

[54] **FLOW CONTROL AND DAMPING MEANS**

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[52] U.S. Cl. **110/7 R, 110/160, 263/40**

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

[58] Field of Search **110/7, 8, 160; 263/48**

[56] **References Cited**

UNITED STATES PATENTS

3,357,375 12/1967 Brophy110/7

2,979,322 4/1961 Dailey, Jr.110/160 X
3,215,501 11/1965 Phillips110/8 X
3,566,811 3/1971 Tidd et al.110/160

Primary Examiner—Kenneth W. Sprague

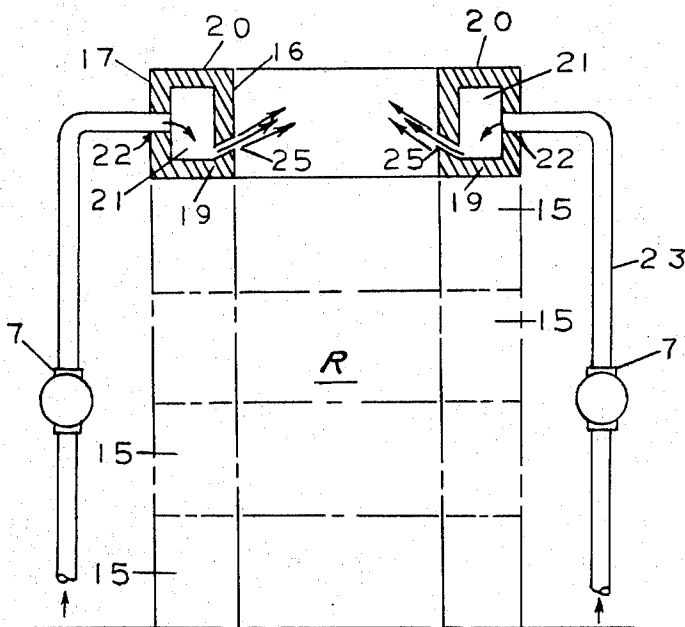
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[57]

ABSTRACT

The rate of passage of a current of fluid moving in one direction through, or out of, a conduit is modified by means of a counter-current of similar or different fluid moving in a direction thereby impeding the passage of said current and prolonging its dwell time in such conduit.

16 Claims, 15 Drawing Figures



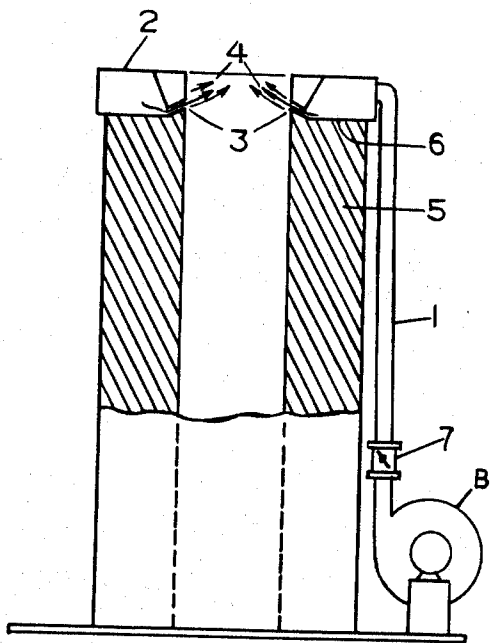


FIG-1

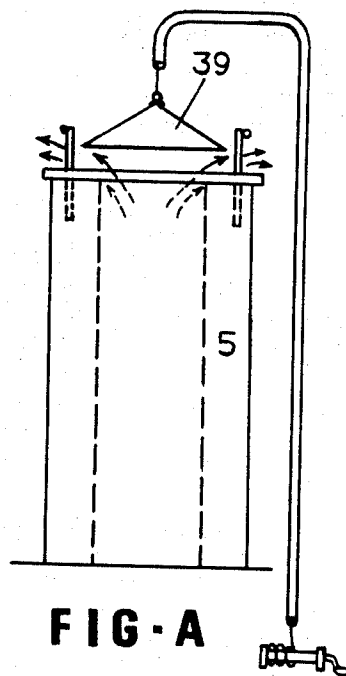


FIG-A

FIG-2

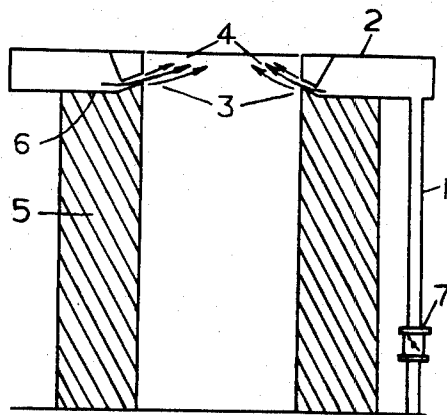
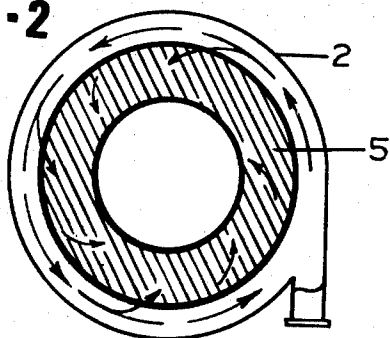


