Aug. 17, 1954 C. E. STOLTZ 2,686,399

EXHAUST GAS CONDITIONER

Filed April 14, 1952 4 Sheets-Sheet 1

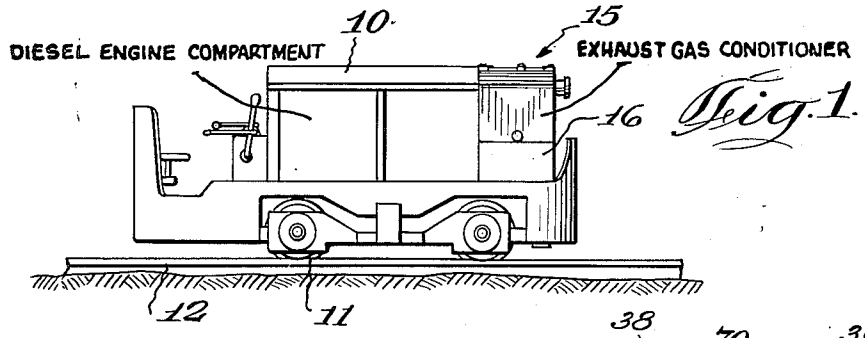


Fig. 1.

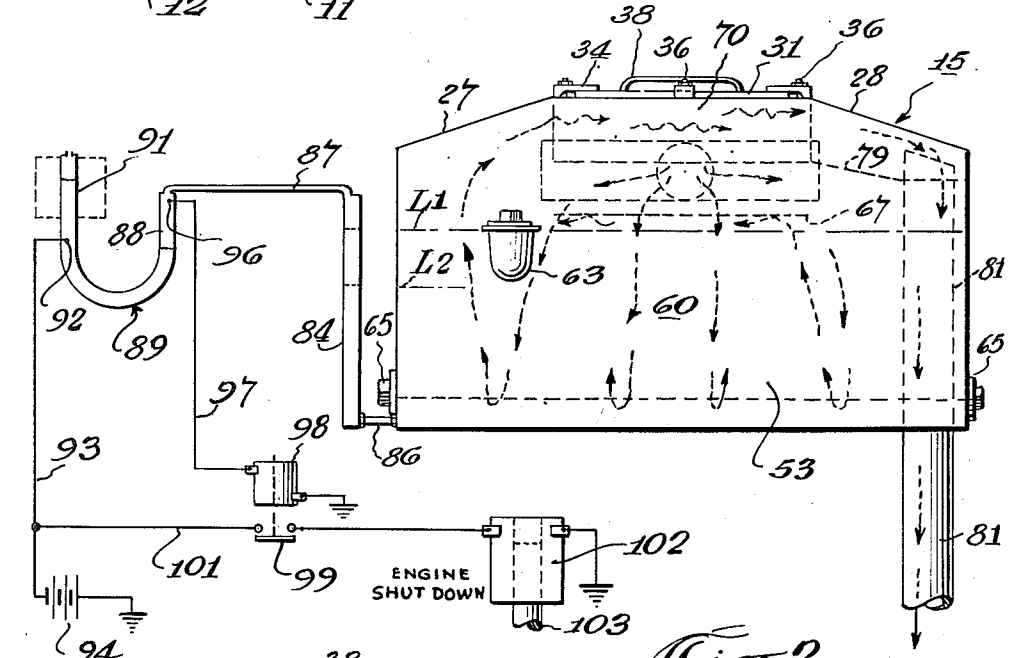


Fig. 2.

