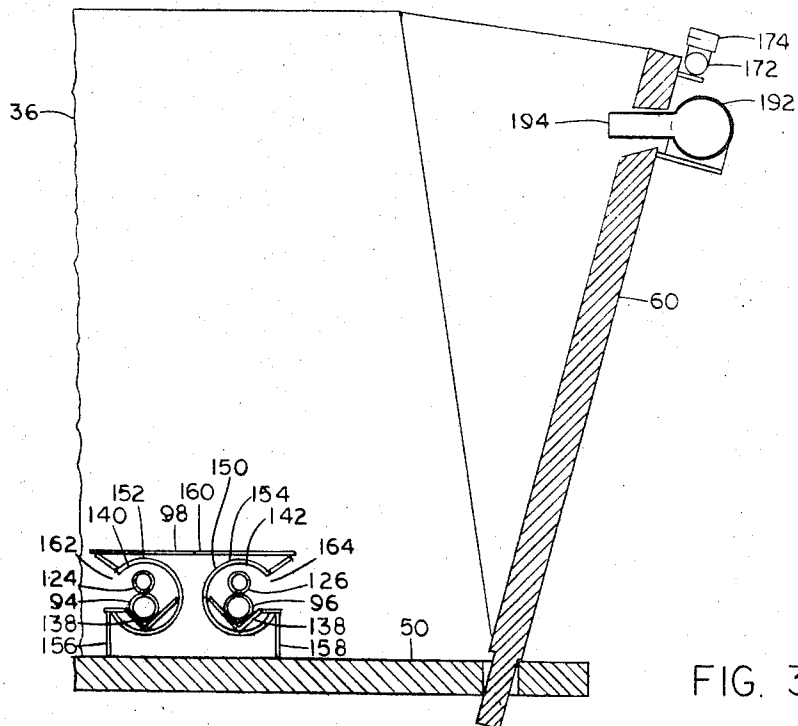


FIG. 3

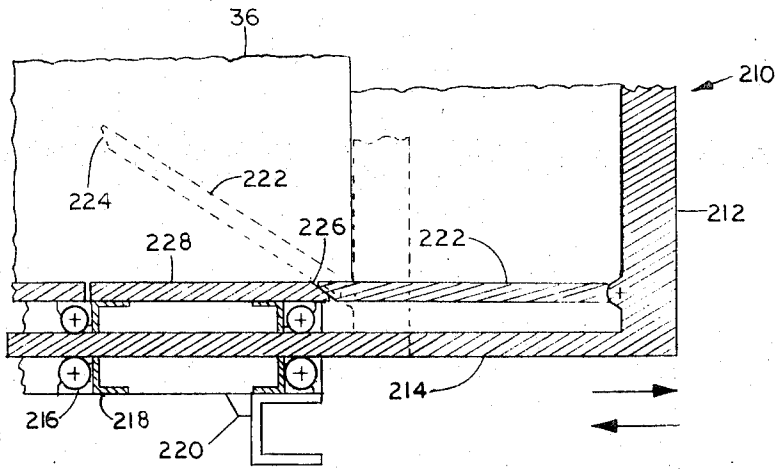


FIG. 4

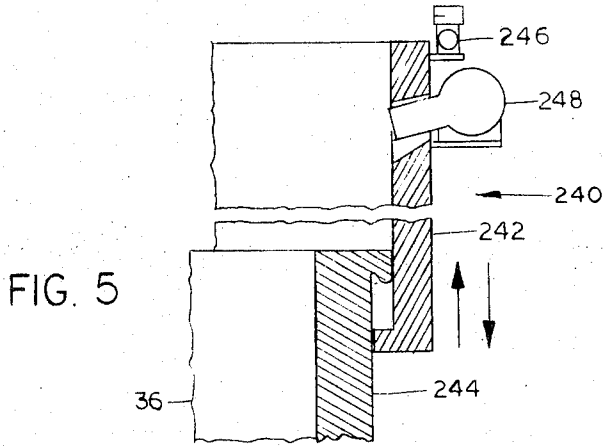


FIG. 5

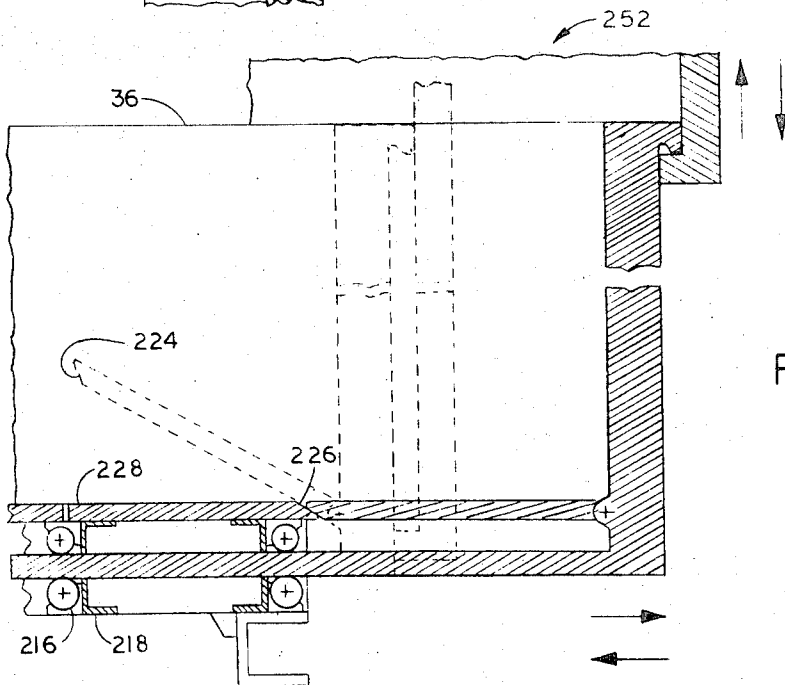


FIG. 6

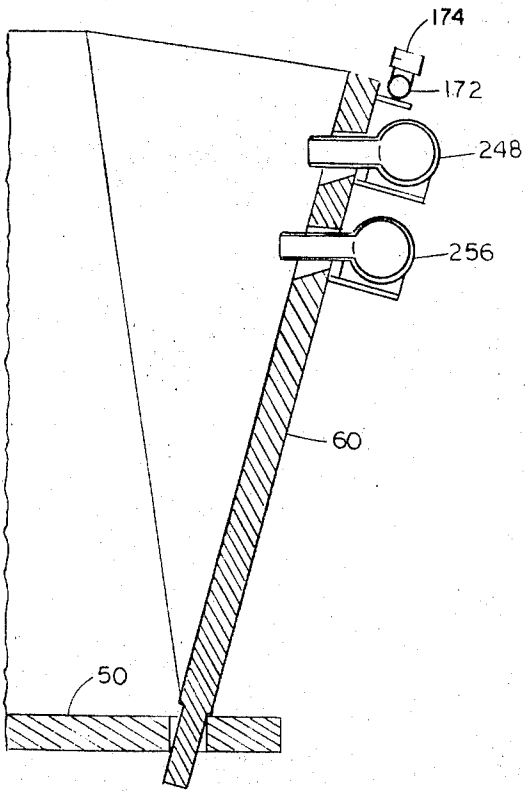


FIG. 7

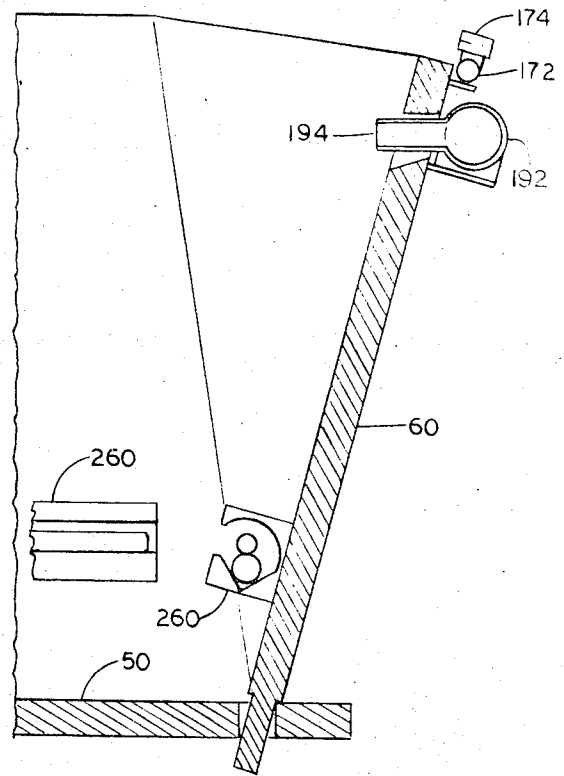


FIG. 8

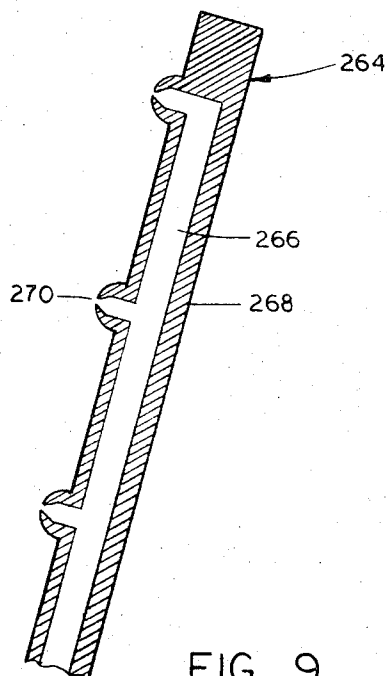


FIG. 9

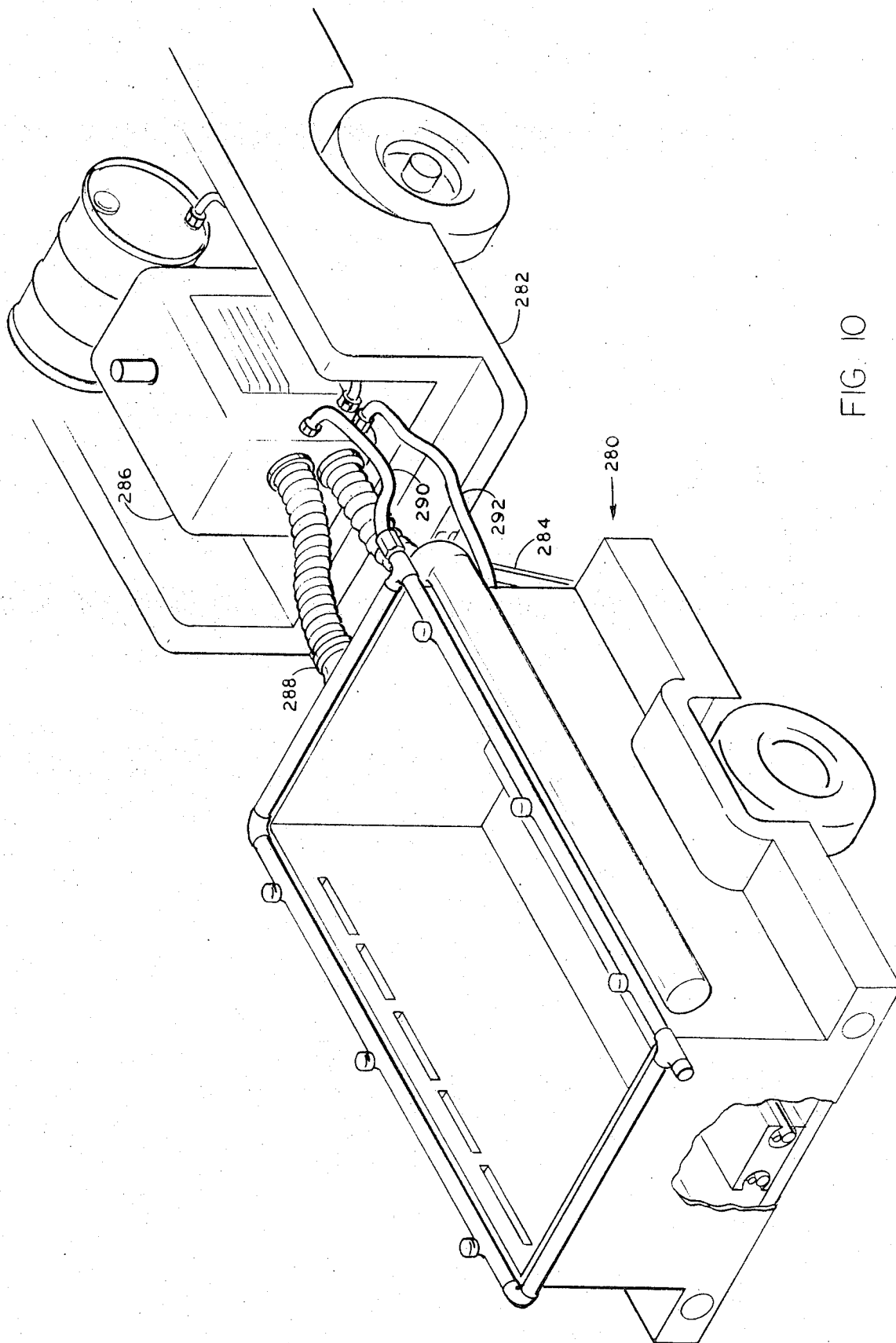


FIG. 10

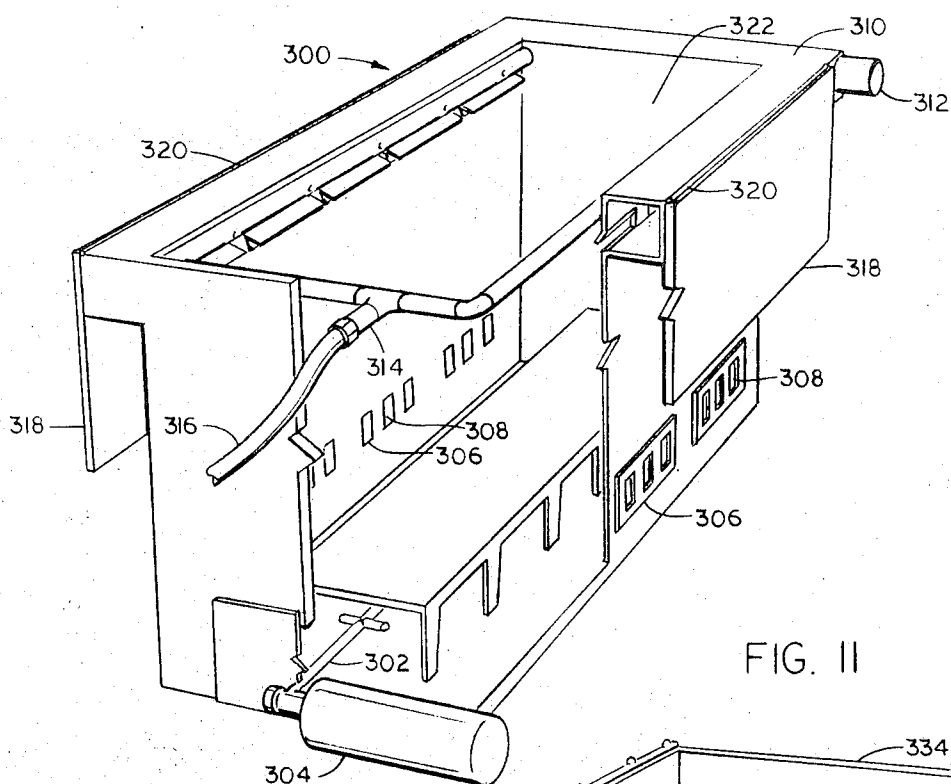


FIG. II

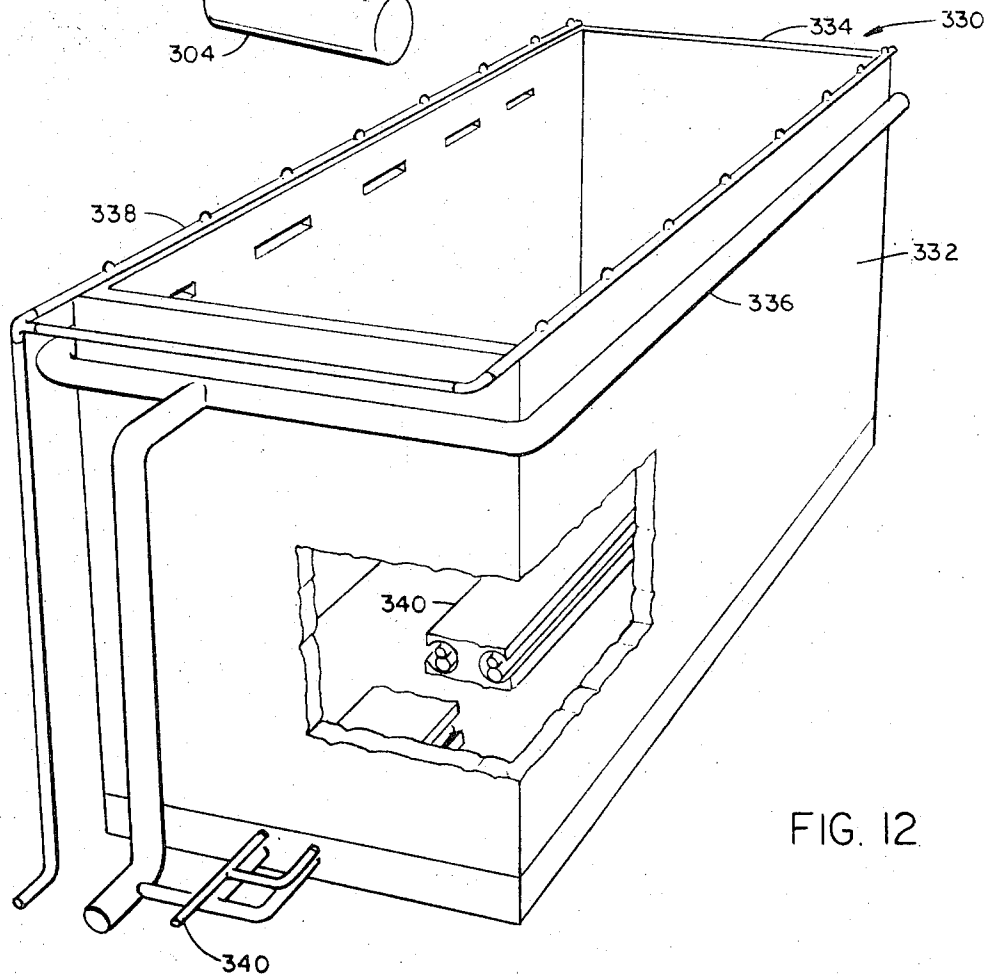


FIG. 12

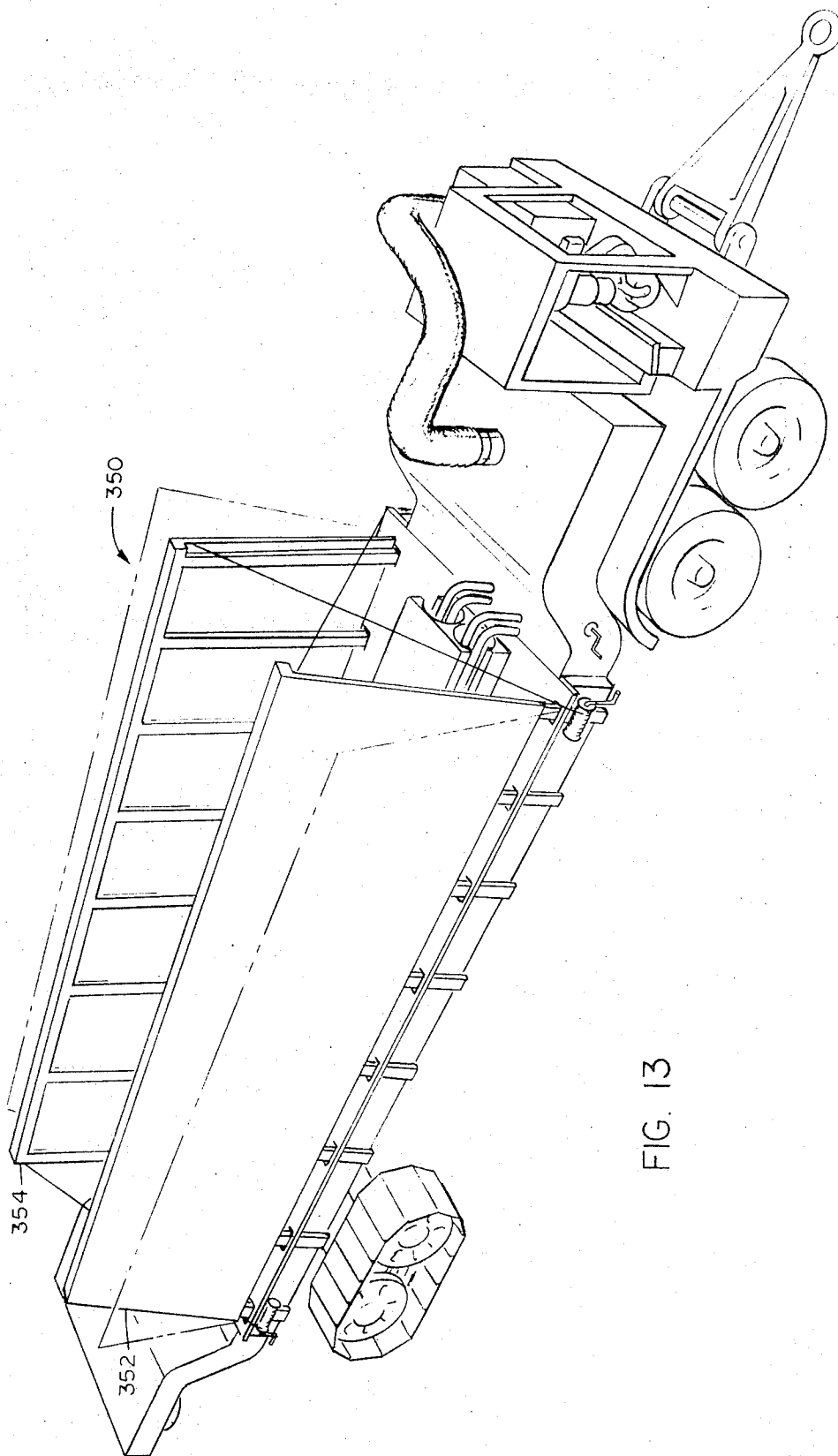


FIG. 13

**INCINERATORS FOR POLLUTION FREE
BURNING OF SOLID WASTE MATERIALS AT
LOW COST AND WITH REDUCED POSSIBILITY
OF ACCIDENTAL FIRE SETTING, OFTEN,
TRANSPORTABLE, PORTABLE, AND/OR SEMI
PERMANENTLY LOCATED**

Essentially pollution free burning of burnable solid waste material is accomplished using open top incinerators in various embodiments, which