FIG-3

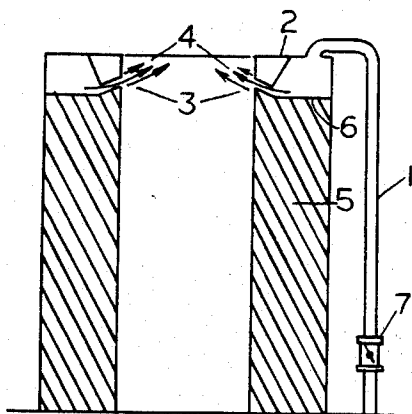


FIG-4

FIG-5

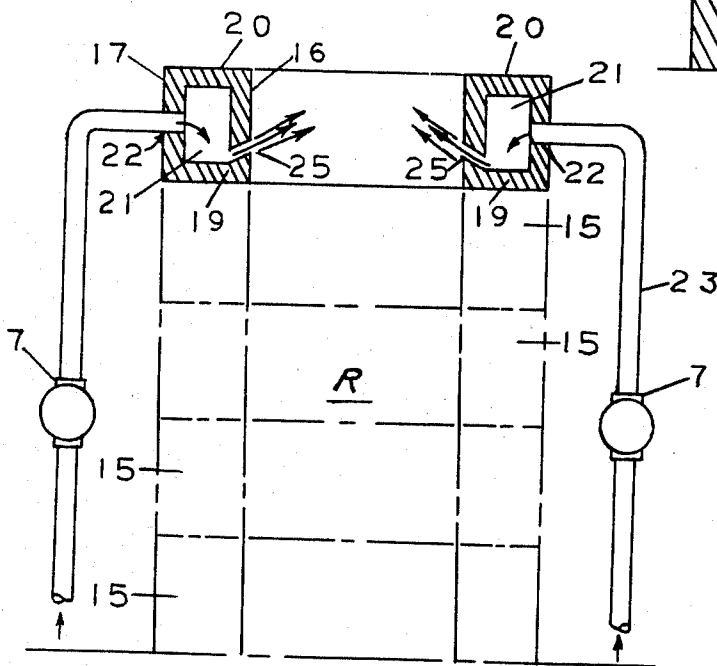
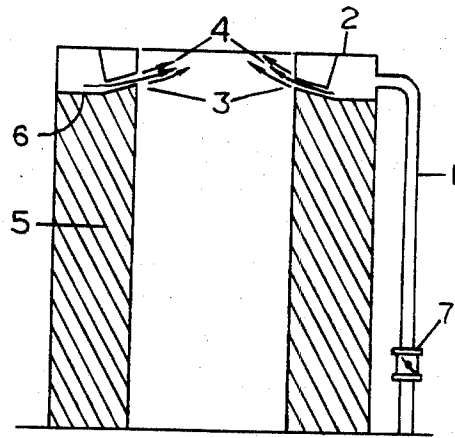