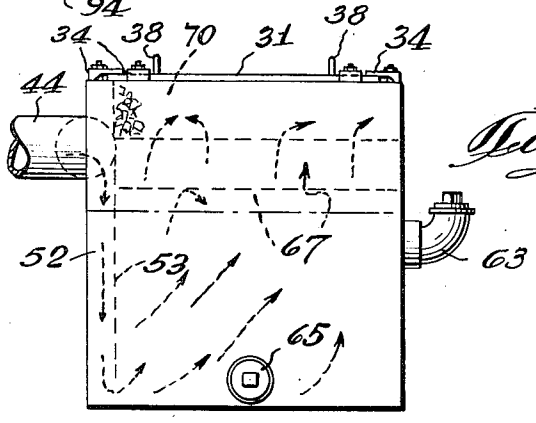


Fig. 3.

Inventor
Charles E. Stoltz
By Murray A. Gleason
Attorney

Aug. 17, 1954 C. E. STOLTZ 2,686,399

EXHAUST GAS CONDITIONER

Filed April 14, 1952 4 Sheets-Sheet 2

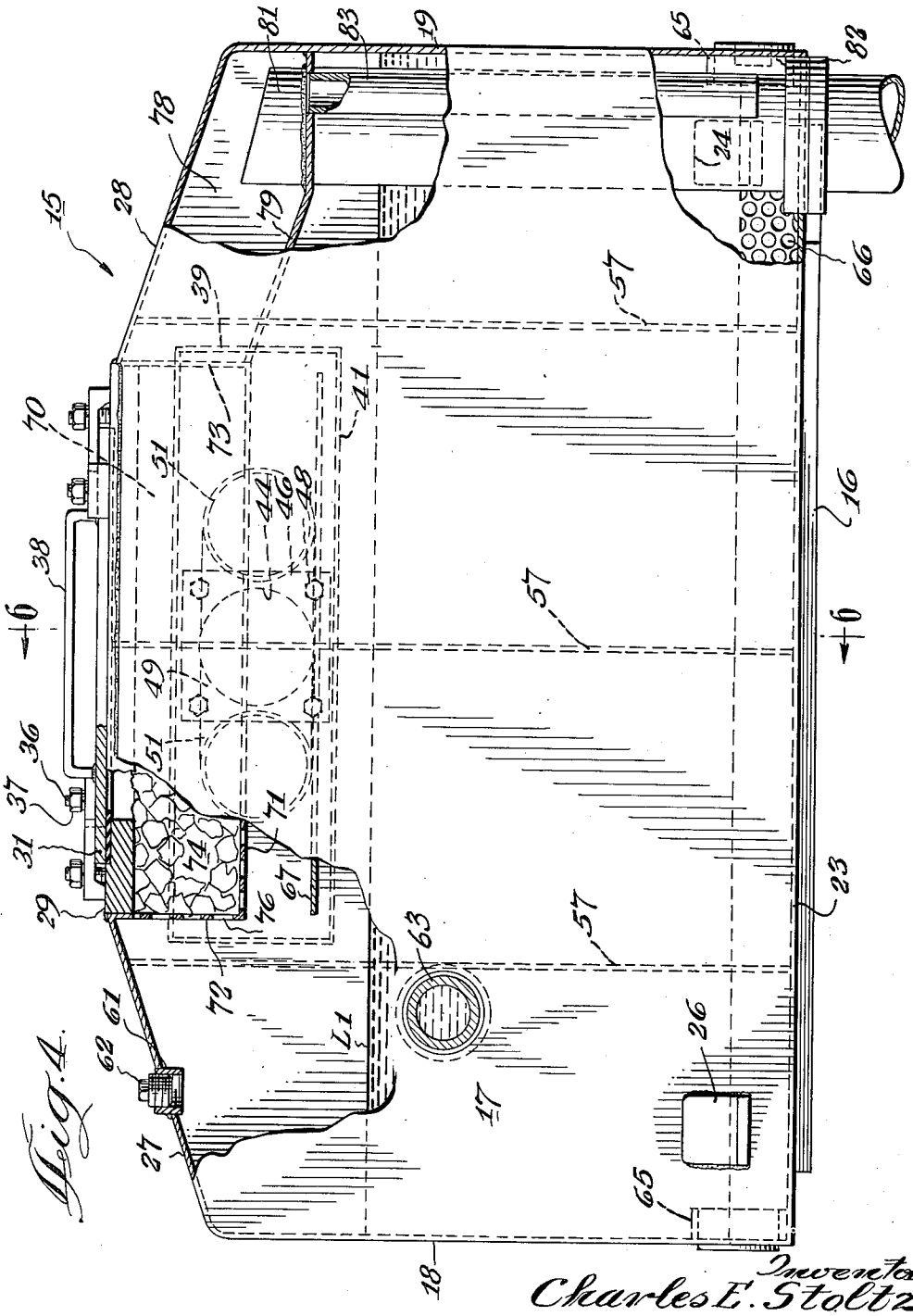


Fig. 4.

