May 8, 1956 J. VAN VLIET 2,744,737

APPARATUS FOR SMOKE ABATEMENT AND BY-PRODUCTS RECOVERY

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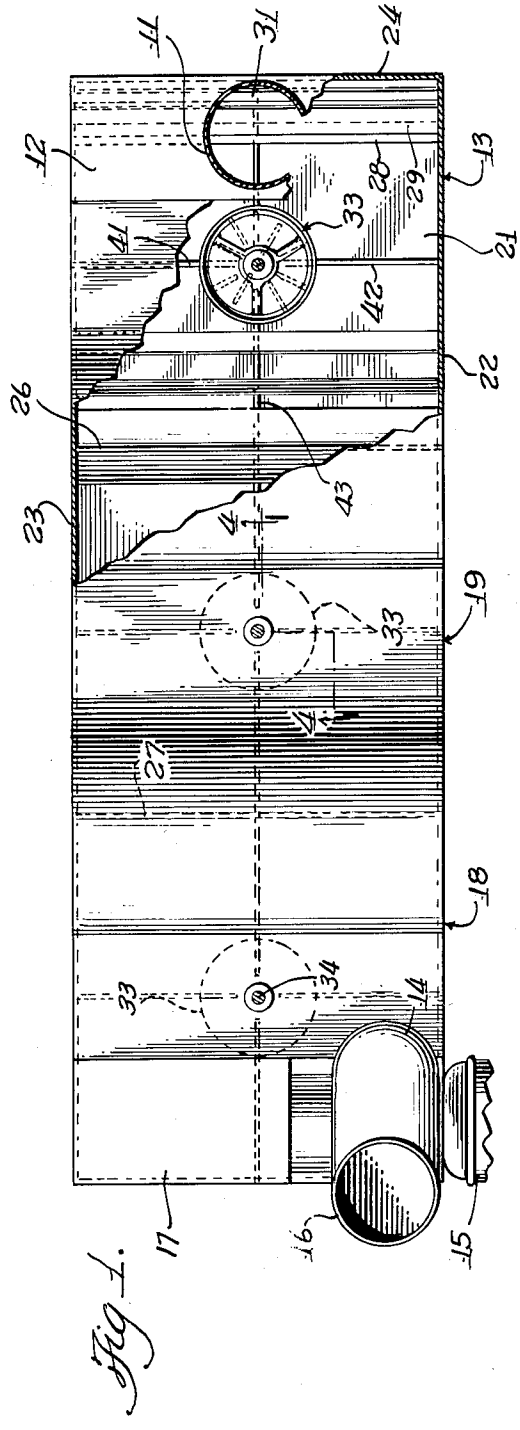


Fig. 1.

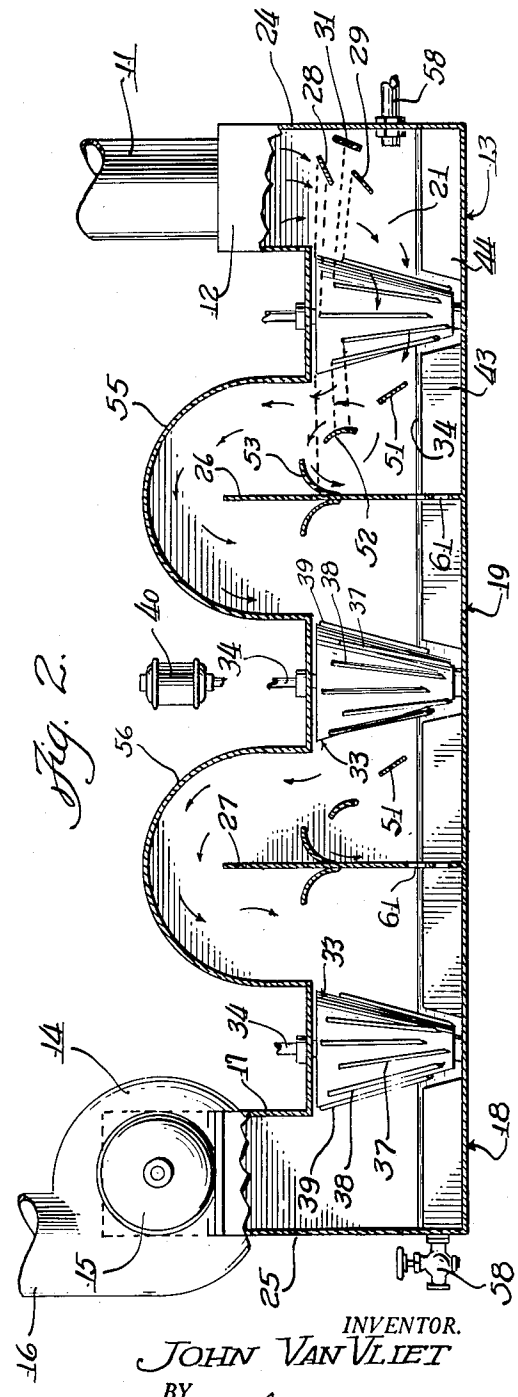


Fig. 2.

