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2,849,294

EXHAUST GAS CONDITIONER

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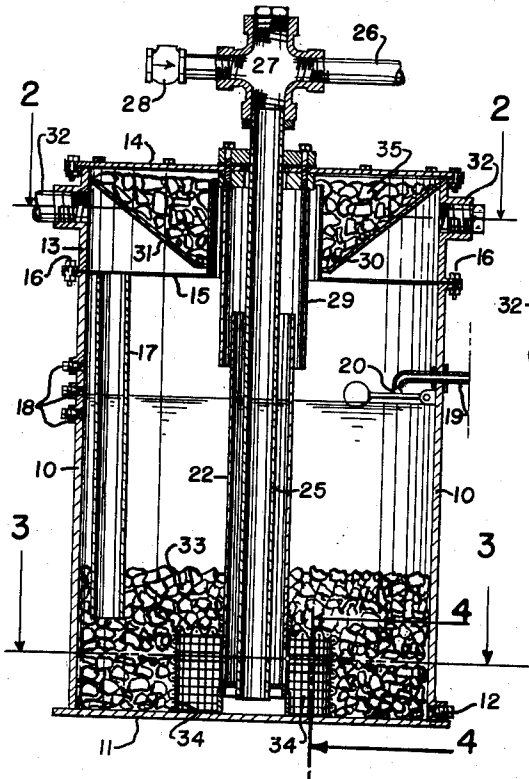


Fig. 1

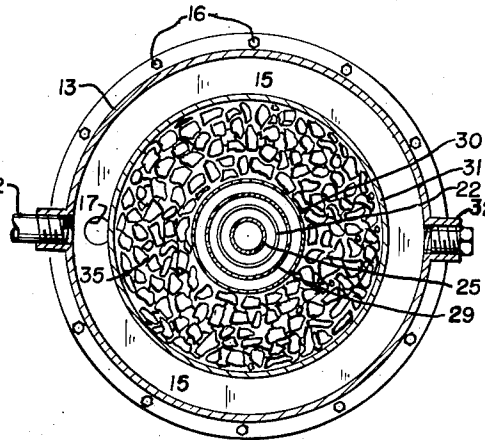


Fig. 2

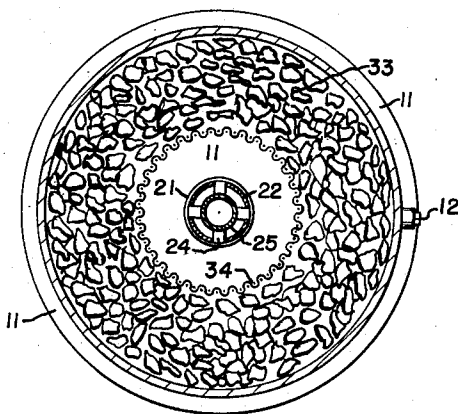


Fig. 3

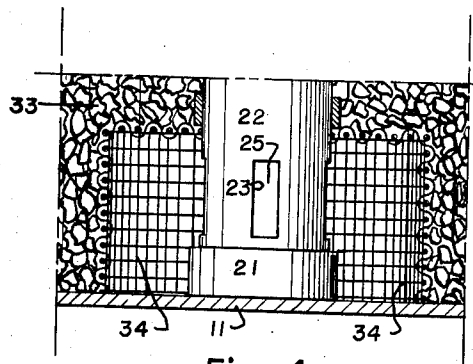


Fig. 4

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EXHAUST GAS CONDITIONER

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8 Claims. (Cl. 23—284)

As a development from and an improvement over the techniques pertinent to and apparatus appropriate for the conditioning of internal combustion engine exhaust gases as taught in my Patents No. 2,611,680, dated September 23, 1952, and No. 2,678,261, dated May 11, 1954, and in my pending applications for Patent Serial No. 396,049, filed December 3, 1953, Serial No. 462,891, filed October 18, 1954, Serial No. 465,790, filed November 1, 1954, and Serial No. 488,099, filed February 14, 1955, the instant invention relates to means for the treatment of internal combustion engine exhaust gases, and more especially the exhaust gases from diesel-type engines, for suppression and elimination of the irritant and noxious properties thereof, and has an object to provide novel and improved apparatus employable for the conditioning of such exhaust gases with facility, advantage, and improved ameliorative result.

