

Sept. 23, 1952

J. P. RUTH

2,611,680

EXHAUST GAS CONDITIONING METHOD

Filed Jan. 16, 1950

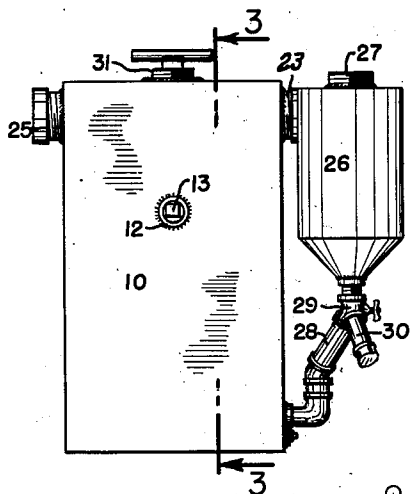


Fig. 1

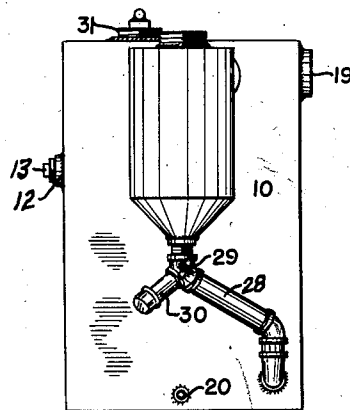


Fig. 2

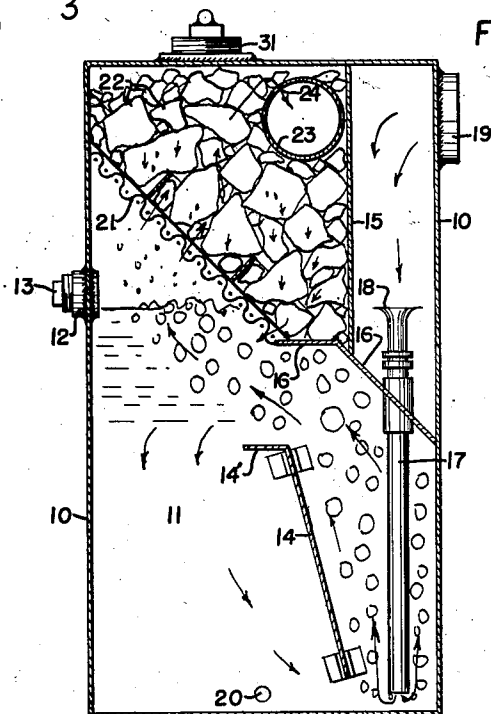


Fig. 3

INVENTOR.
JOSEPH P. RUTH
BY *Harmon G. Sweet*
ATTORNEYS

UNITED STATES PATENT OFFICE

2,611,680

EXHAUST GAS CONDITIONING METHOD

Joseph P. Ruth, Denver, Colo.

Application January 16, 1950, Serial No. 133,801

6 Claims. (Cl. 23—2)

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This invention relates to treatment of internal combustion exhaust gases for the washing, cooling, and conditioning thereof into form substantially free from noxious and hazard-promoting properties prior to and as an incident of their discharge to atmosphere, and has as an object to provide a novel gas conditioning method and improved gas conditioning apparatus automatically operable to effectively cool, cleanse, and purify such exhaust gases.

A further object of the invention is to provide a novel gas conditioning method and improved gas conditioning apparatus operatively responsive to and without adverse operative effect upon the normal exhaust gas discharge from an internal combustion engine.

A further object of the invention is to provide a novel exhaust gas conditioning method characterized by chemical modification of the normal gas and consequent enhanced cleansing and purification thereof.

A further object of the invention is to provide improved exhaust gas conditioning apparatus automatically operable in and as the exhaust gas discharge line of an internal combustion engine to wash, cool, chemically modify, cleanse and purify the engine exhaust gas output.

A further object of the invention is to provide exhaust gas conditioning methods and apparatus operable to adapt internal combustion engines for non-hazardous use in enclosures and underground workings, effective to materially minimize, if not wholly eliminate, the injurious properties of engine exhaust gas discharge, economically adaptable to use with a wide range of particular engine types and constructions in either fixed or translatable installations, and characterized by positive, efficient, automatic reaction to normal engine gas discharge pressures.