FIG-6

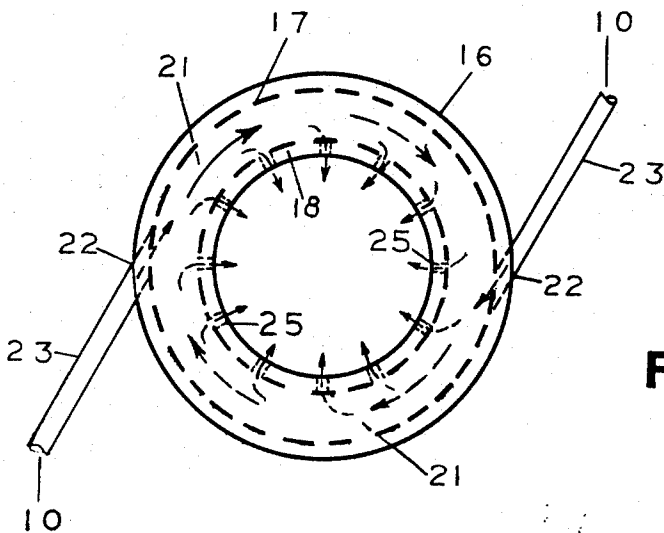


FIG-7

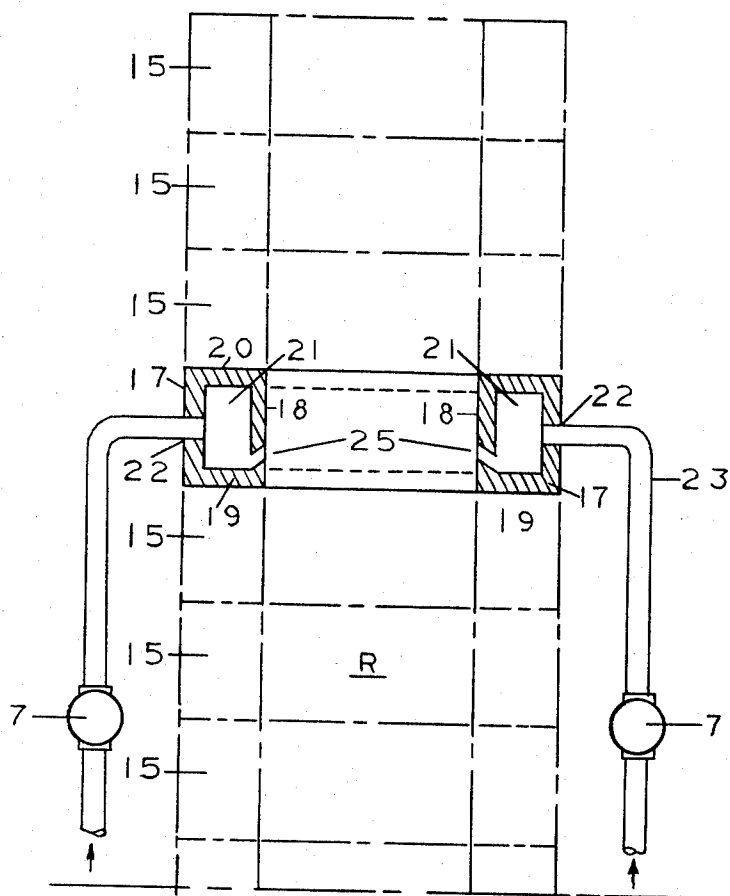


FIG-8

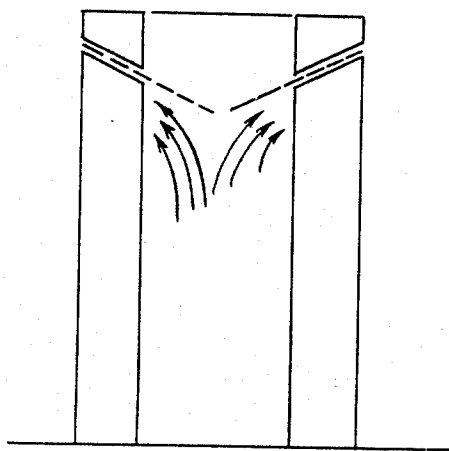


FIG-9

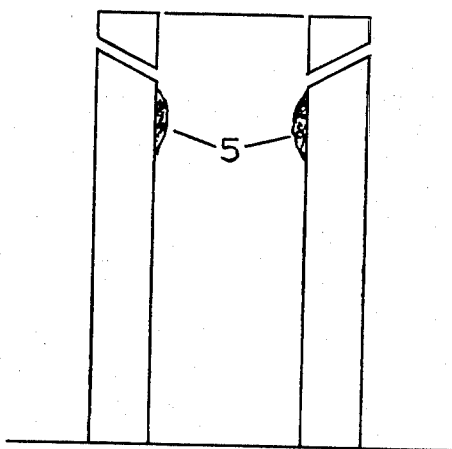


FIG-10

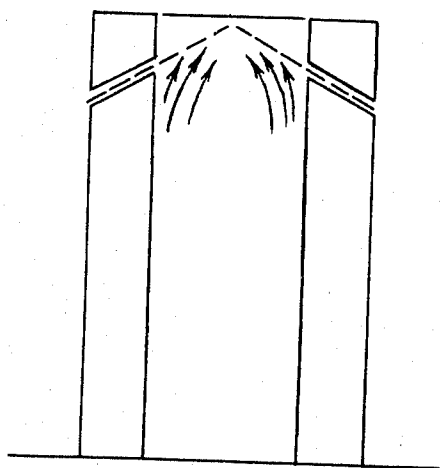


FIG-11

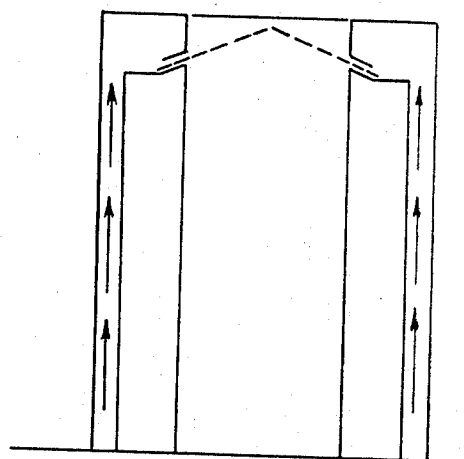


FIG-12

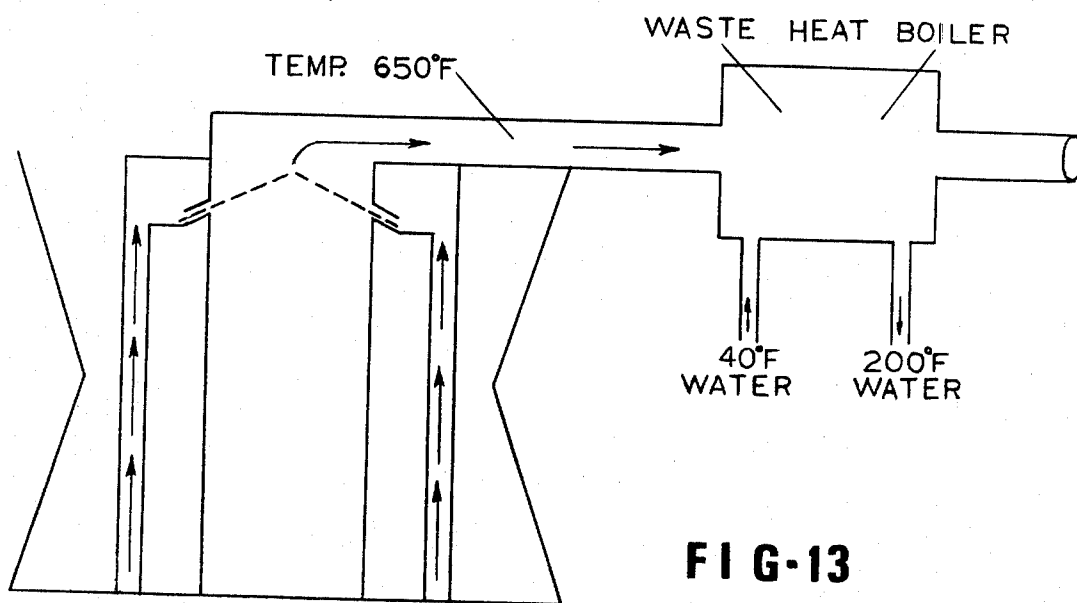


FIG-13

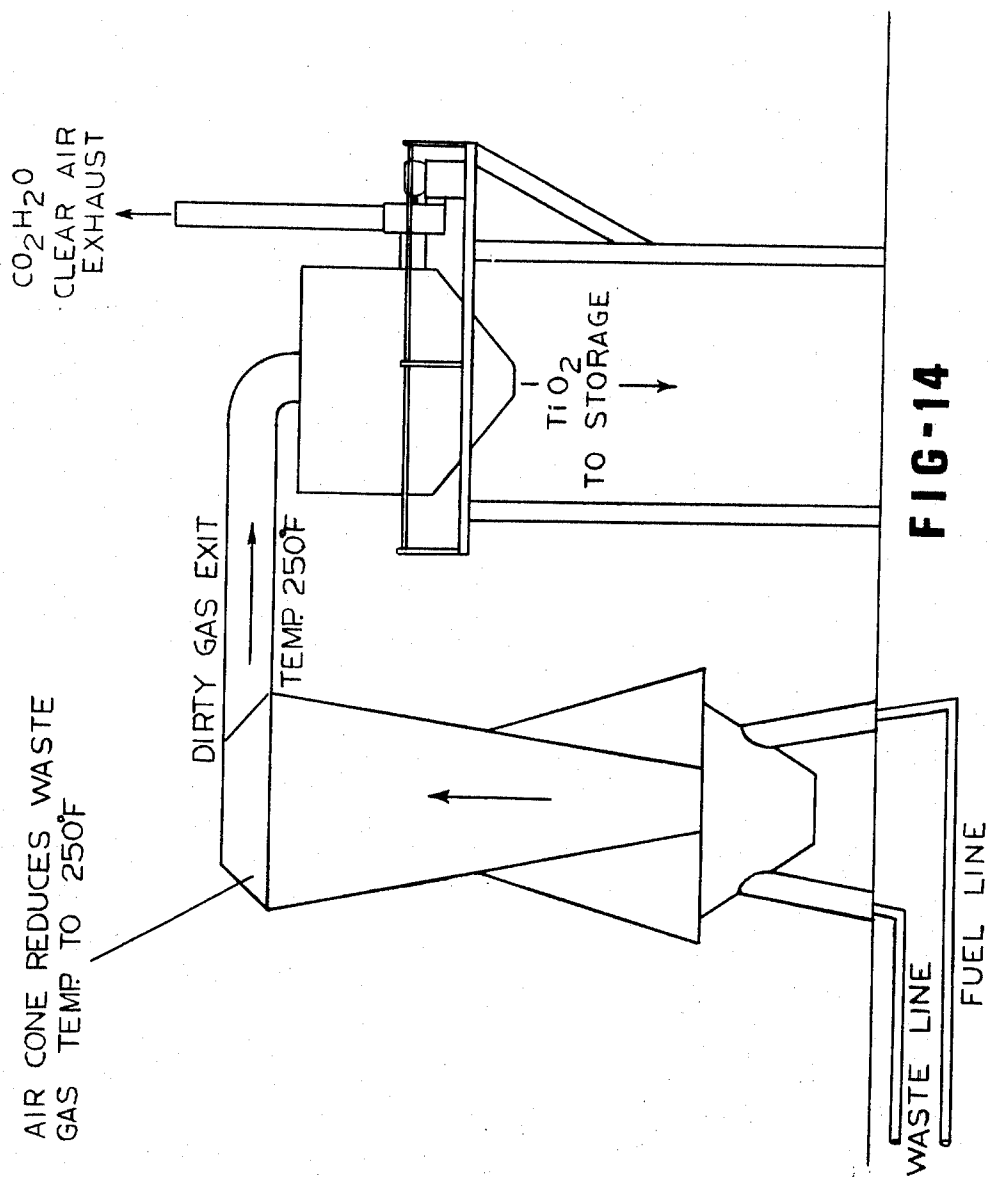


FIG-14

FLOW SHEET FOR PRENCO
SUPER E₃ WITH DRY SCRUBBER

FLOW CONTROL AND DAMPING MEANS

This invention relates to the control, by non-mechanical means of the rate of passage of a current of a first fluid normally tending to move, under pressure, in one direction through (or, out of) a conduit whereby to bring about a damping effect or velocity impedance or backpressure or counter-flow with respect to such current. The term "first fluid" as here used is meant to include gases, vapors, Newtonian liquids and non-Newtonian liquids. By the term "conduit" is here meant any tube, pipe, passageway and generally cylindrical retort. The expression "non-mechanical means" is meant to comprise both pneumatic means and hydraulic means including gases, vapors, Newtonian liquids and non-Newtonian liquids. In the following disclosure the expression "counter-flowing substance" when used, will be equivalent in scope and intent to "non-mechanical means."