A further object of the invention is to provide a novel and improved exhaust gas conditioner operable to effect successive multiple expansions of gases passed there-through under the influence of the normal gas output pressure.

A further object of the invention is to provide a novel and improved exhaust gas conditioner effective to repetitiously expose gases passed therethrough under the influence of their normal output pressure to intimate contact and admixture with ameliorating agencies.

A further object of the invention is to provide a novel and improved exhaust gas conditioner adapted for operative association with a source or supply of water in a manner effective to maintain the unit in efficient operating throughout extended periods of use.

A further object of the invention is to provide a novel and improved construction and correlation of elements constituting an exhaust gas conditioner.

A further object of the invention is to provide a novel and improved exhaust gas conditioner that is simple and relatively inexpensive of production in sizes appropriate for operative association with particular engines, that is convenient of installation in desired use association with either fixed or mobile engines, that is facile of servicing, maintenance, and rehabilitation, that is durable and long-lived in practical use, and that is efficient in attainment of the ends for which designed.

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 drawing, in which—

Figure 1 is a vertical section taken axially through a typical exhaust gas conditioner exemplifying the principles of the invention.

Figure 2 is a cross section through the organization according to Figure 1 taken substantially on the indicated line 2—2 of said latter view.

Figure 3 is a cross section through and substantially on the indicated line 3—3 of Figure 1.

Figure 4 is a fragmentary, detail section, on a rela-

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tively enlarged scale, taken substantially on the indicated line 4—4 of Figure 1.

As is disclosed in my earlier Patent No. 2,611,680, a method satisfactorily effective for the suppression and elimination of inimical and undesirable properties characteristic of internal combustion engine exhaust gases is distinguished by circulation of the gases under the sole influence of their output pressures through a body of water and subsequently through an intersticed diffusing bed or medium capable, as repetitiously washed and wetted by the gas-water mixture, of neutralizing the acidity of the wetted gases, collecting the drip and condensate from the diffusing bed or medium in and for reuse with the water body, and venting the scrubbed and modified gases to atmosphere. Using broken limerock, or the equivalent, as a diffusing medium, the method taught by the patent above noted operates to cool, cleanse, and modify exhaust gas fumes, and particularly those from diesel-type engines, to a degree qualifying the treated gases for delivery within underground workings and other confined spaces where humans are active without adverse effect upon, or hazard to, those present. However, it has been determined that the ameliorating effectiveness of the exhaust gas treatment accomplished as above set forth is directly related to the intimacy and pervasiveness of the gas-water contact established, to the hydrogen ion concentration of the water first encountered by the incoming gases, and to the removal of entrained water from the treated gases prior to their release to atmosphere. Practical application of the realizations just mentioned has resulted in the refinements of the original method disclosed in my pending application Serial No. 488,099. Such refinements include exposure of the water body to, and circulation thereof through, an intersticed diffusing bed or medium effective to neutralize any acidity in the water first contacted by the incoming gases, thus to enhance the intimacy and completeness of the resulting gas-water mixture, and successive expansions of the gas-water mixture, both prior and subsequent to entrainment of the vapors through an intersticed diffusing bed or medium remote from the water body, whereby to further enhance the intimacy and completeness of the gas-water contact, to facilitate condensation of entrained water and removal thereof from the gas stream, and to repetitiously retard the velocity of the gas stream with consequent improved separation of entrained solids, such as carbon particles and the like, therefrom, all in reaction to and as an incident of circulation of the gases under the influence of their output pressures alone.