With the foregoing and other objects in view, my invention consists in the nature and sequential relation of method steps and in the construction, arrangement, and combination of elements as hereinafter set forth, pointed out in my claims, and illustrated by the accompanying drawing, in which—

Figure 1 is a side elevation of a typical apparatus unit embodying the principles of my invention and effective for practice of my novel method. Figure 2 is an elevation of the right-hand end of the unit shown in Figure 1. Figure 3 is a vertical section, on an enlarged scale, taken substantially on the indicated line 3—3 of Figure 1.

The instant invention is a development from and an improvement over the subject matter of

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my pending application for United States patent filed September 9, 1946, Serial No. 695,659, now matured as Patent No. 2,508,297.

As is well understood, exhaust gases discharged during the operation of internal combustion engines are at high temperature, entrain particles of solids, such as carbon, barely cooled from an incandescent state, carry a diffusion of finely divided oil, and may be characterized by constituent vapors inimical to human health and life. Diesel-type engines, in particular, may produce exhaust gases free from noxious and injurious vapors to a degree permitting use of such engines in enclosures and underground workings were it not for the high heat and concentration of oil and solids particles in their gas discharge, with consequent fire hazard and health menace, while engines operated with the more refined hydrocarbon fuels may show less solids and oil concentration in their exhaust gas discharge along with the typical high temperature and possible obnoxious vapor constituents limiting the range of engine utility. Regardless of the presence or absence of the inimical vapor constituents, cooling, washing, cleansing, and purifying of internal combustion engine exhaust gases practically accomplished with economy and expedition enlarges the utility of such engines, safe-guards against explosive and fire hazards incident to engine use, and minimizes the menace to human health and life implicit in the release of unconditioned gas discharge, hence the instant invention is directed to a novel method and improved means for modifying the initial exhaust gas discharge to a condition suited for release to atmosphere without hazard or harm.

My novel and improved method for the conditioning of internal combustion engine exhaust gases includes entrainment of the gas by virtue of its discharge pressure through and with circulating effect upon a body of water for initial cooling and washing of the gas accompanied by a settling out of solids, diffusion of the mingled gas, water spray, and water vapor ebullient emanations from the water body through a labyrinthine zone with filtering and condensing effect, expansion of the output from the labyrinthine zone for consequent cooling and deceleration marked by release of entrained solids and moisture, and ultimate centrifuging of the expanded vapors to extract and separate therefrom a high proportion of condensable constituents, all through the agency of and in automatic response to the initial discharge pressure and velocity of the exhaust gas, and is particularly

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characterized by automatic chemical modification of the vapors diffused through the labyrinthine zone in a manner and to a degree enhancing desirable cleansing and purification of the ultimate discharge.

As is well known, internal combustion engine exhaust gases have inherently a marked acid characteristic, or low pH value, conducive to corrosive effect in the presence of moisture and productive of malaise and irritations in humans. Further, it now appears that the exhaust gas acid characteristic normally hampers desired cleansing and purification thereof attempted conventionally and is hence a factor meriting correction. As is also well known, oils may be readily caused to saponify in a neutral or alkaline medium and become more resistant to saponification as the pH factor of the medium declines away from neutral, so that, oily matter being universally present in the exhaust gas discharge from internal combustion engines, correction of the acid characteristic of such discharge may operate to condition the entrained oily matter for saponification and consequent material aid in the gas cleansing and purification sought.