In its broadest aspect, the invention consists in impeding or "damping" the flow of a current of a first fluid in one direction through a conduit by imposing thereagainst a restricting second fluid moving in a more or less obliquely upward direction. Such "second fluid" — may be a gas or a vapor or a liquid, and such counter-current may originate adjacent the exit end of such conduit — thereby impeding the discharge of the current of first fluid from the conduit — or it may originate at a zone intermediate the ends of said conduit — thereby imposing a damping effect on the current of such first fluid during passage of the latter toward but spaced from the exit end of such conduit.

The flow rate and pressure of such "second fluid" may be infinitely controllable by suitable valve means manually or by a suitable form of sensing or computer means.

It is further contemplated by applicant that by proper design this damping device shall be capable of producing velocity changes, and such flow directions, in a flue gas that would make possible a superamalgamation or flocculation of suspended particles — to be found in flue gases — thus rendering their collection and removal easy, such removal thereby reducing pollution.

In the following, the invention will be disclosed and explained with particular reference to a modification in the mode of, and device for, effecting back pressure on highly heated gaseous (and, gas-borne) combustion products moving upwardly through a retort or furnace shaft of an incineration apparatus such as that disclosed in U.S. Pat. No. 3,357,375 issued Dec. 12, 1967, to John W. Brophy. Said patent disclosure is incorporated by reference into the present application.

One feature of the apparatus specifically disclosed in said Brophy patent is "a balanced, weighted, adjustable cover member vertically displaceably suspended above the end of said retort . . . maintaining a pre-determined back pressure on gases moving upwardly through said retort." This cover member or mechanical damper — shown at "39" in FIGS. 1, 2, and 5 of said Brophy patent and repeated herein as "FIG. A" of the present drawing — is used to provide a back pressure in the retort or combustion chamber of the "Prencor" high-temperature incinerator. The back pressure so produced decreases the velocity of the products of combustion in said chamber.

It is desirable to reduce the velocity of these gases by reason of the fact that fine particles of material to be burned exist in suspension in the gases, and decreasing their velocity increases their dwell time in the combustion chamber. The increased dwell time insures more complete combustion of these particles.

However, the mechanical damper or cover just referred to is marked by several disadvantages.

1. High temperatures up to 3,000° F. cause a very high rate of oxidation of any metal-type damper resulting in a very short life of the damper.

2. Some of the mechanism required to operate the damper is exposed to very high temperatures and likewise suffers from this exposure.

3. The cost of replacing the damper presently being used is very high as it must be made of stainless steel in order to have even a short life in service.

4. The cost of labor to change dampers, together with the inconvenience to the operator, is considerable.

5. When the conventional mechanical damper is used the gaseous (and, gas-borne) products of combustion are caused to escape at high velocity in the generally radial direction shown by the arrows in FIG. 1 of said patent. It is undesirable to have the products of combustion issue in the radial direction shown by the arrows, for several reasons, viz.:

a. These high temperature gases are directed at, and across the top of, the refractory structure of the retort. The action of these gases on the refractory tends to cause a breakdown of the refractory by erosion, etc.

b. The gases issuing in the direction shown, by reason of their very high temperature, tend to deface the metal shroud by burning off the paint.

In FIG. 1 of the aforesaid patent, it will be seen that part "39" is a stainless steel "High Cone" or damper adjustably carried by a suspension arm assembly including a flexible wire cable used to raise and lower said damper through the medium of a hand winch. The raising of the damper relative to the top of the combustion chamber reduces the static pressure in the combustion chamber whereas the lowering of said damper increases the pressure in the combustion chamber of the retort providing a longer dwell for burnable particles therein.

An object of the present invention is the replacement of the aforesaid mechanical damper by damping means which exposes no mechanical parts to high-temperature gases.

The present invention now to be described will be recognized as a completely new concept in means to produce a damping action of high-temperature gases in a vertical combustion chamber or retort.

Damping is accomplished in this invention by directing high-pressure blower air in such a fashion that it tends to restrict the escaping products of combustion thus building up a back pressure in the combustion chamber. With the build-up of back pressure, the velocity of the combustion gases escaping from the combustion chamber is greatly reduced, and with this reduction in velocity, a longer "dwell time" for combustible particles in the combustion chamber is provided.

This invention thus accomplishes the same results as the mechanical type of damper described in the patent above referred to, but without all the inherent problems associated with a mechanical type of damper.

The "air curtain damper" has no mechanical parts exposed to the high-temperature products of combustion that issue from the top of the combustion chamber. Further, the pattern of the products of combustion issuing from the combustion chamber is modified from that shown in FIG. 1 of said patent so that when using the "air curtain damper" the products of combustion flow straight up into the atmosphere without suffering mechanical deflection.

As the "air curtain" is introduced in the obliquely upward direction, great turbulence takes place causing a very intimate association with fresh air and the products of combustion. Such intimacy of mingling provides an "after-burning" effect which consumes any burnable matter not previously consumed in the combustion chamber.

