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**2,677,601**

EXHAUST GAS CONDITIONER

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2 Sheets-Sheet 1

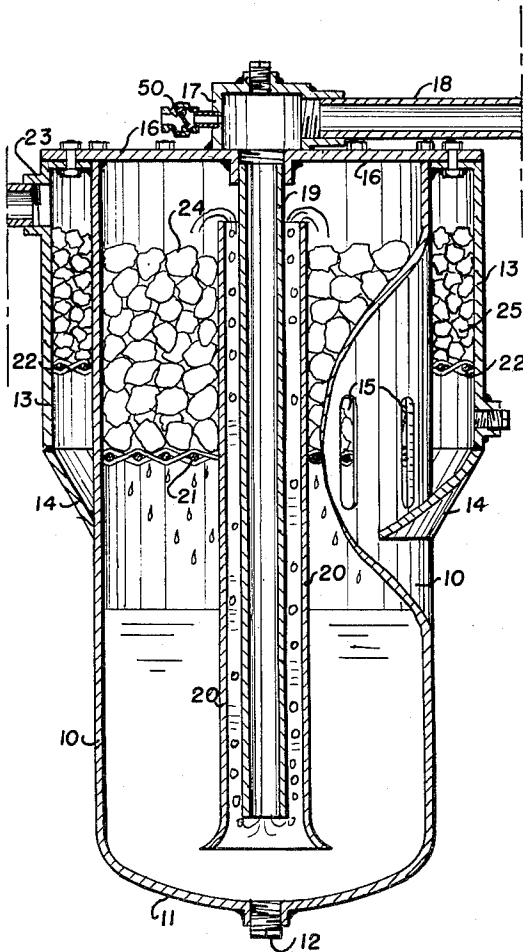


**Fig. 1**

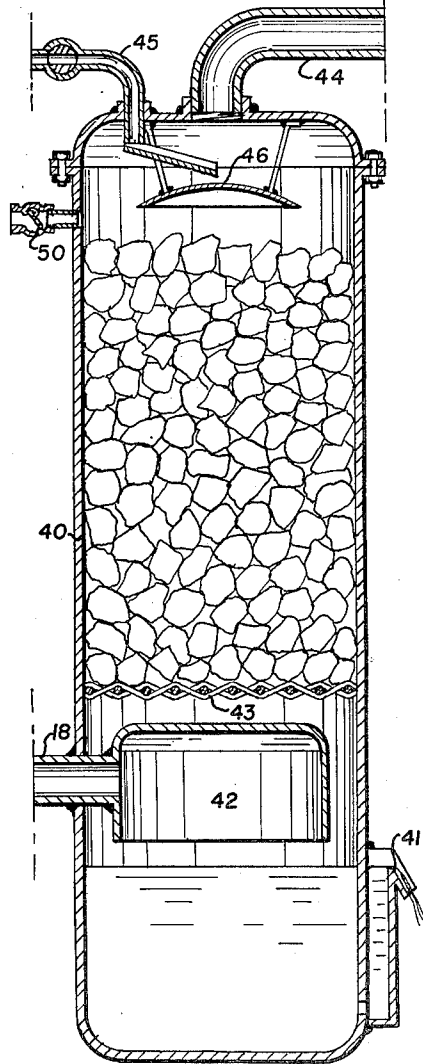


**Fig. 5**

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2 Sheets-Sheet 2

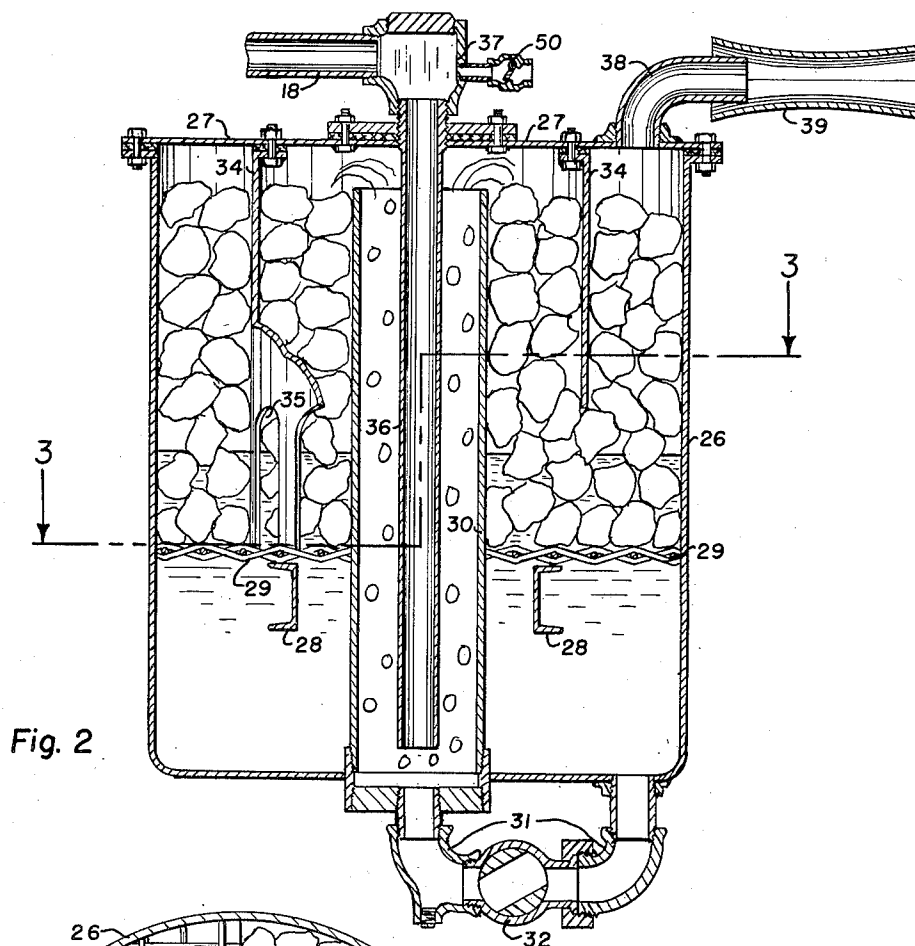


Fig. 2

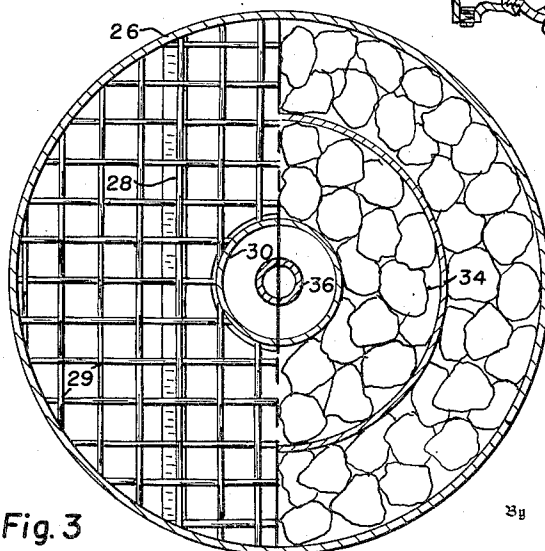


Fig. 3

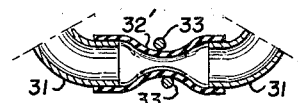


Fig. 4

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## UNITED STATES PATENT OFFICE

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## EXHAUST GAS CONDITIONER

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9 Claims. (Cl. 23-284)

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This invention relates to apparatus units for the treatment of exhaust gases incident to the operation of "diesel," and other, internal combustion engines, whereby to condition the said gases for discharge within underground workings and enclosed spaces free from the usual hazards of fire and noxious effect, and has as an object to provide an improved exhaust gas conditioner susceptible of convenient and efficient operative association with various types and constructions of conventional internal combustion engines.

A further object of the invention is to provide a novel construction and interassociation of elements constituting an exhaust gas conditioner for internal combustion engines.

A further object of the invention is to provide a simple and novel arrangement for passing internal combustion engine gases through a neutralizing medium and for continuously wetting said medium, all through the agency of the normal exhaust gas velocities and without the development of adverse back pressures.