In accordance with my improved method as above described, the exhaust gases are comingled with water spray and water vapor as they emerge from the water body just prior to their passage through the diffusing labyrinthine zone, in which condition the gases manifest their inherent acid characteristic, and it is hence feasible and convenient to constitute the diffusing labyrinthine zone from material reactive to the passage of the moist gases therethrough in a manner to neutralize the acidity of the gases and to consequently condition the oily matter entrained by the gases for saponification. It is hence a novel and significant feature of the improved method to neutralize the exhaust gas acid characteristic as the gas passes through a diffusing zone in the presence of moisture, and this modification of the exhaust gas is conveniently and practically accomplished by forming the diffusing zone as a bed or layer of broken lime rock, or similar alkaline material, interposed in the path of wet gas travel. Manifestly, the moisture entrained with the gases as they emerge from a water body is deposited upon and spreads to coat the surfaces of lime rock fragments disposed in the gas travel path immediately above the water body surface, and such moistening of the lime rock surfaces conditions the latter to effectively neutralize the acidity of gases flowing thereover and to raise the pH value of the gas to or above the neutral point; agitation of the so-neutralized gas as it passes through the diffusing zone operating in the presence of moisture to develop a soapy froth because of the oily matter characterizing the gas. Somewhat analogous to the action of the soapy froths generated and utilized in froth flotation techniques, the froth bubbles from saponification of exhaust gas constituents neutralized in the diffusing zone function to entrap and surround particles of solid matter entrained with the gas and to thereby more thoroughly cleanse and purify the gas prior to its release to atmosphere.

Similar in operative principle to the disclosure of my earlier application, apparatus effective for practice of the improved method is typically illustrated in the drawing. Manifestly susceptible of various particular embodiments, the illustrated apparatus comprises a conveniently rectangular housing 10 of suitable material, such

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as sheet metal, fabricated in any appropriate manner and adequate size to constitute a container and receiver closed save as hereinafter specified. The lower portion of the housing 10 is adapted to be charged with and functions as a container for a body of liquid 11, and an outlet 12, normally closed by a removable and replaceable plug 13, intersects one wall of the housing 10 at a point suitable to determine the upper level of the water body 11. A baffle 14 is mounted longitudinally of the housing 10 with its lower margin spaced upwardly from the housing bottom and its upper margin well below the surface level of the water body 11, and said baffle is disposed more nearly to the housing wall remote from the outlet 12 and at a moderate inclination to the vertical to define intercommunicating compartments in the housing lower portion whereof the smaller is enlarged upwardly from a narrower lower end and the larger is constricted upwardly from a wider lower end by virtue of the baffle inclination. It is the function of the baffle 14 to promote circulation of the water body 11 through the two compartments defined by said baffle in response to exhaust gas inflow to the apparatus, and such functioning of the baffle is facilitated by a horizontally-disposed flange 14' integral with and directed toward the housing wall intersected by the outlet 12 from the upper long margin of said baffle. Spacedly paralleling the upper portion of the housing wall remote from the outlet 12 and fixedly closing between the housing end walls, a partition 15 depends from the upper end of said housing across and somewhat below the upper level of the water body 11 as determined by the outlet 12, and the lower margin of said partition 15 closes against a downwardly and outwardly inclined plate 16 which in turn closes against the adjacent housing wall, said partition 15 and plate 16 thus cooperating to define a chamber interiorly of the housing 10 and closed away from communication with other portions of said housing interior. The plate 16 is intersected by and operatively supports a plurality of gas inflow tubes 17 in a number and spacing appropriate to the desired capacity of the apparatus, and each of said tubes 17 comprises an upwardly-opening bell mouth 18 on its upper end within the chamber defined by the elements 15 and 16 and at an elevation slightly above the water body 11 level, and a straight tubular portion communicating with said bell mouth and extending vertically through the water 11 below the plate 16 to terminate in an open end spacedly adjacent the housing bottom and interiorly of the lesser compartment defined between the baffle 14 and adjacent housing wall. An inflow port, conveniently defined by an annular collar 19, opens through the housing wall to affect communication with the upper portion of the chamber defined by the elements 15 and 16, and the exhaust line from an internal combustion engine is connected to discharge through said port and interiorly of said chamber for delivery of the engine exhaust gases within said chamber and thence, under the influence of their inherent pressures, through the mouths 18 and associated tubes to the base of the lesser water-charged housing compartment for uprise in the form of bubbles through said lesser compartment to ebullient escape from the water body at the upper level thereof. As is readily apparent, engine exhaust gases fed interiorly of the chamber defined by the elements 15 and 16 and thence through the tubes 17 to the base of the lesser