The water charge utilized in practice of the conditioning method being subject to depletion and the presence of an adequate body of water being significant to the effectiveness of the method, a factor of consequence is maintenance of the water body in appropriate quantity during prolonged use of the method for the treatment of exhaust gases from the engines of mobile units, such as buses, trucks, locomotives, and the like, operating away from convenient access to recharging facilities.

Facilitating practice of the method disclosed in my patent and pending application above noted, the instant invention is directed to the provision of a novel and improved conditioner unit characterized by unique structure and structural relationships particularly adapting it for efficient use through extended time periods in operative association with mobile engine installations.

In the construction of the improved conditioner unit as shown, a separable housing is represented as comprised from a relatively-deep, cylindrical lower member 10 formed with an open upper end and a closed bottom 11 adjacent which a normally-plugged drain aperture 12 is provided, and a tubular member 13, axially shorter than

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the member 10, whereof the lower end is open and registrable with the upper end of the member 10 and the upper end is furnished with a closure plate 14 detachably secured thereto. The coacting ends of the members 10 and 13 are preferably flanged to engage with a partition plate 15 clampable therebetween in transversely-obstructing relation with the interior of the housing, as by means of bolts 16 through the housing member flanges, and said plate 15 is imperforate save for a central aperture, hereinafter more particularly described, and a drain opening at one side of said plate delivering to a tube 17 depending from fixed relation with said plate to an open lower end spacedly above the bottom closure 11. The housing member 10 is adapted to confine a charge of water well above the lower end of the tube 17 and to a level conveniently determinable by normally-plugged, vertically-spaced drain ports 18. A line 19 leading from a source or supply of water, such as a pressurized or gravity feed tank susceptible of translation with the engine to be served by the conditioner, is sealed through a wall of the member 10 above the water charge level therein for delivery of water interiorly of the housing through a float-controlled valve 20 operable in a usual manner to open the line 19 for admission of water when the level within the housing is lowered and to close said line when the level of the water charge is at the desired height.

Functionally identical with and structurally analogous to the pump means reactive to exhaust gas input as shown in my pending application Serial No. 488,099, a short tubular sleeve 21 fixedly upstands centrally from the bottom 11 interiorly of the housing member 10 in telescopic engagement with the open lower end of a tubular conduit 22 thereby mounted coaxially of the member 10 in a length such as to terminate in an open end somewhat below the plane of the partition plate 15. Vertically-elongated apertures 23 open in diametric registration through the sides of the conduit 22 above and immediately adjacent the upper edge of the sleeve 21 as water inlet passages from the member 10 to the base of the conduit, and material struck from the apertures 23 is bent to project from the lower ends of the said apertures inwardly and radially of the conduit 22 as angularly-separated arms 24. Input of the exhaust gases to the base of the conduit 22 within the sleeve 21 and below the arms 24 is had through a flow line 25 connected to and as an extension of the exhaust gas line 26 of the engine to be served through an appropriate fitting 27; said line 25 being of less maximum diameter than the interior diameter of the conduit 22 and being sealed through the top closure 14 of the housing member 13 coaxially of and telescopically within the conduit 22 to terminate in an open lower end within the sleeve 21 and below the plane of the arms 24 at the lower end of conduit. Thus, water from the interior of the housing member 10 being free to enter through the apertures 23 to fill the sleeve 21 and the lower end of the conduit 22, exhaust gases incoming through the lines 25 and 26 are delivered from the lower end of the line 25 with a pumping effect on the column of water about said line interiorly of the conduit operable to develop an intimate mixture of water and gases and to discharge the same through the open upper end of the conduit about the line 25 and below the level of the partition plate 15. The gas input circuit constituted by the lines 25 and 26 and the fitting 27 is equipped exteriorly of the housing with a check valve 28 reactive to pressure obtaining within the circuit to open the latter to atmosphere when the gas flow pressure is less than atmospheric and to close the circuit away from atmosphere when the circuit flow pressure is above atmospheric, whereby to inhibit induction of water from the charge within the member 10 through said circuit under any engine operating conditions.