With the foregoing and other objects in view, my invention consists in the construction, arrangement, and operative combination of elements as hereinafter set forth, pointed out in my claims, and illustrated by the accompanying drawings, in which—

Figure 1 is a vertical sectional view taken substantially axially through an exhaust gas conditioner unit typically embodying the principles of the invention. Figure 2 is a vertical section taken axially through a somewhat modified unit construction. Figure 3 is a cross section taken substantially on the indicated line 3-3 of Figure 2. Figure 4 is a fragmentary, detail section illustrative of circulation regulating means employable in substitution for the means shown in Figure 2. Figure 5 is a vertical section through a simplified conditioner unit construction adapted for fixed, as distinguished from mobile, installation.

Desired conditioning of internal combustion engine exhaust gases includes cooling of the gas, entrapment of solids particles entrained by the gas, and conversion of the noxious gas constituents into innocuous form. It has been established that diffusion of the exhaust gas from internal combustion engines through a bed of wetted, broken lime rock, or an equivalent medium, is effective to accomplish the desired resolution, or neutralization, of the noxious gas constituents, hence the instant invention is directed to the provision of a simple, compact, condi-

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tioner unit adapted for either fixed or mobile installation in association with an internal combustion engine and automatically operable to cool, cleanse, and diffusively neutralize gases passed therethrough under the influence of their normal discharge velocities.

In the typical organization according to Figure 1, a cylindrical shell 10, formed of any suitable material in any appropriate size and dimension proportion, is arranged to be mounted with its axis vertical and is closed at its lower end, as by means of an interiorly-concaved member 11 furnished with a central drain aperture normally stopped by a removable and replaceable plug 12. A sleeve 13 spacedly and concentrically surrounds the upper portion of the shell 10 and merges at its lower end into a conical skirt 14 which converges downwardly to sealed engagement with the shell 10 exterior wall, and apertures, such as vertically-elongated slots 15, are spaced successively about and to intersect the shell 10 wall just above the junction of said wall with the skirt 14 to establish free communication between the shell 10 interior and the annular chamber between said shell and the sleeve 13. The upper ends of the shell 10 and sleeve 13 are coplanar and seal against the under surface of a cover plate 16 removably engaged therewith.

The cover plate 16 is centrally apertured beneath a fitting 17 which operatively receives, and is served by, the discharge end of the exhaust gas line 18 conventionally leading from the associated internal combustion engine, and a tube 19, preferably no smaller than the line 18, registers with the plate 16 central aperture and extends thence axially and interiorly of the shell 10 to terminate in an open end near, but spacedly above, the shell lower end closure 11, thus to provide for delivery of gas incoming through the line 18 within and adjacent the lower end of the shell. An elongated, open-ended conduit 20 spacedly and concentrically surrounds the major length of the tube 19 to define an annular channel thereabout, the lower, preferably-flared end of said conduit depending slightly beyond the tube 19 lower end and the conduit upper end opening about said tube in well-spaced relation with and below the cover plate 16, and a centrally-apertured mesh or foraminous web 21 is perpendicularly traversed by and secured to said conduit 20 transversely of the shell 10 and in marginal attachment to the latter such as will dispose said web to divide the shell 10 length at about the plane of the sleeve 13 lower end, thus positioning said web to bridge the slots 15 at

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their approximate mid-lengths. Above the slots 15, an annular mesh or foraminous web 22 is engaged between and secured to the shell 10 and sleeve 13 to divide the compartment therebetween on a plane parallel to and above that of the web 21, and an outflow line or nipple 23 is carried by and opens through an upper end portion of the sleeve 13.