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Fig 3.

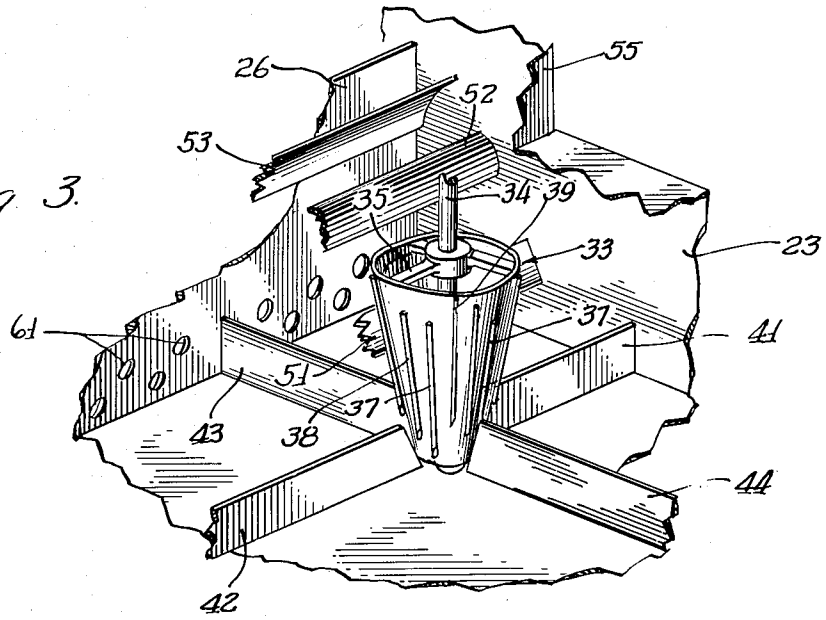
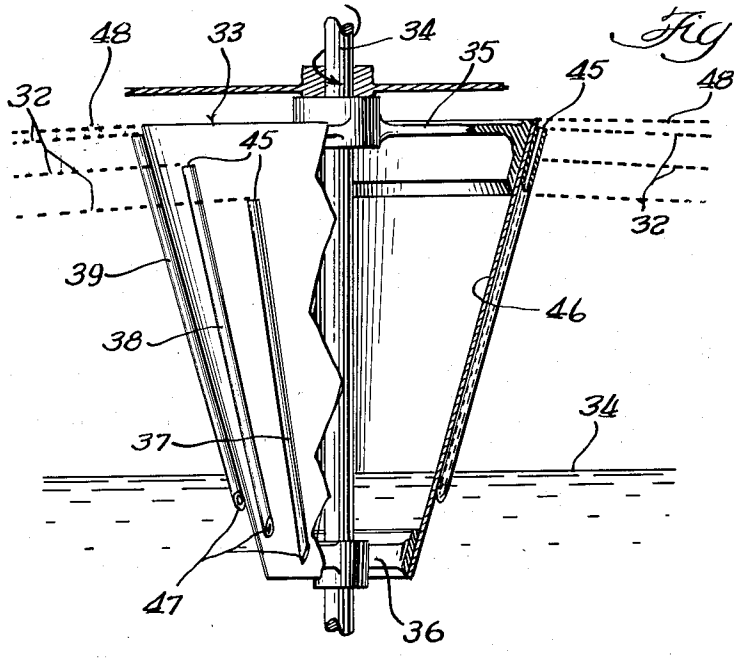


Fig 4.



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United States Patent Office 2,744,737
Patented May 8, 1956

2,744,737

APPARATUS FOR SMOKE ABATEMENT AND BY-PRODUCTS RECOVERY

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Application December 17, 1952, Serial No. 326,446

6 Claims. (Cl. 261—91)

This invention relates to apparatus for recovering airborne solids which are the by-products of combustion resulting from the burning of oil, coal, or other hydrocarbon fuels for the dual purposes of diminishing air pollution and for the recovery of the airborne particles.

A principal object of the present invention is to provide an inexpensive yet highly efficient exhaust gas cleansing and purifying apparatus adaptable to both domestic as well as industrial application for abating health hazard and contamination which are characteristic of the smoke fumes discharged by various types of combustion systems.