Fixed centrally to and closing at its upper end against

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the closure plate 14 of the housing member 13, a tubular hood 29 spacedly and coaxially surrounds the flow line 25 in an interior diameter greater than the exterior diameter of the conduit 22 and depends loosely and freely through the central aperture of the partition plate 15 in spaced, telescopic association with the upper end of said conduit to terminate in an open lower end below the upper end of the conduit and above the highest operating level of the water charge within the housing member 10, thus to provide a restricted annular passage between the lower end of the hood and the upper end of the conduit where-through discharge from the latter, initially received with expansive effect within the hood 29, is impelled to pass with momentarily-enhanced velocity to reception and a second expansion within the space at the upper end of the housing member 10 between the surface of the water charge and the partition plate 15.

Sealed at its lower end to and peripherally about the central aperture through the partition plate 15, a tubular sleeve 30 upstands in an interior diameter greater than the exterior diameter of the hood 29 coaxially with and spacedly about the latter to terminate in an open upper end adjacent and spacedly below the closure plate 14, whereby to define a restricted annular passage through which the vapors expanded within the space below the partition plate 15 may travel with enhanced velocity to expand within the space at the upper end of the housing member 13. The interior of the housing member 13 is divided by means of an imperforate, inverted, frusto-conical baffle 31 which is sealed peripherally of its major base area to the upper end of said member adjacent the closure plate 14 and inclines inwardly and downwardly of the member to disposition of its open lesser base area spacedly about the sleeve 30 a short distance above the partition plate 15. The open lesser base area of the baffle 31 cooperates with the sleeve 30 to define yet another restricted annular throat or passage through which the vapors delivered from the sleeve 30 to the upper portion of the housing member 13 are constrained to pass with enhanced velocity for a final expansion within the space between the partition plate 15 and baffle 31 prior to ultimate discharge from the housing assembly through one or more ports or lines 32. Thus provision is made for the application of the exhaust gas pressures to effect a thorough and intimate admixture of the gas with water from the charge within the housing member 10 and for successive entrainment of the resulting vapors through a series of restricted passages separating expansion phases operable to cool the vapors, to dewater the same, to stimulate release of entrained solid particles therefrom, and to enhance the intimacy of gas and water vapor contact, all prior to delivery of gases to atmosphere and all in reaction to the input pressures of the gases alone.

Supplementing the corrective action of the organization as thus far described and for the separation and elimination of noxious properties characteristic of exhaust gas fumes, provision is made for chemical modification of the gases by means of diffusing beds of appropriate materials, such as broken limerock. The wet exhaust gases have an acid nature which is transferred to the water charge of the housing with adverse effect upon the desired operation of the conditioner, unless corrected. Counteractive of acid concentration in the water charge and to maintain the latter in condition for the desired reaction with the incoming gases, the lower portion of the housing member 10 about the lower end of the conduit 22 is filled with a charge 33 of broken limerock, or the equivalent, in a depth adequate to rise above the apertures 23 of the conduit 22 and also above the lower end of the drain tube 17. The charge 33 might operate to restrict desired feed of water to and through the apertures 23 in a quantity adequate for reaction with the incoming gases, and any such possible restriction of the water feed to the lower end of the conduit is obviated by an inverted cup 34 of reticulate or foraminous ma-

terial surrounding the lower end of the conduit 22 and its supporting sleeve 21 within the charge 33 just above the bottom 11. The cup 34 acts to hold the material of the charge 33 somewhat away from the base of the conduit 22 for the provision of a chamber at all times charged with water immediately adjacent and for feed to the lower end of the conduit. With the charge 33 and cup 34 present in the arrangement shown and described, water from the charge within the housing member 10 percolates through the charge 33 where it is freed from entrained solids and neutralized as to acidity prior to collection within the cup 34 reuse as pumped upwardly through the conduit 22 in reaction to the incoming gases.