The lower portion of the shell 10 is designed to be charged with water in a depth less than will rise to the slots 15, the web 21 supports a charge 24 of broken lime rock, or analogous diffusing and neutralizing material, in a depth extending well above the slots 15 and preferably reaching almost to the upper end of the conduit 20, and the web 22 supports a charge 25 of lime rock, or analogous material, in a depth less than would serve to obstruct the nipple or line 23, so that gas incoming to the unit through the line 13 and fitting 17 is impelled downwardly through the tube 19, expelling any water therefrom, and escapes from the lower end of said tube to rise through the annular channel defined by the conduit 20 about said tube with pumping effect, due to the tube and conduit proportions, operable to lift water from the shell charge through the conduit and to spray discharge from the conduit upper end with wetting effect upon the lime rock charge 24; the bubbling of the hot incoming gas through and with pumping effect upon the water column within the conduit 20 acting to cool the gas, to release solids entrained by the gas to fall to entrapment in the shell lower end, and to commingle the gas with water vapor developed through heating and agitation of the pumped column. As will be manifest, the lime rock charge 24 is kept thoroughly wetted by the pumping action of the incoming gas, the excess water present in the charge draining through the web 21 to return to the main water body in the shell 10 lower portion, and the gas outflowing from the conduit 20 upper end expands above said charge 24, with further cooling effect and release of solids, and is constrained to penetrate and diffuse through the said charge 24 for escape from the shell 10 through the slots 15; such diffusion of the gas through the wetted lime rock charge operating to chemically alter and modify the noxious constituents of the gas to innocuous form and to further cleanse and filter the gas, the sludge and condensates incident to the diffusion stage draining through the web 21 to maintain the charge 24 in an active state. The cleansed and neutralized vapors outflowing from the shell 10 through the slots 15 are received within the sleeve 13 below the charge 25 therewithin and must uprise through the web 22 and said charge 25, with further filtering and diffusing effect, before they may escape to atmosphere through the line or nipple 23, thus thoroughly cooling, filtering, and conditioning the ultimately discharged gases and eliminating the hazards normally inherent in the exhaust gases of internal combustion engines.

Essentially equivalent in function and operation to the unit hereinabove described, the modified construction according to Figures 2, 3 and 4 permits of certain refinements and a control not available in the simpler form of the unit. In the modified construction a drum 25 is formed with a centrally-apertured, closed lower end and is closed at its upper end by a removable, centrally-apertured cover plate 27. Beams 28 fixedly and chordally bridging the drum 25 lower portion support a mesh or foraminous web 29 transversely of the

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drum and a conduit 30 fixedly registered with the central aperture of the drum lower end closure upstands axially within the drum to termination of its open upper end in spaced relation with and beneath the cover plate 27. The lower portion of the drum 26 is charged with water and the conduit 30 interior is sealed away from such water charge save for a by-pass 31, equipped with an adjustable valve 32, which connects between the conduit lower end and a nipple serving the drum at one side of the conduit, whereby to provide for delivery of water from the drum charge and to the conduit in an amount and at a rate susceptible of regulation. As shown in Figure 4, the flow control means of the by-pass 31 may take the form of a compressible section 32' in the by-pass and a clip or fork 33 engageable with and to restrict the passage through said section.

A tubular skirt 34 fixedly depends from the cover plate 27 and to the plane of the web 29 in a diameter less than that of the drum 26 and greater than that of the conduit 30, whereby to divide the drum interior above said web into two annular, concentric compartments, each of which is charged with broken lime rock, or analogous material, to approximately the plane of the conduit upper end, and vertically-elongated apertures, or notches, 35 interrupt the skirt 34 lower portion to provide communication between said two annular compartments above the web 29. An input tube 36 registers with and extends through the central aperture of the cover plate 27 and depends axially of the assembly within the conduit 30 to terminate in an open end spacedly adjacent the bypass 31 delivery to said conduit, and the exhaust gas line 18 of the associated engine serves said tube 36 through a fitting 37 carried by the tube upper end above the cover plate 27, so that the exhaust gases delivered through the line 18 escape from the tube 36 in the lower end of the conduit 30 and rise within the latter with pumping effect on the water supplied through the by-pass 31 to traverse the wetted lime rock charge of the inner of the two annular compartments, diffuse downwardly there-through and outwardly thence through the apertures 35, uprise through the lime rock charge of the outer of said two annular compartments, and escape to atmosphere through a nipple 38 serving said outer annular compartment through the cover plate 27, all with the same gas conditioning effect heretofore explained. As is shown in Figure 2, the nipple 38 may deliver within and axially of a Venturi tube 39 arranged to induct atmospheric air and commingle the same with and to dilution of the discharged gas.