Another object of the present invention is to provide an apparatus for separating and collecting airborne solids from the discharge flues of combustion systems in a manner of recovery which will accomplish efficient accumulation of such particles in concentrated form, after which they may be variously processed for different purposes of economic utilization.

Still another object of the present invention is to provide an apparatus for the recovery of solids from combustion system smoke discharge by the sole use of water as a trapping agency under conditions which will permit the repeated re-use of the water over repeated operations and without incurring waste such as is incident to conventional structures of water spray apparatus.

For a better understanding of the foregoing and other objects and purposes of this invention as will later appear, reference will now be had to the following detailed description, as well as to the accompanying drawings, in both of which like reference numerals designate corresponding parts throughout, and in which:

Fig. 1 is a plan view with parts broken out of a multiple unit filter apparatus for smoke abatement embodying certain features of the present invention;

Fig. 2 is a side elevational view of the apparatus illustrated in Fig. 1 with various portions broken away and in section;

Fig. 3 is a fragmentary perspective view of certain of the structural elements disposed in the interior of one of the filter units, and

Fig. 4 is a transverse sectional view on an enlarged scale taken approximately on line 4—4 of Fig. 1.

Referring now more particularly to the accompanying drawings, the reference numeral 11 designates an inlet flue which may be connected with a chimney or fire chamber exhaust conduit of a hydrocarbon combustion apparatus whose smoke is ordinarily beset with certain undesirable airborne particles commonly identified as soot, fly ash, etc. From its source of generation the smoke is directed downwardly through the flue 11 into a preliminary expanding chamber 12, which, because of its larger cross section affords a momentary check upon the down draft velocity while at the same time the gases are permitted to spread laterally throughout the full width afforded by the first filtering unit 13. Under this action the more massive airborne particles experience a centrifuge effect and seek to plunge downward.

A draft action is induced forcibly throughout the train of units by reason of a centrifugal fan 14 driven by an electric motor 15 which is located at the egress end of the filtration system and identified with the exhaust flue 16 which communicates with a header chamber 17 located at the rear of the third, and in the instant embodiment, final one of a series of filtering units designated 18.

Also, in the instant embodiment three successive filtering units designated 13, 19 and 18 operate successively upon the gaseous discharge fumes as they thread from right to left in the arrangement viewed in Figs. 1 and 2. The number of such units which are to be employed in tandem is dependent upon several considerations, such as the precise nature of the hydrocarbon fuel, or in other words, the density of its discharge fumes, as well as upon the degree of purification and particles recovery which it is desired to attain. For some purposes a single filtration unit may be adequate, and for many purposes will comply with minimum standards of purification. It is to be recognized, therefore, that other than as an indication of the feasible and practical manner to which the present invention lends itself to an arrangement in tandem, the number of such units is purely a matter of designing and may be left to particular choice or preference.

Each one of the filtering units 13, 19 and 18 consists essentially of a substantially equilateral trapping chamber 21 defined by the longitudinal side walls 22 and 23 which extend throughout the series or battery of filters, the end walls 24 and 25 which define the extremities of the unit and the intermediate barrier or baffle walls 26 and 27. As the flue gases are directed downwardly through the pipe 11 and expander chamber 12, they encounter a series of angularly disposed baffles 28, 29 and 31, Figs. 1 and 2. These, after the manner best indicated in Fig. 2, extend transversely across the width of the unit 13, causing the airstream to be deflected leftwardly at the same time that it encounters a series of liquid umbrella syrays generally indicated at 32 and 48. These liquid sprays hereinafter described are generated by a rotary turbine 33, the unique performance and operation of which will be described later, and the effect of which is to dispose a series of centrifugal spray discharges at different levels whereby there is increased the probalility of encounter and wetting of airborne particles carried by the flue discharge airstream.

The effectiveness of entrampment and precipitation of the particles has been found to be materially or substantially enhanced by the provision of the angularly disposed baffles 28—31, and in cooperation with the vapor spray, these particles are thereby more promptly precipitated into the water bath 34, where, because of their aerated structure, together with their oleic coating, they remain in floatation upon the surface to accumulate as a spumescent scum. This results in the achievement of a compact condition with respect to the precipitated material and enhances collection of the same, particularly where the collected material is to be processed for utilitarian purposes. Some portions of these accumulations may become sufficiently waterlogged to descend partially below the surface of the bath 34, but, for the most part, it has been found that these frothy accumulations retain their flotation characteristics indefinitely so that they may be drawn off the surface by any suitable drainage or separation method.

For these reasons it is said that the present filtration and trapping method is one that is operative without perceptibile water consumption beyond that which is incident to evaporation or that lost through vehicular dissipation as the froth accumulation is periodically removed.