Entrained water and solids in the vapors discharged from the lower end of the hood 29 return to the water charge within the housing member 10 as said vapors expand in the space beneath the partition plate 15, thus partially conditioning the exhaust gases for ultimate discharge. The moist vapors uprising through and delivered from the annular throat at the upper end of the sleeve 30 are further neutralized as to acidity and de-watered by means of a diffusing charge 35, of broken limerock, or the like, carried by the baffle 31, about the sleeve 30 in substantially filling relation with the space between said baffle and the closure plate 14. The vapors expanded from the upper end of the sleeve 30 carry moisture sufficient to maintain the surfaces of the charge 35 constituents washed and wet for such reaction with the acid characteristic of the gases as to completely neutralize the same, and diffusion of the vapors through the charge 35 acts to scrub the gases free from entrained particles, to stimulate condensation of moisture out of the gas stream, and to complete such treatment of the gases as renders them innocuous when discharged to atmosphere. The final expansion of the gases within the space of the housing member 13 beneath the baffle 31 releases condensed water and any entrained particles for collection upon the partition plate 15, from which, in common with the drip from the lower end of the baffle 31, such released material is returned to and within the charge 33 of the housing member 10 by means of the drain tube 17.

As should be manifest, the improved conditioner is compact in structure, adaptable for expedient association with and to treat the exhaust gases from mobile engines, and is adapted for operative correlation with a reserve supply of water in a manner to insure efficient operation of the unit through long periods of time.

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 an upright housing formed with top and bottom closures, a partition transversely dividing said housing into a lower member adapted to confine a charge of water and an upper member, a water supply line serving said lower member through a float-controlled valve operable to maintain water therein at a substantially uniform level spacedly subjacent said partition, means characterized by a concentric tube assembly upstanding centrally of said lower member from the bottom closure thereof in communication through the lower end of the outer tube with the lower housing member interior adapted in reaction to the input of exhaust gases through the inner of the tubes to intermix the gases with water entering the outer tube from the charge of the lower housing member and to circulate the resulting mixture upwardly between the tubes to discharge in the zone of the housing lower member between

said partition and the water charge, a hood closed at one end against and depending from the housing top closure loosely through said partition to spaced, telescopic cooperation with the delivery end of said tube assembly above the water charge, an outlet to atmosphere from the upper housing member, and sleeve and baffle means in the housing upper member defining a succession of expansion chambers intercommunicating through restricted passages as a vapor travel path between the lower end of said hood and said outlet.

2. An exhaust gas conditioner comprising an upright housing formed with top and bottom closures, a partition transversely dividing said housing into a lower member adapted to confine a charge of water and an upper member, a water supply line serving said lower member through a float-controlled valve operable to maintain water therein at a substantially uniform level spacedly subjacent said partition, means characterized by a concentric tube assembly upstanding centrally of said lower member from the bottom closure thereof in communication through the lower end of the outer tube with the lower housing member interior adapted in reaction to the input of exhaust gases through the inner of the tubes to intermix the gases with water entering the outer tube from the charge of the lower housing member and to circulate the resulting mixture upwardly between the tubes to discharge in the zone of the housing lower member between said partition and the water charge, a hood closed at one end against and depending from the housing top closure loosely through said partition to spaced, telescopic cooperation with the delivery end of said tube assembly above the water charge, an outlet to atmosphere from the upper housing member, sleeve and baffle means in the housing upper member defining a succession of expansion chambers intercommunicating through restricted passages as a vapor travel path between the lower end of said hood and said outlet, and a diffusing bed of alkaline material baffle-supported about associated sleeve means in the path of vapor travel through one of said expansion chambers.