Internal combustion engines occasionally operate, particularly in mobile installations, to induce a reduced pressure, or suction effect, in their exhaust lines in place of the somewhat elevated pressure normally characteristic of such lines. As operatively associated with gas conditioning apparatus of the type shown in Figures 1 and 2, the exhaust gas line outlet is normally submerged in water, especially when no outflow pressure is present, and any reduced pressure obtaining in the line would induce inflow of water therethrough and to the engine, with damaging effect, hence it is expedient to provide a check valve 50, of any appropriate type and construction, to serve the exhaust flow system between the engine and exhaust line outlet, conveniently at the fittings 17 and 37 of the illustrated organizations, in an arrangement effective to open communication from atmosphere and to the ex-

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haust flow system interior in reaction to a reduced pressure condition within the system, thereby obviating the possibility of water induction from the conditioning unit to and through said system.

In the modification according to Figure 5 a vertically-deep tank 40 is designed to house a water charge in its lower end and is furnished with an exterior overflow lip 41 served through a submerged orifice for the maintenance of a constant water charge level within the tank. The exhaust gas line serves the tank 40 through a tank wall slightly above the tank water level and delivers to a bell 42 opening towards the surface of the tank water charge, thus to direct the incoming gas against and across the said water surface for cooling and release of solids. A mesh or foraminous web 43 traverses the tank 40 interior above the bell 42 and supports a charge of lime rock, or analogous material, of considerable depth through which the gas must diffuse as it uprises from the bell and to exhaust through a line or nipple 44 centrally intersecting the tank upper end closure, said lime rock charge being wetted for its desired functioning by means of water inflow, from any suitable source or supply, through a valved line 45 discharging through the tank upper end closure, conveniently to and across a deflector 46 operable to spread and distribute the inflow, and to the upper surface of the lime rock charge within the tank. Manifestly, in a fixed installation where a continuous supply flow of water is available there is no occasion for repetitious use of the water charge to accomplish the functions of the conditioning cycle, and hence no necessity exists for circulating and recirculating the water charge over and through the lime rock charge in the manner and by the means characterizing the constructions previously described.

Internal combustion exhaust gases are consistently characterized by the presence of aldehydes which oxidize to yield acids and are hence lachrymogenic and irritant, and an accordingly important function of the lime rock charges of the improved conditioning apparatus is to establish and maintain a condition of hydrogen ion concentration in the water and vapors through which the gas outflow is entrained such as will effect absorption and modification of the aldehydes to nullification of their customary irritant properties. It is naturally manifest that circulation of the water charge over and through the lime rock acts to elevate the pH value of the solution, and it has been established that a pH value of 4.0 is the lowest with which the solution may effectively modify the aldehydes to suitably condition the gases for discharge, hence the quantity and condition of the lime rock charges subject to wetting within the conditioning apparatus is a significant feature of the invention and is to be so adjusted and controlled as to maintain a solution pH value not less than 4.0 when the apparatus is operating.

Since changes, variations, and modifications in the form, construction, and arrangement of the elements shown and described may be had without departing from the spirit of my invention, I wish to be understood as being limited solely by the scope of the appended claims, rather than by any details of the illustrative showing and foregoing description.

I claim as my invention—

1. An exhaust gas conditioner comprising a housing, a foraminous baffle transversely and

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horizontally within said housing adapted to support a charge of broken lime rock within the housing upper portion, a water charge in the housing lower portion, an outlet to atmosphere from the upper end of the housing, a conduit centrally and perpendicularly through said baffle with its lower end well below said baffle and its upper end opening spacedly adjacent the housing upper end, an exhaust gas inlet sealed through said housing in a disposition axially of and spacedly within said conduit to termination in an open delivery end adjacent the lower end of the latter, whereby gas inflow operates to elevate water through said conduit about the inlet for ejection thence against the housing upper end, and a skirt spacedly about the conduit upper end depending from closed engagement with the housing upper end to flow-accommodating proximity with said baffle, whereby to direct flow of the exhaust gas downwardly through the zone confined by said skirt and thence outwardly and upwardly in its transit from the conduit upper end to and for escape through said outlet.

2. The organization according to claim 1, wherein said exhaust gas inlet is equipped with a check valve adapted to open the inlet to atmospheric air in reaction to pressures less than atmospheric obtaining therewithin, whereby to inhibit induction of water from the housing and through said inlet.

3. The organization according to claim 1, wherein the conduit lower end is spaced from and above the housing lower end to open inwardly adjacent thereto and the exhaust gas inlet delivers in upwardly-spaced relation with said conduit lower end.