The invention will now be described in greater particularity and with reference to the appended drawings, in which

FIG. A is a diagrammatical representation of a mechanical damper known in the prior art;

FIG. 1 is a diagrammatical representation of one embodiment of apparatus for furnishing an air curtain damper to the incinerator retort;

FIG. 2 is a top plan view of the housing in FIG. 1, indicating the tangential flow of the air curtain over the top edge of the retort;

FIGS. 3, 4 and 5 show slight modifications of the structure illustrated in FIG. 1;

FIG. 6 diagrammatically represents a further and more general embodiment of the "air damper" concept of the present invention;

FIG. 7 is a top plan view of the apparatus represented in FIG. 6;

FIG. 8 is a modification of the structure illustrated in FIG. 6, differing from the latter in that the "air damper" is disposed at a level intermediate the ends of the conduit instead of adjacent the exit end of the latter;

FIG. 9 diagrammatically represents the course of gaseous products of combustion were the same influenced by a radially downwardly and inwardly directed "air damper" current;

FIG. 10 shows a build-up of solids resulting from the arrangement pictured in FIG. 9, whereas

FIG. 11 shows how a radially inwardly and upwardly directed "air damper" current tends to force gaseous products of combustion away from the refractory wall of the retort;

FIG. 12 diagrammatically represents a further development of the present inventive concept, according to which air for the "air damper" is directed through an annulus between the refractory wall and the outer shell of the retort and finally to the discharge means adjacent the upper end of the retort;

FIG. 13 diagrammatically represents a further development of the concept illustrated in FIG. 12 according to which gases emanating from the retort are led into and through a heat exchanger means; and

FIG. 14 illustrates the concept of combining with the retort a gas-scrubbing means.

Referring to FIG. 1 of the drawing, a more detailed description of the air damper device and its function is now given.

High pressure blower air from a blower "B" mounted at or about the base of the incinerator flows upwardly through delivery pipe 1 making entry into annular chamber 2 preferably in a tangential direction. The air flows through and around annular chamber 2 making exit through a direction controlling inner peripheral orifice 3 at a pressure which is substantially greater than that of the gases exiting from the combustion chamber. Arrows 4 indicate a preferred direction of flow for the air curtain. At 5 is shown the refractory material composing the combustion chamber of the retort. The top of the combustion chamber on which said annular chamber 2 may rest, is indicated at 6. The degree of damping effect may be infinitely controlled by making use of valve 7 in delivery pipe 1.

Another feature of the air curtain damper is that it provides great dilution of the issuing products of combustion. As previously mentioned, it is not absolutely essential that the air from the blower enters the annular dispersion ring in a tangential fashion, but this manner of entry is preferred.

Having reference now to FIG. 3, it will be noted that delivery pipe 1 from the blower makes entry into the annular chamber 2 through the bottom of said chamber.

Another method of feeding air to the annular dispersion chamber 2 is shown in FIG. 4, according to which air flows from the blower through delivery pipe 1 making entry into the annular dispersion chamber 2 through its top wall.

FIG. 5 shows still another means of feeding air to the annular dispersion chamber 2: in this embodiment air flows through delivery pipe 1 making entry into the annular dispersion chamber at a point on its outer periphery.

The retorts discussed above have monolithic refractory walls, with the "air damper" means mounted (or, otherwise disposed) at the top or exit end of the retort. As is illustrated in FIG. 6, the retort may be formed from a plurality of annuli, of refractory material (advantageously, pre-cast) piled on top of each other and suitably secured to each other to form a gas-tight open-ended shaft. One annulus of the plurality is hollow, thereby providing an annular plenum chamber. Ingress to the plenum chamber is made possible by a suitable inlet let into the refractory outer wall of the hollow annulus, with which inlet there communicates a suitable delivery conduit for a current of fluid under pressure. Egress from the plenum chamber is made possible by the provision of an upwardly and inwardly

extending annular slit formed in the inner wall or/and bottom of the hollow annulus, which slit induces an upwardly and converging discharge of fluid into the interior of the retort. In a manner similar to the showing in FIG. 2, it is advantageous that the fluid be introduced tangentially into the plenum chamber, as illustrated in FIG. 7, so as to ensure a pronounced swirling movement of the introduced current of fluid.

This hollow annulus may — as illustrated in FIG. 6 — constitute the uppermost of the annuli forming the shaft; or, it may be integrated into the built-up shaft as an annulus intermediate the bottom and top of the shaft, as is illustrated in FIG. 8. If the hollow annulus be disposed at the top of the retort, then the "air damper" counter current therefrom functions to retard egress of combustion gases from the retort, whereas if the hollow annulus be located at an intermediate level in the shaft its "air damper" serves to retard the rate of passage of combustion gases from a lower to a higher zone in the retort.

As will be apparent to one skilled in the art of forming refractory-walled shafts or retorts, the aforesaid hollow annulus with its upwardly converging discharge slit may be an addition to an otherwise monolithic furnace shaft or retort.

According to the showing made in FIG. 6, the generally vertical, cylindrical, retort "R" has walls formed by a plurality of similar individual annuli 15, 15, each being a precast body formed from a conventional refractory composition, stacked one on top of another to give, in conjunction with a special annulus 16, a retort of desired height. FIG. 6 shows only the shaft part the retort; its base preferably is the same as that of the incinerator disclosed in Brophy U.S. Pat. No. 3,357,375.