are all equipped with a burner assembly located at the lower inner extremes of the incinerator structure, an air ejection assembly to create an air shield and controlled air turbulence and a water ejection assembly to create a water curtain, both assemblies being positioned on the upper portions of the side walls of the incinerator, with the water ejection assembly at the top. Air is ejected from one side wall at a slightly downward angle forming an almost flat and continuous air shield flow over the open face of the incinerator. Air is ejected from the other side wall at a steep angle to impinge on the almost flat air shield flow causing the combined air flow to bend downwardly and be redirected upon striking the nearest side wall below at an angle. Rebounding from the side wall the combined air flow moves through and above the burning solid waste material presenting its oxygen in sufficient quantity to insure essentially complete combustion of the debris. The remaining gases leave the fire area, some being directed toward the opposite side wall while others move upward at varying angles and velocities. Gases striking the side wall then move upwardly where, with the other gases, they are drawn into the underside of the almost flat air shield flow and forced back down again into the heart of the fire. This action of the overall air and gas flow creates a turbulent area under the air shield flow, thereby ensuring that any included unburned particles of solid waste material and unused oxygen is directed back into the fire. All gases eventually escaping through the air shield flow are substantially stripped of pollutants. Then on subsequently passing upwardly through the water curtain, the gases are cooled and scrubbed to remove any pollutants not stripped out by the air shield flow.