Inventor
Charles E. Stoltz
By Murray A. Gleeson
Attorney

Aug. 17, 1954 C. E. STOLTZ 2,686,399

EXHAUST GAS CONDITIONER

Filed April 14, 1952 4 Sheets-Sheet 3

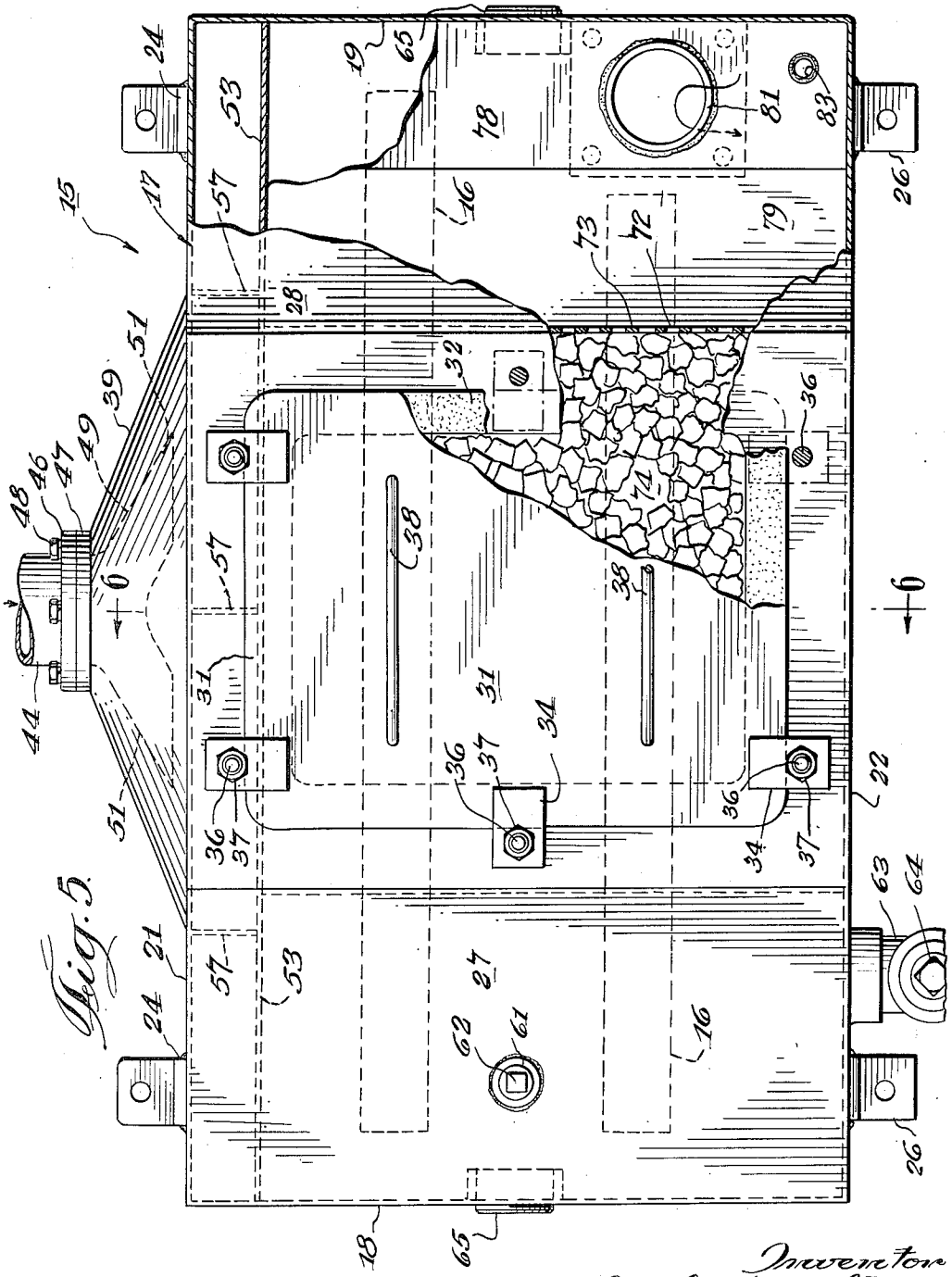


Fig. 5.