At 16 is represented a hollow annulus, having substantially the same outside diameter and the same inside diameter as those of the other annuli 15, 15, and having a height equal to or differing from that of the other annuli. The outside wall 17, inside wall 18, bottom wall 19 and top wall 20 of special annulus 16 define an annular plenum chamber 21. Let into wall 17 is or are one or more inlet openings 22, 22, to which are fitted valved delivery conduits 23, 23 for supplying a current of fluid, under pressure, from any suitable source (not shown), to the interior of plenum chamber 21. As is more particularly shown in FIG. 7, inlet openings 22, 22 are disposed tangentially with respect to annular plenum chamber 21.

In the inside wall 18 of the hollow annulus 16 and at the base thereof contiguous with bottom wall 19 there is provided an upwardly and inwardly extending annular slit 25 providing for the upward and inward discharge, from plenum chamber 21 into the interior of the retort "R" of a curtain of fluid to constitute the hereinabove referred-to "air damper."

The structure shown in FIG. 8 differs from that shown in FIG. 6 solely in that hollow annulus 16 has been integrated into the retort wall above a plurality of annuli 15 and below a plurality of other annuli 15, whereby to locate the "air damper" at a level intermediate bottom and top of the retort.

Referring again more particularly to FIGS. 6 and 8, it is noted control of the flow of air or other fluid through the delivery pipe 23 is regulated by a valve 7 in said pipe. At this point only one delivery pipe may be used, instead of the two shown, without departure from the inventive concept. By the use of a valve or valves 7, the degree of damping affect in the retort "R" may be infinitely varied. The introduction of the upwardly converging fluid in the fashion shown will, in some instances, produce in the retort an after burning effect which is highly desirable; such function being in addition to the "air damper" affect.

Annulus 16 may assume any position and/or take the place of the solid cast refractory annuli 15.

The invention is not limited to the use of high pressure blower air as the aforesaid counter current fluid, but rather is intended to embrace other fluids (e.g., CO₂, N₂) and even liquids.

In the drawings, the arrows indicate the general flow pattern of the counter current fluid into the retort or conduit in which a current of a "first fluid" is to be "damped."

With reference to the importance of the radial outward direction of the "air damper" stream or "air cone," the following is to be noted.

When a downwardly converging cone is used, tests have demonstrated that the products of combustion are caused to flow in the generally radial outward direction shown by the arrows in FIG. 9. It is undesirable to have the products of combustion issue in the radial direction shown by the arrows, for several reasons, viz:

a. The action of these gases on the refractory FIG. 5 tends to cause a buildup of particulate matter on the refractory wall by the process of particle impaction as in FIG. 10.

b. The gases issuing in the direction shown, by reason of their very high temperature, tend to cause hot spots in the areas just below the air damper.

As can be readily seen from FIG. 11, the upwardly converging cone causes the flow streamlines to follow a course away from the refractory wall and thus eliminating the problems associated with a radially downwardly directed air damper such, for example, as is described in U.S. Pat. No. 3,215,501 to Philip.

Another object of the present invention is the use of a cooling medium for the refractory wall and the shell of the retort. One feature of the aforementioned Brophy patent is the construction of the retort walls composed of an outer steel shell, and an intermediate annulus of heat insulating material.

This retort wall construction is marked by several disadvantages:

1. Burnout of insulation at high operating temperatures.
2. Blistering of finish on exterior facade.
3. Excessive heat loss through the retort wall.
4. Rapid high heat oxidation of the steel shell itself.

In FIG. 12 it will be seen that the blower delivery pipe of FIG. 6 has been replaced by the intermediate annulus between the refractory modules and outer steel shell. Passage of air from the blower to the air damper through this annulus results in a direct cooling of both the refractory and outer shell. Thus an object of the present invention is the elimination of the heat insulating material. This particular use of the air damper thus accomplishes far superior results than the heat insulating material used in the patent previously referred to.

Another object of the present invention is the use of the heat recovery aspects of the air damper: FIG. 13.

In applications where the recovery of heat via a waste heat boiler is feasible, it can readily be seen that considerable heat is recovered which would otherwise be lost to the atmosphere by means of radiation through the retort walls.

Another object of the present invention is the inherent reduction in exhaust temperature from the high temperature of the retort interior. Reductions in operating temperature from 2,500° to 300° F. can be achieved using the air cone damper. Reductions in temperature permit the use of suitable collection devices for the recovery of valuable by-products. Heretofore recovery of by-products was not attempted due to the high exhaust temperatures.

The following is an example of how the disposal of a troublesome industrial waste resulted in an actual profit by using the principles of the present invention in connection with a fabric filter collection device.

SPECIFIC EXAMPLE, FIG. 14

The problem consisted in disposing of waste automotive paints and thinners. The materials to be disposed of consisted of a variety of enamel and lacquer automotive finishes which become unusable through model changeover, off-color or some other form of contamination. Nominally the accumulated fluid material consists of 22 percent non-volatile solids of which 30 percent is non-combustible, inorganic pigment such as iron oxide and/or rutile titanium dioxide, and approximately 78 percent combustible, organic solvents.

Formerly these wastes were burned in open pits or various other incinerator devices. This mode of disposal was certainly not acceptable from an air pollution standpoint since it released several tons per day of inorganic particulate into the

atmosphere in the form of a visible smoke plume. From a conservation standpoint it meant the loss of a valuable mineral resource; namely titanium dioxide.