Whether the incinerator is made for essentially pollution free burning or lesser degrees of pollution control burning it may be made completely self contained and mounted on a trailer. Then, when used in conjunction with a self propelled loading device secured to its trailer, one man completely tends and feeds a fire in the incinerator by utilizing the self propelled loading device to pick up solid waste material from throughout a surrounding work area, and drop it into the incinerator and then to move ahead to a new area nearby where solid waste material needs burning. Or an incinerator may be permanently installed at locations such as a transfer station, industrial complex, or large apartment site, where its various assemblies may be coupled to a city water supply, natural gas lines and a remote air source in lieu of the self-containment features of a transportable unit. Moreover, around private dwellings, farms, orchards, and small apartments, a semi-portable incinerator having all or some of the same types of structural arrangements and assemblies of the larger incinerators is operated. Often, the water is supplied through a standard garden hose, compressed air is obtained by operating a vacuum cleaner or other small electric driven blower, and small bottles of pro-

pane gas or other low pressure gas sources supply fuel to the burner.

Other embodiments optionally include: the use of wetting agents and detergents in the water spray curtain assembly; an extended air flow assembly to increase the supply of oxygen at selected locations throughout the burning chamber often using air ducts cast into the side walls; side walls that tilt and/or move outwardly and/or upwardly in order to increase the volume of the incinerator, and thereby increase the burning capacity, and that move back together to decrease in the overall dimensions of the incinerator for transporting it over public roadways without escorts; a vacuum system effective above the air system to selectively remove escaping gases in whole or in part, as necessary, for subsequent filtering; a fifth wheel, placed on the underside of the box of the low boy trailer to facilitate towing a large transportable incinerator assembly over public roads by a four wheeled vehicle; a track for placement on a trailer for greater load bearing surface; incinerator structures fabricated from weldable steel, cast iron, concrete, fire brick, ferro cement and other heat resistant materials; and additional burner assemblies placed on the side and/or end walls of the incinerator.

BACKGROUND OF THE INVENTION

The most common method of disposing of solid waste material, such as slash or small growth left over from logging operations or clearance of right of ways or other debris, is generally by setting of a number of individual fires spaced centrally to the whereabouts of the material to be disposed of or by trucking to a designated burning area. In many situations when the solid waste material is ready to be burned it is dumped onto some old rubber tires, doused with a flammable liquid, and set on fire. The amount of escaping pollutants, from such a fire, to the atmosphere, is enormous as evidenced by the amount of black smoke being emitted. Also the possibility of sparks or hot ashes causing ancillary fires is ever present. Moreover, in the past old frame buildings and other burnable debris have been set afire at the clearing site exposing the surrounding buildings to a fire hazard and also to the pollutants leaving the fire area being carried away by the rising gases.

In respect to known attempts to better control clearing and demolition burning, some government organizations have tried different ways. In trying to burn wastes derived from wood, their crews have forced air at high velocity into the fire to cause turbulence in the surrounding air. The increase in the available oxygen has decreased the amount of departing pollutants.

Also various incinerators are described in patents. However, in trying to make them effective in not discharging pollutants the burning volume is totally or substantially totally enclosed during the burning. Such closures prevent the incinerator from being loaded continuously and often limit the size of the waste debris which may be put directly into the burning volume.

There remains therefore a need for an incinerator which may be loaded continuously as burning continues with all sizes of debris derived from wood and wood products and yet the pollutants may be substantially completely controlled or released within tolerable limits depending on where, why, and how, the burning is being undertaken. This invention is directed to this

overall purpose. In various embodiments burning is successfully undertaken meeting the objectives established regarding overall pollution regulations and related specifications for specific embodiments of the incinerator.

SUMMARY OF THE DISCLOSURE

In respect to all embodiments, the objectives are: substantially eliminating and/or reducing the amount of pollutants discharged into the atmosphere; lowering of overall operational costs; and decreasing the dangers of burning when a full open top incinerator is used whether it be transportable, or it is semi-permanently or permanently installed. When pollutants are to be substantially eliminated, a water ejection assembly is used to create and maintain a water spray curtain which cools the escaping gases and scrubs out pollutants, entrained in the escaping gases, and an air ejection assembly located just below the water ejection assembly to supply vast quantities of air carrying oxygen in an abundant supply to the burning solid wastes, which in all embodiments are placed immediately over and around a low placement burner assembly.

In respect to the air ejection assembly, air ejected from the vicinity of one side wall of the incinerator forms a nearly flat air shield of flowing air across the open top incinerator, while air ejected from the vicinity of the other side of the incinerator is directed at a steep downward angle to mix with and redirect the nearly flat air shield flow downwardly to impinge on the side wall below deflecting the entire air flow into the direction of the burning solid waste material. As this combined air flow passes through and nearby the burning solid waste material it delivers its oxygen content in abundant supply to aid in this overall complete combustion process of the solid waste material derived from wood and wood products and other burnable materials. The remaining gases, air and smoke leaving this area at various velocities and directions, rise up to the underside of the nearly flat air shield flow to be drawn into the overall air flow and to be returned again to the burning area. This total ejected air action creates a violent turbulent area under the nearly flat air shield, which extends also through the heart of the fire, thereby ensuring that all consumable oxygen needed for complete burning of the debris is removed from the air prior to its escape with smoke and other gases through the air shield flow. Due to the high velocity of the ejected air moving in the air shield flow, substantially all pollutants contained in the escaping air, smoke and other gases are stripped out. Those pollutants that do escape through the air shield flow are subsequently removed and scrubbed when trying to pass upwardly through the water spray curtain.

In regard to various embodiments incorporating different assemblies, some of the selectable aspects of different designs are as follows: an incinerator structure may be mounted on a low boy trailer together with all or some components of the varying assemblies of air, water and heat thereby making the incinerator self contained in many ways to be extremely useful in remote areas during logging operations, clearing for vehicles or power lines, and disposing of selected debris resulting from demolition operations; an incinerator structure also may be semi permanently or permanently installed, often receiving air, water and heat supplies for its systems from city water lines, natural gas lines, and

industrial compressed air systems; and another smaller embodiment may be semi-permanently installed near homes, apartments, small businesses, receiving water through a standard garden hose, air from an operating vacuum cleaner or other electric driven blower, and burner fuel from a small propane bottle supply system.

In respect to many other embodiments, selectable options include: the use of wetting agents in the water of the spray curtain; utilization of air ducts cast into the side walls of an incinerator to increase the supply of oxygen throughout the burning chamber and often cool the side walls; use of tilting or outwardly and/or upwardly moving side walls and end walls to increase the burning chamber volume of an incinerator; employment of a vacuum system effectively operating just above the air system to remove some or all of the escaping gases, for subsequent filtering; attachment of a fifth wheel to facilitate towing of an incinerator on its trailer on public highways by a four wheeled vehicle; fabrication of incinerator structures from weldable steel, cast iron, concrete, fire brick, ferro cement, or other heat resistant materials; and the operation of burner systems placed on side and end walls and elsewhere in lieu of or to supplement floor mounted burner systems.