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water-filled compartment rise through said lesser compartment in upward, divergent paths and are deflected by the inclined plate 16 across the flange 14' of the baffle 14 to escape through the upper level surface of the water body 11. Such uprise of the gases through the lesser water-filled compartment generates a water circulation about the baffle 14, as indicated by the arrows in Figure 3, so that, as the inflowing gases are washed and cooled by their passage through the water body 11, a supply of cooler water is continuously infed beneath the baffle 14 from the greater and to the base of the lesser water-filled compartment. Due to the relative size of the water-filled compartments separated by the baffle 14, the water charge in the greater of the compartments is relatively more quiescent than that filling the lesser compartment, and as a consequence the solid particles entrained and carried by the inflowing gases across and above the baffle flange 14' may sink and collect in said greater compartment for removal from the housing, at times, through a drain outlet 20 adjacent the housing bottom.

An inner margin extension of the plate 16 is horizontally directed away from the partition 15 as a flange 16' spacedly paralleling and overhanging the baffle flange 14' slightly below the top surface level of the water body 11; said flanges 14' and 16' defining a throat wherethrough the uprise established within the lesser water-charged compartment is directed to the upper region of the water body. Closing between the housing wall intersected by the outlet 12 and the free margin of the flange 16', preferably at a pronounced inclination to the horizontal effective to elevate its outer margin well above the outlet 12, a screen 21 of any suitable reticulate or foraminous material traverses the housing interior with its major area above the water charge level. The screen 21 is the base or floor of a labyrinthine diffusing zone effective to filter, chemically modify, and cleanse the comingled vapors uprising through and from the surface of the water body 11, and in addition to the operative effect of the screen 21 the diffusing zone is constituted from a relatively deep layer or bed of lime rock fragments 22 loosely supported on said screen, the flange 16', and between said elements and the partition 15. Constitution of the diffusing zone from the lime rock fragments 22 provides a maze of passages through which the gas and water vapors must pass as they rise from the water body 11, the spray and water vapor entrained with the exhaust gases adhering to and coating the lime rock surfaces for drip return thence to the water body and for coaction with the lime rock material effective to neutralize the inherent acidity of the gases. As the vapors pass through the lime rock bed or layer, their travel paths and velocities are repeatedly altered in direction and interrupted to facilitate release of solid particles moving with the vapors. return of such released particles to the quiescent zone of the water body, and to generate an agitation and interaction productive of oil saponification and the development of froth bubbles which in turn facilitate cleansing and purification of the gas.

After penetration of the diffusing zone, the gases collect in the upper portion of the housing at the side of the partition 15 remote from the inflow chamber and are received in a cylindrical conduit 23 bridging interiorly of the housing 10 in spaced parallelism with and above the flange

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16' through a longitudinal slot 24 interrupting the full length of an upper arc of said conduit. The conduit 23 preferably opens exteriorly through both end walls of the housing 10, thereby to facilitate servicing and maintenance of the unit, and is closed at one of its exterior ends by means of a removable cap 25. At its other exterior end, the conduit 23 communicates with and for delivery of gases interiorly of a conventional centrifuging assembly 26, so constructed and arranged as to apply the pressures and velocities of the incoming gases for the generation of cyclonic effect operable to separate out any moisture and solid particles carried by the gas, and the assembly 26 is furnished with an outlet 27 for final discharge of the purified gases and a return line 28 connected with the lower portion of the housing 10 through which the sludge removed from the gases by the assembly 26 may drain to the water-charged region of the housing. The return line 28 may be equipped with a control valve 29, selectively operable to direct the sludge through a branch 30 leading to waste, or elsewhere, as may be desired, thereby obviating concentration of sludge within the housing 10.

An access opening normally closed by means of a removable plug 31 may be provided in the top of the housing 10 for charging and servicing of the apparatus, or, as either an alternative or supplement to said opening, the top member of the housing may be removably or hingedly associated with the housing side and end wall elements, it being important only that the relation of the housing top element with the other housing elements be such as to constitute a seal gas-tight at normal operating pressures of the apparatus.