4. The organization according to claim 1, wherein the conduit lower end closes against the housing lower end out of direct communication with the housing lower portion interior, a by-pass operatively connects the conduit lower end with the housing lower portion interior through the housing lower end, and a valve is included in said by-pass for regulation of flow therethrough.

5. The organization according to claim 1, wherein the housing walls are vertically slotted across the plane of the foraminous baffle, a sleeve spacedly surrounds the housing upper portion in closing engagement at its lower end with the housing walls below the slotted wall area and at its upper end with the housing top closure, an annular foraminous baffle adapted to support a lime rock charge bridges the space between said sleeve and the adjacent housing walls, and the outlet to atmosphere opens from the space enclosed by said sleeve.

6. The organization according to claim 1, wherein the housing exterior walls are smoothly continuous and imperforate, the skirt depends to the plane of the foraminous baffle and divides the lime rock charge supported by said baffle into inner and outer, concentric zones, the lower end of the skirt is upwardly notched to accommodate gas flow from the inner and to the outer of the zones thereby defined, and the outlet to atmosphere opens from the outer of said zones.

7. In an exhaust gas conditioner having a closed housing, an outlet to atmosphere at one side of the housing upper end, and an exhaust gas inlet to said housing, means for cooling, washing, and purifying exhaust gas input in reaction to its inflow to and circulation within said housing, said means comprising a foraminous baffle horizontally and transversely dividing said housing into an upper portion adapted to house a charge of

broken lime rock and a lower portion adapted to contain water, a conduit vertically through said baffle with its open upper end spacedly adjacent the housing upper end, an extension of said gas inlet spacedly within and axially of said conduit to disposition of its delivery end upwardly adjacent the conduit lower end, whereby to direct the gas inflow for uprise through said conduit with pumping effect on water therein, a skirt fixedly depending from the housing upper end spacedly about the upper end of said conduit above said baffle and between said conduit and outlet to atmosphere, and flow openings through the skirt lower margin.

8. In an exhaust gas conditioner having a closed housing, an outlet to atmosphere at one side of the housing upper end, and an exhaust gas inlet to said housing, means for cooling, washing, and purifying exhaust gas input in reaction to its inflow to and circulation within said housing, said means comprising a foraminous baffle horizontally and transversely dividing said housing into an upper portion adapted to house a charge of broken lime rock and a lower portion adapted to contain water, a conduit vertically through said baffle with its open upper end spacedly adjacent the housing upper end and its open lower end spacedly adjacent the housing lower end, whereby to establish flow communication between the housing lower portion and the lower interior of the conduit, an extension of said gas inlet depending spacedly within and axially of said conduit to disposition of its delivery end upwardly adjacent the conduit lower end, whereby to direct the gas inflow for uprise through said conduit exteriorly about said extension with pumping effect on a proportioned volume of water within and determined by the spacing between said conduit and extension, and a skirt fixedly depending from the housing upper end spacedly about the upper end of said conduit between said conduit and the outlet to atmosphere for deflection of gas flow toward said baffle and outwardly beneath said skirt prior to escape through said outlet.

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9. In an exhaust gas conditioner having a closed housing, an outlet to atmosphere at one side of the housing upper end, and an exhaust gas inlet to said housing, means for cooling, washing and purifying exhaust gas input in reaction to its inflow to and circulation within said housing, said means comprising a foraminous baffle horizontally and transversely dividing said housing into an upper portion adapted to house a charge of broken lime rock and a lower portion adapted to contain water, a conduit vertically through said baffle with its open upper end spacedly adjacent the housing upper end and its lower end closing against the housing lower end, a by-pass operatively connecting as a flow passage between the conduit lower end and the housing lower portion interior, valve means in and adjustable to meter flow through said by-pass, an extension of said gas inlet depending spacedly within and axially of said conduit to disposition of its delivery end spacedly adjacent the conduit lower end, whereby to direct the gas inflow for uprise through said conduit exteriorly about said extension with pumping effect on water within said conduit, and a skirt fixedly depending from the housing upper end spacedly about the upper end of said conduit between said conduit and the outlet to atmosphere for deflection of gas flow toward said baffle and outwardly beneath said skirt prior to escape through said outlet.

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