DRAWINGS

FIG. 1 is a perspective view of a large transportable incinerator used both for land clearing and demolition operations; indicating how the burner chamber is expanded while keeping its ends covered; also illustrating both the self contained water supply assembly operated under pressure to form a top water curtain and the self contained air assembly operated under pressure to form a curtain of air and thereafter redirect it into the burning debris to increase the overall efficiency of the burning which is occurring below the water and air curtains or shields; the centrally located burner system; and illustrating the various locations of the blower, engine, pumps, fuel and water tanks, all arranged for self contained operations;

FIG. 2 is a cross section of the incinerator, shown in FIG. 1, illustrating by using flow arrows and radiating lines the operation, wherein ejected air flows from a near level shield or curtain and a resultant flow pattern below to create a turbulent air mass about the burning debris and eventually gases escape by successfully passing up through the air shield and water spray curtain;

FIG. 3 is a partial cross section of the incinerator, shown in FIG. 1, illustrating the expansion of the burning chamber upon tilting of the incinerator side walls, the positions of both the upper distribution assemblies of pressurized air and water, and the central location of the fuel and air burner system on the bed of the incinerator;

FIG. 4 is a partial cross section of an incinerator illustrating the transverse expansion of the burning chamber with dotted lines and arrows showing alternate positions of components;

FIG. 5 is a cross section of an incinerator illustrating the increase in height of the burner chamber by vertical movement of the side walls;

FIG. 6 is a cross section of an incinerator illustrating both the transverse and vertical movements of portions of the burning chamber to increase its volumetric capacity with dotted lines and arrows showing alternate positions of components;

FIG. 7 is a partial cross section of an incinerator, somewhat similar to the incinerator shown in FIG. 1, illustrating the expansion of the burner chamber, the location of both upper distribution sources of pressurized air and water, and the installation of a vacuum system which is operationally effective below the water curtain and above the air flow shield;

FIG. 8 is a partial cross section of an incinerator, somewhat similar to the incinerator shown in FIG. 1, illustrating the positioning of burner assemblies affixed to the lower extremes of side and/or end walls of the combustion or burner chamber;

FIG. 9 is a partial cross section of an incinerator wall having vertically distributed pressurized air passageways essentially all formed within the cast wall when it is cast;

FIG. 10 is a partial perspective view showing how an incinerator is towed by a pickup truck or other vehicle for effective utilization where smaller size pieces of debris are found or essentially made smaller to be burned in this smaller incinerator which may be used in more congested areas;

FIG. 11 is a perspective view of a semi-permanently installed incinerator conveniently placed near a dwelling such as a private home, small apartment, or supermarket, to burn waste obtained from within and about the dwelling, often utilizing water received from a garden hose, gas from a propane bottle, and compressed air from an operating home vacuum cleaner;

FIG. 12 is a perspective view of a permanently installed incinerator conveniently located near a city transfer station, a city dump, or a large industrial or apartment complex, to burn solid waste material, often utilizing water from a city water supply, fuel from a natural gas line, and compressed air from an industrial source; and

FIG. 13 is a perspective view of a large transportable incinerator of minimum components used in clearing of slash from logged off forest land, where pollution controls for the countryside operation permit its utilization to reduce the fire hazard and to get the job done sooner, the dotted lines indicating the lateral expansion of the burning chamber, which is supplied along its bottom by fuel and air under pressure.

DESCRIPTION OF PREFERRED EMBODIMENTS

Introduction to all Embodiments

All embodiments perform specified burning jobs meeting the objectives of essentially eliminating or reducing the amount of pollutants and odorous hydrocarbons otherwise discharged into the atmosphere as smoke, lowering of overall operational costs, and decreasing the dangers of burning. As embodiments are to be operated under vastly differing conditions from countryside to the city they often have different components arranged in different sizes. They often must be sized for roadway travel, alongside road operations, and/or permanent and semi-permanent installations. To make some embodiments movable over roadways and yet be efficiently operated after arrival at the site, their combustion chambers are expandable at the burning site in one or more directions as shown in FIGS. 1 through 8. Also all their systems and components are preferably self contained and carried on the basic supporting structure of the incinerator.

In other embodiments such as the permanently and semi-permanently installed units, the systems derive

their supplies from available local sources and/or auxiliary equipment.

Method of Operation

In all embodiments where substantially complete combustion pollution free burning is to occur, the method of employing the burner assembly, air ejection assembly and water ejection assembly is similar as illustrated in FIG. 2. The only changes ever made are in sizes of components, materials used, their specific location, and their connections to available water, air, and fuel supplies.

The air fed burner system generally located on the centerline of the floor of the burning chamber of the incinerator, as shown in FIGS. 1, 2 and 3, is activated until the debris is burning quite well at which point the fuel supply is shut off and thereafter only used sparingly if the fire tends to burn down. The air supply is continued or shut off depending also on the condition of the fire.

Air nozzles, generally located at the upper extreme of each side wall of the burning chamber supply air into the incinerator to aid in the control of the complete combustion process. As viewed in FIG. 2, air from one side wall is ejected in a nearly flat shield or curtain substantially across the open top of the incinerator at a slightly downward angle, while air from the other side wall, aimed downwardly at a steeper angle, impinges on the nearly flat air shield, thereby bending, deflecting and/or driving the nearly flat air shield flow downwardly as the two air flows combine. The combined air flow after striking the side wall below is directed toward the burning solid waste material where most of the oxygen content of the air is consumed in the complete combustion of the debris. The remaining gases pass through the burning solid waste material in many directions but are generally directed in the turbulent flow paths, as shown in FIG. 2. All departing gases eventually rise to the top and are picked up or drawn into the underside of the nearly flat air shield flow where they are carried along and down into the fire area again thereby adding to the turbulent air and gas mass moving over the top and through the burning material. Gases that do escape up through the nearly flat air shield are stripped of many pollutants, and, if any pollutants remain, they are scrubbed and cooled by the water spray curtain in operation above the air shield flow. During debris loading cycles, both the air shield and water curtain minimize the attempted escape of any flyash which may be stirred up by the dropping debris.

Embodiments for Burning Slash and Uprooted Small Growth Resulting from Logging Operations and/or Clearing Areas for Roads, Power Lines, and Buildings

In FIG. 1 a large transportable incinerator, shown as embodiment 20, utilizes all the basic systems for pollution free burning of solid waste material. In addition it has side walls to be tilted outwardly to enlarge the combustion chamber when the incinerator 20 is located in an off highway area, and to be tilted inwardly when the incinerator 20 is transported over highways to reach a temporary operational site. More specifically, the various components of this embodiment 20 and their relation to one another are described as follows:

Trailer

In FIG. 1, the embodiment 20 is supported on the bed 24 of a trailer 26 or other suitable carrying vehicle. At one end of the trailer 26 is a steerable bogie 28 upon which is mounted an air blower 30, an engine 32, and a fuel tank 34. To this same trailer end a self powered loading machine, not shown, is often secured during burning operations. It is operated by one man who loads the combustion chamber 36 while periodically moving the coupled vehicles along the cleared area. At the other end of the trailer 26 there are connection structures 38 used when the entire embodiment 20 is secured to a towing vehicle for highway travel. Such a connection often involves what is referred to as a fifth wheel mounting arrangement 38. During burning operations and travel over soft ground, steel track or running gear 40 is secured to the running gear attachment structure 42 and it is removed during highway travel.

Combustion Chamber

In FIG. 1 embodiment 20 has a combustion chamber 36 which is enlarged during burning operations to conveniently receive more debris. The base 50 of each combustion chamber 36 is spaced above and then secured at dispersed locations to the bed 24 of the trailer 26 or another suitable carrying vehicle. Through this formed space, air circulates between the base 22 and trailer bed 24 protecting the trailer 26 and its running gear attachment structures 28 and its other components from the otherwise possible structural distortion effects of the extreme heat being generated during burning operations.