Inventor
Charles E. Stoltz
By Murray A. Gleason
Attorney

Aug. 17, 1954 C. E. STOLTZ 2,686,399

EXHAUST GAS CONDITIONER

Filed April 14, 1952 4 Sheets-Sheet 4

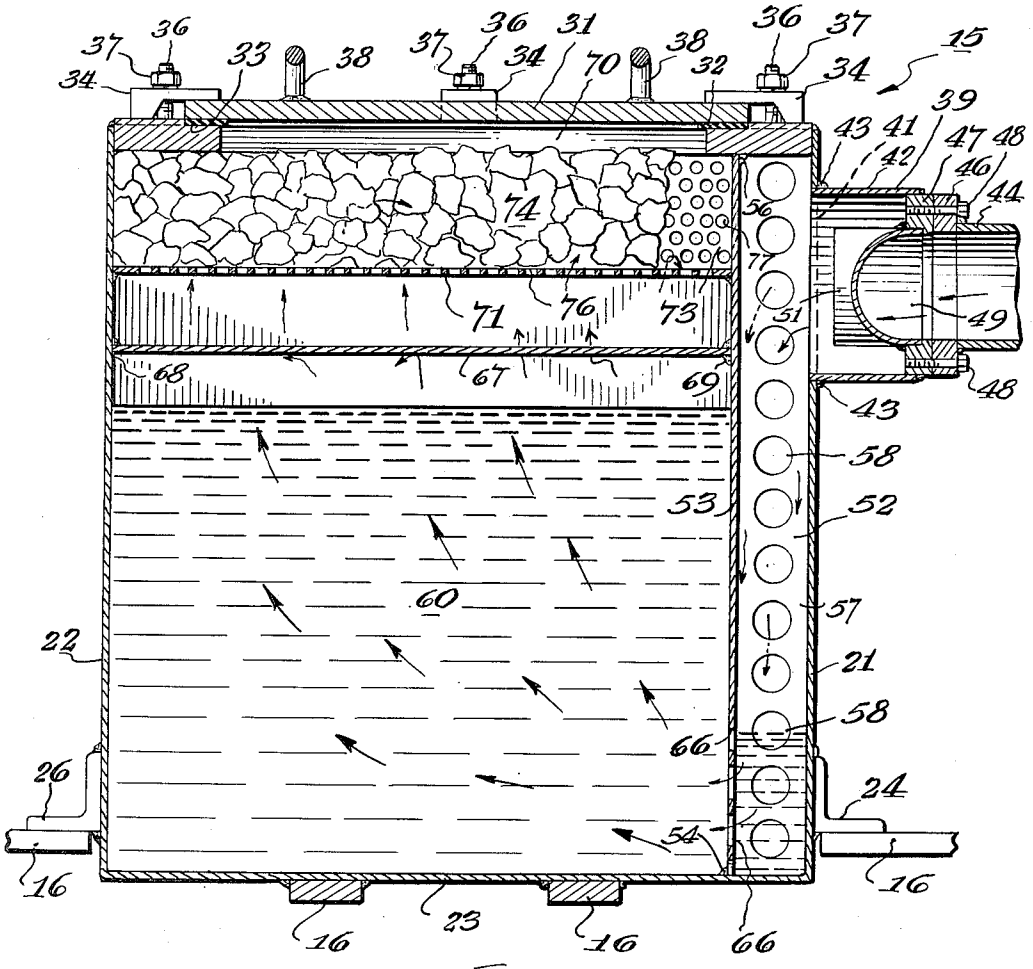


Fig. 6.

Inventor
Charles E. Stoltz
By Murray A. Gleeson
Attorney

Patented Aug. 17, 1954

2,686,399

UNITED STATES PATENT OFFICE

2,686,399

EXHAUST GAS CONDITIONER

Charles E. Stoltz, Chicago, Ill., assignor to Goodman Manufacturing Company, Chicago, Ill., a corporation of Illinois

Application April 14, 1952, Serial No. 282,213

9 Claims. (Cl. 60—30)

1

This invention relates generally to apparatus for purifying the exhaust gases from an internal combustion engine and more particularly to apparatus for conditioning the exhaust gas from a compression ignited oil engine such as may be used for driving a locomotive in a mine underground.

As is known, the operating characteristics of diesel engines are such that the exhaust gases therefrom are relatively low in carbon monoxide content as compared to a gasoline engine, but other considerations prevent their use in confined spaces such as an underground mine. These considerations are mainly the other products of combustion of the oil fuel therefor, such products including oxides of nitrogen and aldehydes such as formaldehyde, acetaldehyde and acrolein. Oxides of nitrogen are extremely toxic, and concentrations in the ventilating air in excess of twenty-five parts per million are not permitted by many mine safety codes. Aldehydes found in such exhaust gases account mainly for the odor thereof and are extremely irritating, and the recommended maximum limit for aldehydes is not in excess of ten parts per million.

Sulfur present in the fuel likewise causes irritating products of combustion, either sulfur dioxide or sulfur trioxide. The concentration of such sulfur products is not permitted to exceed ten parts per million for prolonged exposure.