The rotary impellers 33 are vertically journaled on

shafts 34 and may be driven independently by individual motors as shown at 40 or in unison from any suitable driving source at a rotary speed of approximately 1750 R. P. M. in a counterclockwise direction, as viewed in Fig. 1. Each turbine or impeller 33 is an inverted conical member formed of sheet or thin metal and supported upon spider elements 35 and 36 at top and bottom, as may be observed from Figs. 3 and 4. Where the conical elements 33 impinge upon the circumferential limbs of the spider elements 35 and 36, they may be secured by soldering or riveting. The angular slope of the conical elements is about 15° from vertical, and at spaced intervals along elemental lines there is secured to their outer surface a series of tubular spray elevators or lift tubes designated 37, 38 and 39.

In the preferred illustration the elevator tubes are shown to be of three different classes according to their relative disposition, although it is to be understood that this distribution is a matter of arbitrary arrangement and that their number, according to class, may be moderately varied, and also that their total number respecting each in rotor 33 may also be moderately varied. At their lower extremities the tubular scoops 37—39 are cut on a bias, as best indicated in Fig. 4 at 41. This presents a larger intake area foremost in the direction of encounter with the bath water, and since each of the elevator tubes is immersed below the surface of the bath 34, it will gather a column of water, and, under the indicated velocity, eject a spray at its upper terminal 42, which thus liberated will be hurled centrifugally to form the already described umbrella pattern at its respective elevation.

By repeating the stagger of elevator tubes as indicated in Fig. 2 throughout the periphery of each impeller 33 the concentration of water spray at each umbrella level may be made sufficiently dense so that the total barrier effect which is presented to the air stream at each area of intersection will preclude any possibility of escape. A single filtration unit such as that designated 13 in which the base diameter of the spray rotor 33 is about fourteen inches operating in conjunction with an oil fire exhausted through a twelve-inch flue under the stated speed of rotation has been observed to eliminate 92% of the recoverable solids, including fly ash and soot, under a single exchange pass with an operating unit patterened in accordance with the accompanying illustrations.

Each rotor 33 is driven by its vertical spindle shaft 34 in a counterclockwise direction, as observed in Figs. 1 and 3. Its rotation is prevented from setting up a swirl condition in the water bath 34 by an arrangement of vertical breakers or partitions 41, 42, 43 and 44, which extend radially from the axis of rotation, as best indicated in Fig. 3. As a consequence of such rotation, however, each one of the tubular elevators 37—39, because of its obliquely presented apertures 47, scoops up a continuing column of water ejecting it at its upper egress 45 with a constant centrifugal trajectory.

Also, a cylindrical column of water will be frictionally generated to climb the interior surface 46 of each conical element 33. This water, aided by the inclination of the conical wall surface, will climb until it reaches the uppermost edge of its conical element 33, and there be hurled in a similar horizontal trajectory along a line such as that designated 48, also forming an umbrella pattern, and constituting a water barrier against which the airborne stream of solids is assured encounter by a high degree of probability.

With respect to any of the airborne particles which survive encounter by water issuing through the umbrella patterns 32 or 48 in the downdraft portion of its travel in unit 13, a second opportunity for such encounter is afforded in the region of the secondary baffle plates 51, 52 and 53, which are disposed and shaped in the manner in which they are illustrated in Figs. 2 and 3. Baffle 51 is disposed transversely of unit 13 on about a 38° slope from the vertical and is designed to impart an upward and leftward direction to the air stream after it has passed the region of the turbine or rotor. Thereafter, baffle 52, being somewhat crowned or curved inwardly, is designed to cooperate with baffle 53 to set up a local rotary eddy current designed to capture straying solids particles during the upstream portion of their travel, and to revert them into the path of the trajectory lines 32 and 48. Meanwhile, certain portions of the air stream which follow more closely the principal path of curvature parallel to the bonnet 55 will be directed to enter upon a repetition of the aforedescribed treatment under the effect of the intermediate filtering station 19.

It is to be noted that substantially all of the water spray which is lifted by the elevator tubes 37—39, as well as that which is distributed by the centrifugal action of the conical surface 46, returns to the bath 34 and is subject to re-use under conditions of continuous cycling. Periodically, the surface accumulation of carbon and soot particles may be drawn off as through a drainage cock 58, Fig. 2, located at one end of the fitering assembly, and thereafter replenishing water may be supplied from any appropriate source, as through an intake 59 at the other end. Notwithstanding the barriers 26 and 27 which separate the several units, the water in the bath 34 is preferably intercommunicative, and toward this end apertures 61 in the submerged portion of the barriers 26 and 27 provide continuous communication between the water levels which are otherwise partitioned from one another.