The combustion chamber base 50 extends transversely to provide two opposite longitudinal bottom edges 52, each formed with spaced receiving holes 54 which are used to position bracing struts 56, which in turn are secured to the combustion chamber side walls 58 and 60. These receiving holes 54 are large enough so the bracing struts 56 and side walls 58 and 60 are tiltable at their tops to increase the top entry area and the volumetric capacity of the combustion chamber 36 for burning operations, and they are readily returned upright for highway travel. Outward tilting movements of the side walls 58 and 60 are undertaken using separate rigging equipment, not shown. However, their return and securement for highway travel is undertaken by using cables 62, spools 64 and winches 66 equipped with ratchet locking mechanisms, arranged in subassemblies at each end of the combustion chamber 36.

End walls 68 and overlapping extension walls 70 and 72 to complete the upright portions of the open top combustion chamber 36.

Compressed Air Supply System — Burner

Upon operation of an air blower 30 mounted on trailer 26 and driven by engine 32, compressed air is moved through a large flexible conduit 80. It in turn, at the combustion chamber end 82, is attached to an upward extension 84 of a rigid conduit 86. The latter is secured below the base 50 of the combustion chamber 36 throughout its length, thereby distributing the compressed air entirely along the centerlines of the illustrated embodiment 20. Near the meeting of the upward extension 84 and rigid conduit 86, an air flow control damper subassembly 88 is installed to regulate the

quantity of compressed air entering the centerline air distribution system.

Immediately downstream of the damper subassembly 88 on both sides of rigid air conduit 86, two smaller offset air lines 90 and 92 are connected to carry some of the air upwardly into the entries of dual forced air conduits 94 and 96 of a pressurized fuel and air burner subassembly 98. At the opposite end of rigid conduit 86, other sets of smaller offset air lines 90 and 92 are selectively positioned and connected to direct air upwardly into the dual forced air conduits 94 and 96. When a possible additional air supply is to be directed into the other end 100 of air conduit 86, another source of compressed air, not shown, is connected to air conduit 86, after removal of the caps 102, to its auxiliary inlets 104.

Pressurized Fuel System

Mounted on the trailer 26 near the engine 32 is a fuel pump 110, which is driven by the engine 32, to pump fuel from fuel tank 34 into a main fuel supply line 112, where its flow is stopped or regulated upon operation of the master control valve 114. Beyond this valve 114, main fuel supply line 112 branches into two distribution lines 116 and 118, where the respective flows are stopped or regulated upon operation of branch control valves 120 and 122. Fuel continuing beyond control valves 120 and 122 enters, respectively, the burner lines 124 and 126 which run the full length of the combustion chamber 36. Also beyond valve 114, in addition to the fuel entering distribution lines 116 and 118, it is directed through fuel line 128 which soon thereafter enters rigid air conduit 86. Inside, it is positioned along the center throughout the full length thereof emerging at the other end 100 into distribution lines 130 and 132, each having valves 134 and 136. When necessary, fuel is directed into burner lines 124 and 126 from this direction, after passing throughout the length of the trailer, while being protected from the heat of combustion by the surrounding flowing compressed air supply of the rigid air conduit 86.

As indicated in the cross section view of FIG. 3, burner sub assembly 98 includes a vee shaped channel 138 located below its respective compressed air and fuel lines, 94, 96 and 124, 126. At the outset of burning operations, one method of igniting the fuel, which often is diesel fuel, is to pour gasoline along the interior of the vee channel 138 and then ignite it. The heat generated soon heats the impingement structures 140 and 142 where fuel spray from burner lines 124 and 126 are soon thereafter directed to start the operation of the pressurized fuel and air heating system. It in turn is used only to the extent necessary to get the debris burning efficiently by itself. Other ignition apparatus may be used in lieu of starting gasoline, such as high electrical energy discharge units, not shown.

Longitudinal Burner Utilizing the Respective Pressurized Air and Fuel Supply Systems

In a preferred embodiment of the burner sub assembly 98, as illustrated in more detail in FIG. 3 and as it is installed in embodiment 20 illustrated in FIG. 1, dual units are preferably relied upon in a twin forced air fuel burner system 98. This system 98 is positioned and secured to the top of the base 50 along the centerline of the combustion chamber 36. Surrounding it is a protective framing 150 composed of back to back C-shaped channels 152 and 154 having lower side panels 156 and

158 and a common protective top cover 160. Inside the C-shaped channels 152 and 154 are vee shaped supporting channels 138 which are located to receive the igniting gasoline and to position the respective air lines 94 and 96 on which the respective fuel lines 124 and 126 are placed to complete this twin forced air fuel burner system 98.

The spaced apertures in the fuel lines 124 and 126 are all located to direct the ejected fuel upwardly at an angle toward the center line of the incinerator to impinge on the interior top surfaces of the C-shaped channels 152 and 154 of the protective framing 150. The spaced apertures in the air lines 94 and 96 are arranged in two separate sets for each line. One set ejects air downwardly at a slight angle toward the centerline of the incinerator to impinge on the interior lower surfaces of the C-shaped channels 152 and 154 of the protective framing 150, below the impingement area of the fuel. The other set ejects air upwardly at a slight angle to direct air out the large lengthwise opening 162 or 164 of the burner sub assembly 98, as determined by the open structures of the C-shaped channels 152 and 154. During operation of this longitudinal burner, the lengthwise openings 162 and 164 are full of the flaming combustion products of the fuel and air, and they are referred to as the main burner exits 162 and 164 directing fire into the debris loaded into the combustion chamber 36.

To start this longitudinal burner arranged in its twin forced air and fuel burner system 98, gasoline is distributed along the vee channels 138 and ignited, or an electrical energy ignition system, not shown, is energized. Then fuel supply valves are opened and when the fuel is ignited, the air supply valves are opened. As soon as the debris is burning quite well, the fuel supply is stopped and only used sparingly again if the fire begins to die out. The air supply is continued for a while and, if the debris is burning very well, it too is stopped, cut down and/or intermittently relied upon, depending on the conditions of the fire, the burning rate desired, and observations of prevailing surrounding weather conditions inclusive of wind and rain.

Water Spray Curtain

A water spray curtain originating above the nearly flat air shield or curtain, as shown in FIG. 2, filters out heated particles entrained in departing gases and at the same time acts as a cooling membrane or medium for the gases to pass through. Particles filtered out are returned for further combustion and/or eventual collection from the bottom of the combustion chamber 36 for subsequent special handling with other waste products or by-products. This is accomplished, as shown in FIGS. 1, 2, and 3, by rotatably installing water pipes 170 and 172, along the outer top portions of each side wall 58 and 60 and equipping them with spaced nozzles 174 throughout their entire lengths. Water is supplied from a tank 176, secured to the trailer 26, upon the operation of one or more pumps 178 installed in respect to supply lines 180 and 182. The opposite banks of nozzles 174 are directed so, upon the operation of the water pump 178, the water sprays are directed toward each other to form a complete protective and filtering water curtain. Adjustments of the spray pattern are undertaken, for example, by rotating water pipes 170 and 172, which are movably mounted, to change the positions of the nozzles 174. Also wetting

agents and/or cleaning agents may be selectively added to the water being sprayed.