All of the above products of combustion can be removed from the exhaust gases of a diesel engine, at least to such a degree that the percentage of such products in the ambient surrounding the engine is kept to below the maximum limit prescribed for each. Devices of the prior art for conditioning the exhaust gases have in general made use of a water reservoir and a tortuous path over or through the water. The degree of cooling desired for the gases in many cases has not been adequate nor have the products of combustion been removed to a value below that permitted.

According to the present invention the exhaust gases from the engine are directed into a chamber in such a fashion that the gases move downward past a vertical wall of a closed reservoir of conditioning water so that the gases are preliminarily cooled a rather large amount. The bottom portion of the vertical wall is foraminated so as to divide the exhaust gases into a great number of fine jets, the thusly divided gases being enabled to bubble up through the reservoir of water to be washed thereby. During such bubbling action the gases become entrained with water vapor, and the bubbles escaping from the

2

top surface of the water strike a baffle where a large portion of the entrained water is enabled to fall back into the reservoir. A compartment containing limestone fragments of sizes passing a 2½" and retained on a 2" screen is located above the baffle and has foraminous side walls so that the gases may pass around the fragments by way of the voids therebetween.

The limestone fragments serve a double purpose, one of reacting with any acids of nitrogen or sulfur still present in the gases, and second, of scrubbing water out of the gases so that such water may be returned back to the reservoir either by way of the foraminous bottom of the compartment or by way of a vertical return pipe to the water reservoir.

The water reservoir is of such capacity as to supply sufficient water properly to condition the gases during a usual operating shift, but in the event the water should diminish in supply below a critical level, means are operable to shut off the engine until the supply of water is replenished.