Because this method of disposal was undesirable, an incinerator embodying the principles of this present invention was installed at the plant of a local automotive waste disposal service.

Sized to dispose of 140 gallons per hour of the waste paint, the equipment included two "surge" tanks of 2,000 gallons each, equipped with agitator means to keep the paint in suspension. Starting up the incinerator, the latter was heated to an internal temperature of approximately 2,000° F. Thereupon, the waste paint was fed into the atomization chamber where it was atomized with primary air into the lower part of the vertical retort. Being highly exothermic in nature, the waste flow was adjusted so as to approach the design capacity of the incinerator without the need for any auxiliary fuel.

After passage through the main body of the combustion retort all combustibles are entirely consumed leaving only unburnable, inorganic pigment in the exhaust stream. After contact by the herein-described air damper the exhaust gas temperature is reduced to approximately 250° F. by the addition of high-pressure, ambient air. The temperature of the effluent now enables it as an acceptable feed for a standard, fabric filter duct collector. Capable of collecting extremely small particles, the bags retain the microscopic pigment particles while allowing the cleaned effluent to be vented to the atmosphere without smoke, odor or visible plume. The pigment particles are periodically shaken from the collection surface and fall into a hopper from whence they are screw-conveyed into a storage bin for sale to pigment manufacturers as raw materials for subsequent paint formulations.

I claim:

1. In an apparatus wherein a current of a first fluid is caused to move in one direction through a conduit, the improvement which consists in the provision of an air damper means delivering under pressure into said conduit a current of a second fluid directed in a flow direction obliquely upward to the flow direction of said first fluid whereby to impede the rate of flow of such first fluid and hence to prolong the dwell time of such first fluid in said conduit.

2. The improved apparatus defined in claim 1, in which said means consists essentially of an annular chamber having a peripheral orifice extending towards the interior of said conduit, and means for delivering a current of such second fluid under pressure into said annular chamber, said orifice providing discharge of such second fluid, under pressure, upwardly with respect to said conduit and in a direction obliquely upward to that of said first fluid.

3. The improved apparatus defined in claim 1, in which said means comprises at least one second fluid delivery conduit extending beside, and above the discharge end of, said conduit and so bent as to deliver a stream of such second fluid in a flow direction obliquely upward to that of such first fluid.

4. Apparatus defined in claim 1, in which a plurality of spaced air conduits leading from an air manifold disposed about and beneath the discharge end of said conduit extend in the defined manner to deliver a plurality of such streams of air.

5. The improved apparatus defined in claim 2, in which said annular chamber is a plenum chamber within a hollow annulus of refractory material which hollow annulus constitutes a part of said conduit, said hollow annulus being provided with means for the tangential entry of a current of such second fluid and with an annular discharge slit extending upwardly and inwardly from said plenum chamber to the interior of said conduit.

6. The improved apparatus defined in claim 5, in which said hollow annulus constitutes the topmost portion of said conduit.

7. The improved apparatus defined in claim 5, in which said hollow annulus is integrated into said conduit as an intermediate portion of the same.

8. In an apparatus for pyro-decomposing fluid waste material comprising,

a vertical, tubular retort having an interior wall of refractory material;

burner means at the base of said retort;

means for providing primary air to said burner means;

means for feeding fluid waste material to said burner means;

means for dispersing fluid waste material in a current of air; and

means at the upper end of said retort for hindering unimpeded exit from said retort of hot gaseous and gas-borne combustion products collectively constituting a first fluid, the improvement which consists in an air damper means delivering a current of a second fluid at the top of the retort which current of second fluid is mingled with such first fluid in a flow direction obliquely upward to the flow direction of such first fluid whereby to hinder the exiting of such first fluid and hence to prolong its period of dwell within the retort.

9. Apparatus defined in claim 8, in which said air damper means consists essentially of an annular chamber having a peripheral orifice extending in the direction of the top opening of the retort, and means for delivering a current of air under pressure into the interior of said annular chamber, said orifice providing discharge of air under pressure inwardly radially with respect to the top opening of the retort.

10. Apparatus defined in claim 8, in which said air damper means comprises at least one air conduit extending beside, and above the top opening of, the retort and so bent as to

deliver a stream of air in a generally upwardly direction into said top opening and counter to said combustion products.

11. Apparatus defined in claim 10, in which a plurality of spaced air conduits leading from an air manifold disposed about and beneath the top opening of said retort extend in the defined manner to deliver a plurality of such streams of air.

12. Apparatus defined in claim 8, in which said air damper means consists essentially of a hollow annulus of refractory material, having substantially the same external and internal diameters as those of said retort, said hollow annulus having therein an annular plenum chamber and being provided with (a) means for tangential delivery of a current of such second fluid into said plenum chamber and (b) an annular discharge slit extending upwardly and inwardly from said plenum chamber into said retort.

13. Apparatus defined in claim 12, in which said hollow annulus constitutes the topmost portion of the retort.

14. Apparatus defined in claim 12, in which said hollow annulus constitutes an intermediate section of the wall of said retort.

15. Apparatus defined in claim 1 in which said air damper delivery conduit is defined as an intermediate annulus between the refractory wall and the outer shell of the retort, whereby said wall and said shell are cooled.

16. Apparatus defined in claim 1, in which the air damper acts as a means of reducing effluent temperature, and in which effluent gases are directed into and through dust collection apparatus.

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