Compressed Air System — Nearly Flat Air Shield or Curtain

Compressed air distribution ducts 190 and 192, shown in FIGS. 1, 2, and 3, having nozzles 194, direct compressed air into the incinerator burning area as shown diagrammatically in FIG. 2. Air supplied from the blower 40, is moved through a large flexible conduit 80, and from there through two smaller flexible conduits 196 and 198, then on through rigid ducts 200 and 202 to the distribution ducts 190 and 192. Distribution ducts 190 and 192 are mounted for rotational adjustment to selectively position their respective banks of nozzles 194 to create different flow patterns of the ejected compressed air. For example, one duct 190 is preferably rotated so its orifices 194 direct air across the incinerator at a slightly downward angle forming the almost flat air shield, while the other duct 192 is rotated a greater amount so its orifices 194 direct air toward the center of the incinerator. At the intersection of the two air flows the slightly downward path of main stream or air shield is changed considerably and the resultant total flow is directed downward impinging on the side wall below and then back out and down into the heart of the fire. Air passing through and around the burning solid waste material supplies most of its oxygen to aid in the complete combustion of the debris. The remaining gases and air moving away from the heart of the fire carry some pollutants. As they reach the underside 204 of the nearly flat air shield 206, shown in FIG. 2, some air and gases will escape through the nearly flat air shield 206 to be stripped of any pollutants while others will be carried back down into the fire area and the turbulent air and gas mass thereby imparting more oxygen for burning and carrying unburned pollutants back for additional combustion.

Additional Embodiments Used to Obtain Larger Combustion Chambers

Where tilting the walls of combustion chambers, as illustrated throughout FIGS. 1, 2 and 3, either does not obtain the desired size of a combustion chamber and/or either does not permit sufficient retraction for traveling highways unescorted by lead and follow on escort cars, both carrying wide load signs and flashing lights, then the embodiments of FIGS. 4, 5 and 6 are utilized. In FIG. 4, embodiment 210, shown in part on one side of its centerline, is expandable transversely. Its side walls 212 are supported on telescoping support beam subassemblies 214 that utilize multiple wheel supports 216 and their positioning beams 218. Stops 220 are used to limit the travel of the expanding components carrying the side walls 212 farther apart. The expanding base of the combustion chamber, formed as a hinged plate 222, swings down into place where it remains until contraction occurs. Then, upon retraction, its inner chamfered edge 224 coacts with a chamfered edge 226 on the permanent base 228 to tilt the hinged plate 222 out of the way, thereby allowing complete retraction.

In FIG. 5, embodiment 240, shown partially in cross section, is expandable upwardly as the top portions 242 and lower portions 244 of the combustion chamber 36 are sized so they telescope together and apart. Such

movement is undertaken without disturbing water lines 246 and air lines 248.

In FIG. 6, embodiment 252, shown partially in cross section, is a combination of the expansion structures shown in FIGS. 4 and 5. This expansion is also accomplished without disturbing the flow of air and water through the various distribution lines which move directly with the moving portions of the combustion chamber 36. They in turn are all supplied through flexible conduits which move sufficiently to maintain their connections in these embodiments and in other embodiments wherein the combustion chambers are enlarged at the burning site.

Additional Embodiments

Under certain circumstances, a secondary system of air lines 256 is installed as shown in FIG. 7. In this case the air lines 256 may serve the air input function of air lines 248, while the latter are converted to vacuum lines. Under vacuum, heavier particles flow into air lines 248 and thereafter through an auxiliary filtering system, not shown. Such vacuum operation is undertaken when some debris is found to be difficult to burn and/or is an unusual source of heavier gases and/or entrained particles.

FIG. 8 illustrates a method of installing additional burner systems 260 to decrease the time required to obtain a good fire. One half of the twin air fed fuel burner assembly 98, shown in FIGS. 1, 2 and 3 may be affixed to the lower extremes of side and/or end walls either in conjunction with or in lieu of, the twin air fed fuel burner assembly 98.

FIG. 9 shows how additional compressed air distribution ducts are arranged more extensively, wherein embodiment 264, composed of hollow wall sections of cast iron and/or ferro-cement, often includes integrally formed multiple air distribution passageways 266 arranged in patterns extending extensively throughout the interior structures of the side walls 268, thereby presenting many groups of small orifices 270. As a consequence air ejected from orifices 270 enters the burning areas to ensure an adequate supply of oxygen to enhance the complete burning process. The ejected volumes of air are regulated to create the flow patterns indicated in FIG. 2.

Embodiments to be Used in Specific Ways

In FIG. 10, embodiment 280 is shown secured to a vehicle, such as a pickup truck 282, using a conventional ball trailer hitch 284. The bed of the pickup truck supports engine, blowers and pumps of this embodiment 280 within a housing 286. Air 288, water 290, and fuel 292 conduits direct these fluids to their respective places of utilization within the interior combustion chamber. This embodiment 280 is particularly useful in residential neighborhoods to handle the burning of selected debris on a periodic schedule or an on-call service arrangement.

In FIG. 11, embodiment 300 is illustrated, after being conveniently delivered by truck to a place nearby a dwelling to handle the burning of preselected debris collected from the dwelling. A removably secured fuel burner subassembly 302 is shown utilizing, for example, a bottled propane fuel source 304. The intake of outside air below is handled by adjusting overlapping draft plates 306 each with orifices 308. Compressed air is delivered at the top through ducts 310 receiving air

from a blower of a vacuum cleaner, or equivalent equipment, not shown, which is connected to the attachment structure 312. A water spray 314 is secured to a house garden hose 316 and directs a water spray across the top opening over the burning debris. A cover 318 in two parts and hinged 320 to either side is closed when the incinerator is not in use to keep the combustion chamber 322 dry.

In FIG. 12, embodiment 330 shows a permanently installed incinerator with fixed side walls 332 and end walls 334. The air system 336, water system 338 and the burner assembly 340 are supplied from respective industrial type air systems, city water lines, and natural gas lines. Due to the permanency of installation many types of construction materials may be used beyond the weldable steel, cast iron and/or ferro-cement materials used in embodiments that are semi permanent and transportable.

In FIG. 13, embodiment 350 shows a very simplified transportable unit usable for burning slash and like wood products left over from logging operations and road and power line clearing projects in remote areas. This unit has the tilting side walls 352 and 354 and floor mounted burner assembly 98. Surrounding air is drawn in by normal convection currents through many openings to supply the enormous amounts of oxygen required for the complete combustion that occurs.

Summary of Advantages

Throughout all embodiments the objectives are: to burn efficiently; to comply with all government regulations regarding pollution control and other matters and the possible additional specifications of particular jobs; to burn at low cost; and to burn safely. In all embodiments, the ignition and fuel-air burners are located at the bottom with their exits directed to insure continued burning of all debris commencing from the bottom. In embodiments for pollution free burning spray equipment is installed with directable outlets located at the top of the combustion chamber to cool and scrub departing gases, and compressed air impingement equipment is installed with directable outlets located near the top of the combustion chamber and below the water spray outlets, to control the air flow to increase the thoroughness of the burning and to recirculate particles not thoroughly burned. When needed, vacuum equipment is located between the water spray or curtain equipment above and the ejected air shield or curtain equipment below, as shown in FIG. 7.

All these features, are provided using currently available materials, equipment, and processes. When each embodiment is operated, overall cost savings are realized. Controlled burning occurs under safe conditions. Where possible, this burning is generally undertaken at the place of first collection of the debris thereby eliminating the otherwise subsequently incurred transportation and handling costs.

I claim:

1. An incinerator for reducing pollution and ancillary fire risks when burning solid waste debris, and having a design readily adaptable to various capacity, portability, transportability and locality requirements, comprising:

a. an enclosure having an open top during burning and adjustable structures movable to increase the volume, as necessary, when burning is to occur to more conveniently load the debris, and, thereafter

to decrease the volume for more convenient handling of the incinerator; and

- b. a low placement burner assembly to selectively supply fuel and air under pressure from beneath debris placed in the incinerator enclosure.