With the foregoing considerations in mind it is a principal object of this invention to provide a diesel engine exhaust gas conditioner which will function more efficiently than the conditioners of the prior art.

Another object is to afford a simple construction for a diesel exhaust gas conditioner, in which the gases are first cooled by moving past a vertical wall of a water reservoir, the lower part of the wall forming a means for dividing the gases into small jets to be divided into small bubbles moving through the body of water for removal of water soluble components of the gases.

A further and salient object is to afford an exhaust gas conditioner which will be operable for at least the duration of a normal working shift, without the need of replenishing the water therein, and to afford in such a conditioner means for stopping the engine if the conditioning water falls below a certain level.

Other objects and important features of the engine will be apparent from a study of the following description taken with the drawings which together illustrate a preferred embodiment of the invention and the best mode of applying the principles thereof. Other embodiments will be suggested to those having the benefits of the teachings herein, and it is therefore intended that such other embodiments be reserved especially as they fall within the purview and scope of the claims appended.

In the drawings:

Fig. 1 is a side view of a diesel engine powered

mine locomotive having embodied therein an exhaust gas conditioner according to the present invention;

Fig. 2 is a front view of the conditioner, the engine control apparatus which is operable by diminution of the supply of conditioning water being shown somewhat schematically;

Fig. 3 is an end view of the conditioner looking from the left to the right as seen in Fig. 2;

Fig. 4 is an enlarged front elevation view thereof;

Fig. 5 is a plan view to the same scale as Fig. 4, certain parts being broken away to show the interior of the conditioner; and

Fig. 6 is a vertical section taken along the lines 6—6 of Figs. 4 and 5.

Referring now to the drawings, the present invention is shown as embodied in a diesel-powered mine locomotive 10, having wheels 11 adapted to move the locomotive over rails 12. The exhaust gases from the Diesel engine, not shown, of the locomotive 10 are passed through a conditioner referred to generally by the reference numeral 15 and mounted upon a support 16 situated at the forward end of the locomotive 10.

The conditioner 15 is designed to condition the exhaust gases from the engine and to remove therefrom noxious and irritating constituents, so that when the gases are expelled from the conditioner 15 to the ambient, the presence therein of such noxious and irritating constituents such as nitrogen oxide compounds, sulfur compounds and aldehydes in the form of formaldehyde, acetaldehyde and acrolein will be in such percentages as to be below a maximum permitted by the usual safety codes.

Referring now particularly to Figs. 4, 5 and 6 of the drawings, the exhaust gas conditioner comprises a housing 17 having side walls 18 and 19, a rear wall 21 and a front wall 22, the housing including a bottom 23 resting upon the support 16. The rear wall 21 has spaced mounting brackets 24, and the front wall 22 has spaced mounting brackets 26, for securing the housing 17 to the support 16. The top of the housing 17 has sloping portions 27 and 28 which extend away from a centrally located horizontal top frame opening 29, the contour of the sloping portions 27 and 28 and the top frame 29 generally corresponding to the top contours of the housing for the diesel engine of the mine locomotive 10.

The top frame portion is fitted with a substantially rectangular shaped closure 31 resting upon a gasket 32 held in a recess 33 in the top frame 29, the closure 31 being held in firm engagement with the gasket 32 and the top frame portion 29 by lugs 34 held in position by studs 36 and nuts 37. A pair of handles 38 provide for easy removal of the closure 31 when desired.

A hollow manifold 39, in the shape generally of a dove prism overlies a rectangular opening 41 in the top of rear wall 21, the manifold 39 including walls 42 which are welded at 43 to the edges of the rectangular opening 41. The manifold 39 provides a means of connection to the conditioner 15 for an exhaust pipe 44 from the engine of the locomotive 10. The connection includes a flange 46 on the exhaust pipe 44 and a flange 47 in the manifold 39, the two being held together by screws 48 tapped into the flange 47.