3. An exhaust gas conditioner comprising an upright housing formed with top and bottom closures, a partition transversely dividing said housing into a lower member adapted to confine a charge of water and an upper member, a water supply line serving said lower member through a float-controlled valve operable to maintain water therein at a substantially uniform level spacedly subjacent said partition, means characterized by a concentric tube assembly upstanding centrally of said lower member from the bottom closure thereof in communication through the lower end of the outer tube with the lower housing member interior adapted in reaction to the input of exhaust gases through the inner of the tubes to intermix the gases with water entering the outer tube from the charge of the lower housing member and to circulate the resulting mixture upwardly between the tubes to discharge in the zone of the housing lower member between said partition and the water charge, a hood closed at one end against and depending from the housing top closure loosely through said partition to spaced, telescopic cooperation with the delivery end of said tube assembly above the water charge, an outlet to atmosphere from the upper housing member, sleeve and baffle means in the housing upper member defining a succession of expansion chambers intercommunicating through restricted passages as a vapor travel path between the lower end of said hood and said outlet, a diffusing bed of alkaline material baffle-supported about associated sleeve means in the path of vapor travel through one of said expansion chambers, a separate diffusing bed of alkaline material in the lower portion of said lower housing member about said tube assembly, and means spacedly about the base of said tube assembly within said latter bed defining an unobstructed supply chamber surrounding the intake to the outer of said tubes.

4. An exhaust gas conditioner comprising an upright housing formed with top and bottom closures, a partition transversely dividing said housing into a lower member adapted to confine a charge of water and an upper member, a water supply line serving said lower member through a float-controlled valve operable to maintain water therein at a substantially uniform level spacedly subjacent said partition, means characterized by a concentric tube assembly upstanding centrally of said lower member from the bottom closure thereof in communication through the lower end of the outer tube with the lower housing member interior adapted in reaction to the input of exhaust gases through the inner of the tubes to intermix the gases with water entering the outer tube from the charge of the lower housing member and to circulate the resulting mixture upwardly between the tubes to discharge in the zone of the housing lower member between said partition and the water charge, a hood closed at one end against and depending from the housing top closure loosely through said partition to spaced, telescopic cooperation with the delivery end of said tube assembly above the water charge, an outlet to atmosphere from the upper housing member, sleeve and baffle means in the housing upper member defining a succession of expansion chambers intercommunicating through restricted passages as a vapor travel path between the lower end of said hood and said outlet, a diffusing bed of alkaline material baffle-supported about associated sleeve means in the path of vapor travel through one of said expansion chambers, a separate diffusing bed of alkaline material in the lower portion of the lower housing member closing about said tube assembly, and an inverted cup of water-pervious material spacedly about the base of said tube assembly within said latter bed defining an unobstructed supply chamber about the intake to the outer of said tubes.

5. An exhaust gas conditioner comprising an upright housing formed with top and bottom closures, a partition transversely dividing said housing into a lower member adapted to confine a charge of water and an upper member, a water supply line serving said lower member through a float-controlled valve operable to maintain water therein at a substantially uniform level spacedly subjacent said partition, means characterized by a concentric tube assembly upstanding centrally of said lower member from the bottom closure thereof in communication through the lower end of the outer tube with the lower housing member interior adapted in reaction to the input of exhaust gases through the inner of the tubes to intermix the gases with water entering the outer tube from the charge of the lower housing member and to circulate the resulting mixture upwardly between the tubes to discharge in the zone of the housing lower member between said partition and the water charge, a hood closed at one end against and depending from the housing top closure loosely through said partition to spaced, telescopic cooperation with the delivery end of said tube assembly above the water charge, an outlet to atmosphere from the upper housing member, a sleeve fixedly upstanding from said partition spacedly and concentrically about said hood to establish a restricted flow passage between the upper and lower members of said housing, and a baffle adapted to support a diffusing bed of alkaline material dividing the upper housing member into upper and lower compartments communicating through a restricted passage exterior of said sleeve, whereby to dispose said bed in the path of vapor travel through said expansion chambers.