Obviously, the apparatus shown and described is operable in a variety of particular structural embodiments to give full practical effect to the method above described and to cleanse and purify the exhaust gases passed therethrough to a condition suitable for release without harmful or hazardous effect in enclosures and underground workings. The improved method is continuously and automatically effective under the discharge pressures of the exhaust gases and without development of adverse back pressures so long as a supply of water and a diffusing bed of lime rock are maintained in the relationship specified, and the apparatus shown and described is continuously and automatically operable to give effect to the method with a minimum of servicing and maintenance so long as the exhaust gases are infed to the chamber defined by the elements 15 and 16 in the manner above set forth; occasional removal of sludge from the housing and replenishment of the water and lime rock supplies being all that is required to maintain the apparatus in operating condition throughout a long life of practical use.

Since changes, variations, and modifications in the form, construction, and arrangement of the apparatus 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 of the details of the illustrative showing and foregoing description.

I claim as my invention:

1. The method of conditioning internal combustion engine exhaust gases to non-hazardous and unobnoxious form free from entrained solids and acidic constituents which consists of introducing the gases under the influence of their discharge pressures into the lower portion of a liquid

body associated with and disposed to wet the surfaces of an intersticed alkaline diffusing medium insoluble in the liquid of the body and soluble in the characteristic acidity of the gas-liquid mixture, agitating said liquid body in reaction to the gas input flow to dissolve the soluble gas constituents in the liquid and to wash the resulting gas-liquid mixture through the interstices of the diffusing medium with neutralizing effect on the acidity of the gases, collecting the condensate resulting from such agitation in the liquid body, and liberating the undissolved gases.

2. The method of conditioning internal combustion engine exhaust gases to non-hazardous and unobnoxious form free from entrained solids and acidic constituents which consists of introducing the gases under the influence of their discharge pressures into a liquid body associated with an intersticed alkaline diffusing medium insoluble in the liquid of the body and soluble in the characteristic acidity of the gas-liquid mixture, agitating said liquid body in reaction to the gas input flow to dissolve the soluble gas constituents in the liquid and to flow the resulting gas-liquid mixture through the interstices of the diffusing medium with neutralizing effect on the acidity of the gases, and liberating the undissolved gases.

3. The method of conditioning internal combustion engine exhaust gases to non-hazardous and unobnoxious form free from entrained solids and acidic constituents which consists of introducing the gases under the influence of their discharge pressures into the lower portion of a liquid body to create agitation and to form a gas-liquid mixture, repetitiously washing the gas-liquid mixture through an intersticed alkaline medium insoluble in the liquid of the body and soluble in the characteristic acidity of the gas-liquid mixture with neutralizing effect on the acidity of the gases as an incident of such agitation, collecting the condensate resulting from such agitation in the liquid body, and liberating the undissolved gases.

4. The method of conditioning internal combustion engine exhaust gases to non-hazardous and unobnoxious form free from entrained solids and acidic constituents which consists of introducing the gases under the influence of their discharge pressures into the lower portion of a liquid body to create agitation and to form a gas-liquid mixture, repetitiously washing the gas-liquid mixture as an incident of such agitation

through a superjacent intersticed alkaline medium insoluble in the liquid of the body and soluble in the characteristic acidity of the gas-liquid mixture with neutralizing effect on the acidity of the gases, collecting in the liquid body the drip condensate resulting from such agitation and washing, and liberating the undissolved gases.

5. In a method of conditioning internal combustion engine exhaust gases to non-hazardous and unobnoxious form free from entrained solids and acidic constituents, the steps of introducing the gases under the influence of their discharge pressures into the lower portion of a liquid body to create agitation and to form a gas-liquid mixture and repetitiously washing the gas-liquid mixture as an incident of such agitation through an intersticed alkaline medium insoluble in the liquid of the body and soluble in the characteristic acidity of the gas-liquid mixture.

6. In a method of conditioning internal combustion engine exhaust gases to non-hazardous and unobnoxious form free from entrained solids and acidic constituents wherein the gases are introduced under the influence of their discharge pressures into the lower portion of a liquid body to create agitation and to form a gas-liquid mixture, the step of repetitiously washing said gas-liquid mixture as an incident of such agitation through an intersticed alkaline medium insoluble in the liquid of the body and soluble in the characteristic acidity of the gas-liquid mixture.

JOSEPH P. RUTH.

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