The flange 47 is formed integrally with a substantially T-shaped fitting 49 having arms 51 which diverge within the dove-shaped manifold 39 to distribute the exhaust gases from the exhaust pipe 44, and so that they will not impinge directly upon a vertical partition 53.

The manifold 39 thus opens on to an expansion chamber 52 which extends for the length of rear wall 21 and is defined by a vertical partition 53 welded at 54 to the bottom 23 and to the underside of the frame portion 29 and sloping portions 27 and 28 at 56. The vertical partition 53 is held in position additionally by vertical web members 57 having perforations 58 which help to equalize the velocity of the gases entering the expansion chamber 52 from the exhaust pipe 44.

The vertical partition 53 thus defines with the front wall 22 a reservoir 60 for a supply of conditioning water. The reservoir 60 is filled at a filler hole 61 located in the sloping top portion 27, the filler hole being closed by a pipe plug 62. The reservoir 60 is filled to the level shown, such level being regulated by an overflow elbow fitting 63 positioned in the front wall 22 and closed by a pipe plug 64. The reservoir 60 is drained at drain plugs 65 located one each at the bottom of the reservoir in the side walls 18 and 19.

The exhaust gases entering the expansion chamber 52 move downward in heat exchange relationship over the surface of the vertical partition 53, and are directed as small streams thereof through small openings 66 near the bottom of the vertical partition 53. The exhaust gases then bubble up and across the reservoir 60 through the water therein.

Since the exhaust gases from the engine contain oxides of both sulfur and nitrogen, and aldehydes such as acetaldehyde, formaldehyde and acrolein, all of which are soluble in water, a large proportion of such constituents of the exhaust gases will be dissolved in the water in the reservoir 60 by the passage therethrough of the small bubbles of such gases emerging through the openings 66.

A baffle 67 is positioned a slight distance above the top surface of the water within the reservoir 60 and is held by weldments 68 and 69 to the inside of the front wall 22 and the vertical partition 53 respectively. The baffle 67 is impinged by bubbles of exhaust gas emerging from the surface of the water in the reservoir 60. Such bubbles contain entrapped water and the bursting of the bubbles by impingement against the baffle 67 causes the water thereof to fall back into the reservoir 60.

A compartment 70 is disposed above the baffle 67 and comprises a foraminated bottom 71 spaced above the baffle 67 and foraminated side walls 72 and 73, the front wall 22 and the rear wall 21. The compartment 70 is filled through the open frame 29 after removal of the closure 31 with limestone fragments 74. Preferably, the limestone fragments 74 are sized to pass at 2½" screen and to be retained on a 2" screen.

The foraminated bottom 71 and the foraminated side wall 72 having openings 76 therein for exhaust gases emerging from the water reservoir 60, some of which exhaust gases have been dewatered in part by impinging against the underside of the baffle 67.

The openings 76 together with the voids between the fragments 74 thus provide further passageways for the cooled and partly conditioned exhaust gases, further conditioning being achieved by action of the limestone fragments 74. The limestone chemically interacts with any acid constituents remaining in the exhaust gases, such as nitrogen and sulfur oxide compounds. The voids between the fragments 74 and the

surfaces thereof enable the exhaust gases further to be dewatered, the water "wrung out" therefrom returning back to the reservoir 60 through the holes 76 in the bottom 71.

The gases which have been further conditioned within the compartment 70 leave the compartment 70 through openings 77 in the foraminated side wall 73 to enter a further dewatering chamber 78 which is defined by a sloping bottom 79, which is substantially parallel to the inclined top portion 28, and by the front wall 22 and the vertical partition 53.

An exhaust pipe 81 extends above the bottom 79 of the chamber 78 and down through the reservoir 60, terminating below the bottom 23 of the housing 17 to lead the completely conditioned exhaust gases to ambient. As seen more clearly in Figs. 4 and 5, the bottom 23 is reinforced by a flange 82 welded both to the bottom 23 and the exhaust pipe 81, so as to be tight against leakage of water from the reservoir 60.