In summarizing, it is called to attention that in accordance with the present invention there is afforded a simple and unique gas filtering apparatus which lends itself to be employed singly or in tandem, and which utilizes as purging agency for solids-laden gases, such as combustion smoke, etc., the filtering principles of plunging draft, eddy current turbulation, and contemporaneously therewith, a high trajectory multiple-level water spray generated simply and efficiently from a re-usable reservoir fount.

While the present invention has been explained and described with reference to various particular contemplations of structural details, it will be understood nevertheless that numerous changes and modifications are susceptible of being incorporated without departing from the essential spirit or scope thereof. Accordingly, it is not intended to be limited by the features illustrated in the accompanying drawings nor by the language employed in the foregoing description except as indicated in the hereunto appended claims.

What is claimed as new and desired to be secured by Letters Patent of the United States is as follows:

1. Apparatus for separating particles suspended in a gaseous medium which comprises a vertical duct for flow of the medium and particles; means defining a separating chamber; a plurality of baffle means mounted in said chamber at varying angles, said baffle means having active deflecting surfaces disposed substantially normally to the direction of flow of the gaseous medium; a slinger in said chamber mounted for rotation on a vertical axis; means for rotating said slinger; a reservoir for liquid, said slinger being partially immersed in the liquid in the reservoir whereby liquid may be withdrawn therefrom by the slinger and discharged as a substantially horizontal sheet of high velocity droplets intersecting the direction of flow of the medium and impinging on the said baffle surfaces, whereby an intimate permeation of the medium by the liquid is achieved and the particles driven out of the medium, and an outlet duct in communication with said chamber.

2. The combination, as set forth in claim 1, in which said slinger comprises a conical surface with its apex directed downwardly and carrying a plurality of open-ended tubes for lifting the liquid from an intake level to a discharge level.

3. The combination set forth in claim 2, in which said

tubes have their respective exit ends at differing elevations.

4. Apparatus for separating particles suspended in a gaseous medium, which comprises a vertical duct for flow of the medium and particles; means defining a separating chamber; a plurality of baffle means mounted in said chamber at varying angles, said baffle means having active deflecting surfaces disposed substantially normally to the direction of flow of the gaseous medium; a slinger in said chamber mounted for rotation on a vertical axis; means for rotating said slinger; a reservoir for a liquid, said slinger being partially immersed in the liquid in the reservoir, whereby liquid may be withdrawn therefrom by the slinger and discharged as a substantially horizontal sheet of high velocity droplets intersecting the direction of the flow of the medium and impinging on the said baffle surfaces, whereby an intimate permeation of the medium by the liquid is achieved and the particles driven out of the medium; an outlet duct in communication with said chamber; and a second plurality of baffles, said baffles having active surfaces disposed substantially normally to the direction of flow, disposed in said chamber adjacent said outlet duct.

5. Apparatus for separating particles suspended in a gaseous medium, which comprises an inlet duct for passage of the medium and particles; means defining a separating chamber; a plurality of baffle means mounted in said chamber at varying angles having deflecting surfaces substantially normal to the direction of the flow of the gaseous medium; a slinger arranged in said chamber; means for rotating said slinger; a reservoir for liquid; means for transferring liquid from the reservoir to the surface of the slinger from which surface the fluid is discharged in high velocity droplets into the chamber, through the stream of the medium and against the said baffle surfaces to effect an intimate, vigorous permeation of the medium by the fluid to drive the suspended particles thereoutof; an outlet duct leading from said chamber for exit of the particle-free medium, said outlet duct having a second plurality of baffles, having active surfaces disposed substantially normally to the flow of medium disposed in said chamber adjacent said outlet duct.

6. Apparatus for separating particles suspended in a gaseous medium which comprises an inlet duct; an outlet duct substantially parallel to said inlet duct; means defining a chamber joining said ducts whereby the medium passes from the inlet duct into the chamber in a right-angled stream; baffle means positioned in the zone of juncture of the inlet duct and chamber having active surfaces substantially normal to the flow of the medium; means for projecting fluid droplets at high velocity intersecting and through the entering stream for impingement against said baffle surfaces; means for conducting said medium in a right-angled stream toward the outlet duct after said medium has been first intersected; a second baffle means positioned in the zone of juncture of the outlet duct and chamber, said second baffle means having active surfaces substantially normal to the flow of the medium; means for projecting fluid droplets at high velocity intersecting and through the outgoing stream for impingement against said second baffle means, effecting thorough permeation of the stream while in the chamber to drive the particles therefrom before exiting.

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