2. An incinerator for reducing pollution and ancillary fire risks when burning solid waste debris, and having a design readily adaptable to various capacity, portability, transportability and locality requirements, comprising:

- a. an enclosure, having an open top during burning, serving as the incinerator to receive debris;
- b. a low placement burner assembly to selectively supply fuel and air under pressure from beneath debris placed in the incinerator enclosure; and
- c. a high placement air ejection assembly to selectively add air, and to recirculate air, smoke, and particles, rising above the burning debris placed over and around the low placement burner assembly, having at least two air ejection branches, one air ejection branch on one incinerator side to selectively add ejected air directed slightly downwardly to create a nearly level layer of compressed air flow across the interior of the incinerator near its top, and another air ejection branch on the other incinerator side to selectively add ejected air directed downwardly at a steeper angle to combine the air flows of the two branches and thereby create a turbulent air flow involving circulating air flows occurring above the low placement burner assembly while remaining essentially below the nearly level layer of compressed air being ejected slightly downwardly, the overall air ejection assembly thereby supplying oxygen efficiently and effectively for the substantially complete combustion of all the burning debris.

3. An incinerator for reducing pollution and ancillary fire risks when burning solid waste debris, and having a design readily adaptable to various capacity, portability, transportability and locality requirements, comprising:

- a. an enclosure, having an open top during burning, serving as the incinerator to receive debris;
- b. a low placement burner assembly to selectively supply fuel and air under pressure from beneath debris placed in the incinerator enclosure; and
- c. a high placement air ejection assembly to selectively add air, and to recirculate air, smoke, and particles, rising above the burning debris placed over and around the low placement burner assembly, having rotatable air injection branches on respective sides of the incinerator selectively adjusted to direct the departing air flows at different angles, whereby the air flows may be effectively combined to create controllable turbulent flows above the low placement burner assembly to efficiently and effectively supply oxygen for the substantially complete combustion of all the burnable debris.

4. An incinerator for reducing pollution and ancillary fire risks when burning solid waste debris, and having a design readily adaptable to various capacity, portability, transportability and locality requirements, comprising:

- a. an enclosure, having an open top during burning, serving as the incinerator to receive debris;

- b. a low placement burner assembly to selectively supply fuel and air under pressure from beneath debris placed in the incinerator enclosure; and

c. a top placement water ejection assembly to selectively direct water sprays to wash and scrub air, smoke, and particles rising above the burning debris placed over and around the low placement burner assembly, having at least two water ejection branches, one on each top side of the incinerator to fully spray water over the entire top exit area of the incinerator.

5. An incinerator for reducing pollution and ancillary fire risks when burning solid waste debris, and having a design readily adaptable to various capacity, portability, transportability and locality requirements, comprising:

- a. an enclosure, having an open top during burning, serving as the incinerator to receive debris;
- b. a low placement burner assembly to selectively supply fuel and air under pressure from beneath debris placed in the incinerator enclosure; and
- c. a top placement water ejection assembly to selectively direct water sprays to wash and scrub air, smoke, and particles rising above the burning debris placed over and around the low placement burner assembly, having rotatable water ejection branches on respective sides of the incinerator selectively adjusted to direct the departing water flows to effectively cover the entire top exit area of the incinerator.

6. An incinerator for reducing pollution and ancillary fire risks when burning solid waste debris, and having a design readily adaptable to various capacity, portability, transportability and locality requirements, comprising:

- a. an enclosure, having an open top during burning, serving as the incinerator to receive debris; and
- b. a low placement burner assembly to selectively supply fuel and air under pressure from beneath debris placed in the incinerator enclosure, having two branches arranged back to back along the bottom of the incinerator and protectively covered to avoid damage upon loading debris.

7. An incinerator for reducing pollution and ancillary fire risks when burning solid waste debris, and having a design readily adaptable to various capacity, portability, transportability and locality requirements, comprising:

- a. an enclosure, having an open top during burning, serving as the incinerator to receive debris; and
- b. a low placement burner assembly to selectively supply fuel and air under pressure from beneath debris placed in the incinerator enclosure, having two branches, each branch being respectively located near a corner of the enclosure being determined by the connection of the side wall to the bottom of the incinerator.

8. An incinerator for reducing pollution and ancillary fire risks when burning solid waste debris, and having a design readily adaptable to various capacity, portability, transportability and locality requirements, comprising:

- a. an enclosure, having an open top during burning, serving as the incinerator to receive debris; and
- b. a low placement burner assembly to selectively supply fuel and air under pressure from beneath debris placed in the incinerator enclosure, having

multiple branches including a central branch and other branches respectively located near the edges of the bottom of the incinerator.

9. An incinerator for reducing pollution and ancillary fire risks when burning solid waste debris, and having a design readily adaptable to various capacity, portability, transportability and locality requirements, comprising:

- a. an enclosure, having an open top during burning, serving as the incinerator to receive debris; and
- b. a low placement burner assembly to selectively supply fuel and air under pressure from beneath debris placed in the incinerator enclosure, having coextensive and adjacently positioned fuel supply conduit and compressed air conduit, each conduit having orifices arranged to respectively eject fuel and air for immediate mixing.

10. An incinerator, as claimed in claim 9, wherein the low placement burner assembly has coextensive and adjacently positioned ignition means to ignite the fuel supply.

11. An incinerator for reducing pollution and ancillary fire risks when burning solid waste debris, and having a design readily adaptable to various capacity, portability, transportability and locality requirements, comprising:

- a. an enclosure, having an open top during burning, serving as the incinerator to receive debris, and having tiltable sides moved to increase the incinerator volume for countryside travel and to decrease the incinerator volume for highway travel; and
- b. a low placement burner assembly to selectively supply fuel and air under pressure from beneath debris placed in the incinerator enclosure.

12. An incinerator for substantially pollution free burning of burnable solid waste debris, comprising:

- a. an enclosure, having an open top during burning, to receive debris;
- b. a low placement burner assembly to selectively supply fuel and air under pressure from beneath debris in the incinerator;
- c. a high placement air ejection assembly to selectively supply air and to cause recirculation of air, smoke and particles rising above the burning debris located on and about the low placement burner assembly having air ejection branches located on upright sides of the enclosure and arranged so the ejected air from one side forms a near level layer of moving air extending almost across the top of the incinerator until it is moved downwardly by more ejected air coming from an opposite side and directed substantially downwardly, and thereafter

the resultant air flow recirculates in the incinerator volume located over the low placement burner assembly and below the near level layer of moving air, whereby sufficient quantities of oxygen are efficiently and effectively supplied for consumption in burning substantially all the burnable debris; and

- d. a top placement water ejection assembly to direct water sprays which wash and scrub air, smoke, and particles rising up through the supply air and recirculation air, having water ejection branches located on upright sides of the enclosure and arranged so the ejected water from both sides forms a water spray over the entire exit area of the incinerator without disturbing the air flows below.

13. An incinerator, as claimed in claim 12, comprising in addition, a vacuum assembly having vacuum branches located on upright sides of the enclosure between the respective branches of the high placement air ejection assembly and the top placement water ejection assembly, whereby selectively smoke, and particles, may be collected as they depart from the volume served by the air ejection assembly and before they reach the volume served by the high placement water ejection assembly.

14. An incinerator, as claimed in claim 12 wherein the incinerator enclosure has walls cast to provide air passageways which supply air and eject air in several branches.

15. A method of burning debris which is essentially pollution free comprising:

- a. lowering debris into a fully open top enclosure;
- b. commencing a fire below the debris using fuel and air under pressure;
- c. ejecting air from the top of the open top enclosure substantially across the open top;
- d. ejecting air from the top of the open top enclosure downwardly into the air ejected substantially across the open top to redirect the entire mass of ejected air down into the enclosure creating a turbulent flow through and about the burning debris;
- e. ejecting water from the top of the open top enclosure to create a water curtain throughout the open top area above the ejected air, to cool and scrub air, gases, and unburned debris leaving the ejected air flows; and
- f. vacuuming air, smoke, and debris from across the top of the open top enclosure above the ejected air.

16. A method of burning debris, as claimed in claim 15, wherein the vacuuming of air is undertaken below the water curtain.

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