6. An exhaust gas conditioner comprising an upright housing formed with top and bottom closures, a partition transversely dividing said housing into a lower member adapted to confine a charge of water and an upper member, a water supply line serving said lower member through a float-controlled valve operable to maintain water therein at a substantially uniform level spacedly sub-

jacent said partition, means characterized by a concentric tube assembly upstanding centrally of said lower member from the bottom closure thereof in communication through the lower end of the outer tube with the lower housing member interior adapted in reaction to the input of exhaust gases through the inner of the tubes to intermix the gases with water entering the outer tube from the charge of the lower housing member and to circulate the resulting mixture upwardly between the tubes to discharge in the zone of the housing lower member between said partition and the water charge, a hood closed at one end against and depending from the housing top closure loosely through said partition to spaced, telescopic cooperation with the delivery end of said tube assembly above the water charge, an outlet to atmosphere from the upper housing member, a sleeve fixedly upstanding from said partition spacedly and concentrically about said hood to establish a restricted flow passage between the upper and lower members of said housing, a baffle adapted to support a diffusing bed of alkaline material dividing the upper housing member into upper and lower compartments communicating through a restricted passage exterior of said sleeve, whereby to dispose said bed in the path of vapor travel through said expansion chambers, a drain return from the lower said compartment to the lower housing member through said partition, a separate diffusing bed of alkaline material in the lower portion of said lower housing member about said tube assembly, and means spacedly about the base of said tube assembly within said latter bed defining an unobstructed supply chamber surrounding the intake to the outer of said tubes.

7. An exhaust gas conditioner comprising an upright housing formed with top and bottom closures, a partition transversely dividing said housing into a lower member adapted to confine a charge of water and an upper member, a water supply line serving said lower member through a float-controlled valve operable to maintain water therein at a substantially uniform level spacedly subjacent said partition, means characterized by a concentric tube assembly upstanding centrally of said lower member from the bottom closure thereof in communication through the lower end of the outer tube with the lower housing member interior adapted in reaction to the input of exhaust gases through the inner of the tubes to intermix the gases with water entering the outer tube from the charge of the lower housing member and to circulate the resulting mixture upwardly between the tubes to discharge in the zone of the housing lower member between said partition and the water charge, a hood closed at one end against and depending from the housing top closure loosely through said partition to spaced, telescopic cooperation with the delivery end of said tube assembly above the water charge, an outlet to atmosphere from the upper housing member, a sleeve fixedly upstanding from said partition spacedly and concentrically about said hood to establish a restricted flow passage between the upper and lower members of said housing, a baffle adapted to support a diffusing bed of alkaline material dividing the upper housing member into upper and lower compartments communicating through a restricted passage exterior of said sleeve, whereby to dispose said bed in the path of vapor travel through said expansion chambers, a drain return from the lower said compartment to the lower housing member through said partition, a separate diffusing bed of alkaline material in the lower portion of said lower housing member about said tube assembly, and an inverted cup of water-pervious material spacedly about the base of said tube assembly within said latter bed defining an unobstructed supply chamber about the intake to the outer of said tubes.

8. In an exhaust gas conditioner having an upright housing formed with top and bottom closures, a partition transversely dividing said housing into a lower member adapted to confine a charge of water and an upper mem-

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ber, a water supply line serving said lower member through a float-controlled valve operable to maintain water therein at a substantially uniform level spacedly subjacent said partition, means characterized by a concentric tube assembly upstanding centrally of said lower member from the bottom closure thereof in communication through the lower end of the outer tube with the lower housing member interior adapted in reaction to the input of exhaust gases through the inner of the tubes to intermix the gases with water entering the outer tube from the charge of the lower housing member and to circulate the resulting mixture upwardly between the tubes to discharge in the zone of the housing lower member between said partition and the water charge, a hood closed at one end against and depending from the housing top closure loosely through said partition to spaced, telescopic cooperation with the delivery end of said tube assembly above the water charge, and an outlet to atmosphere from the upper housing member, means definitive of a plurality of expansion chambers intercommunicat-

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ing through restricted flow passages and constituting a vapor flow path between said outlet and the delivery end of said hood, said latter means comprising a sleeve fixedly upstanding from said partition spacedly and concentrically about said hood with its upper end subjacent said housing, a baffle adapted to support a diffusing bed of alkaline material dividing the upper housing member into upper and lower compartments exteriorly of said sleeve, and an annular margin inwardly terminating said baffle concentrically about and spaced exteriorly from said sleeve.

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