A return pipe 83 leads from the lowest point of the chamber 78 and extends below the surface of the water in the reservoir 60 to a point near the bottom of the reservoir.

It will be seen that any water entering the chamber 78 will be returned to the reservoir 60 by the return pipe 83 rather than be discharged by the exhaust pipe 81.

The conditioner according to the present invention operates most efficiently when sufficient water is maintained within the reservoir 60. In order to insure that the engine is operable only when sufficient water is present in the reservoir 60 means are provided to shut off the engine when the water level drops below a certain level. Referring particularly to Fig. 2, the housing 17 has alongside thereof a standpipe 84 communicating with the reservoir 60 by a short length of pipe or tubing 86. The top of the standpipe 84 is closed and is connected by a tube 87 to the closed leg 88 of a U-shaped manometer tube 89, the other leg 91 being open to atmospheric pressure. Leg 89 has a contact 92 therein connected by a lead 93 to a source of power 94 as the battery shown. Leg 88 has a contact 96 connected by a lead 97 through a relay 98 and thence to ground shown.

The U-shaped manometer tube 89 is filled with mercury and when the reservoir 60 is filled with water to the level L_1 the mercury makes contact with contact 92, being pushed away from contact 96 by the air entrapped in the tube 87. However, when the level in the reservoir 60 falls to L_2, contact will be made by the mercury with the contact point 96 to energize the relay 98.

The relay 98 has an armature 99 which upon energization of the relay 98 closes a circuit including a lead 101 branching from the lead 93 through a solenoid 102. A solenoid armature 103 is movable upon energization of the solenoid 102 and is connected through a linkage, not shown, to shut off the supply of air to the engine of the locomotive 10 thereby stopping the same.

From the foregoing description it will be apparent that the exhaust conditioner according to the present invention presents many advantages. The chamber 52 enables the gases first to be expanded and then partially cooled by preliminary heat exchange with the water within the reservoir 60 by moving past the partition 53. The same partition also finely divides the gases for dispersion through the water of the chamber 60 further cooling the gases and removing therefrom by solution nitrogen and sulfur oxide compounds and aldehydes. The baffle 67 also provides a means giving a somewhat tortuous path to the gases leaving the surface of the water before entering the dewatering compartment 70, at the same time affording breaking up of the bubbles containing entrained water.

All of the gases leaving the water reservoir 60 must travel over the surface of the limestone fragments in the compartment 70 thereby insuring that chemical and scrubbing action is afforded further to condition the gases. The gases emerging from the compartment 70 and entering the chamber 78 are finally separated from any water contained therein, such separated water returning to the reservoir 60 by the return pipe 83.

The conditioner according to the present invention is capable of use on an eight hour shift without replenishment of the water in the chamber 60. The conditioned gases emanating from the pipe 81 have been lowered in temperature to a value of the order of 150° F., a value well below a maximum permitted in mine safety codes. The gases emerging from the pipe 81 are so reduced in noxious and irritating constituents that when dispersed into the ambient the presence of such constituents in the ambient is maintained well below the maximum permitted amounts.

While the invention has been described in terms of an embodiment which has been found especially suitable in practice, the scope of the invention is intended to be limited only by the terms of the claims here appended.

I claim:

1. A conditioner for removing irritating and noxious constituents from the exhaust gases of a Diesel engine or the like which comprises a housing having therein a reservoir adapted to contain water, a vertical partition spaced from one of the side walls of said housing, said partition defining one wall of said reservoir and a chamber with one wall of said housing, a manifold connected to said chamber and having means therein for diverting exhaust gases in directions alongside said partition, said chamber providing for expansion of exhaust gases from said engine, web members spacing said partition from the said one wall of said housing and having openings extending therealong for equalizing the velocity of the gases entering said chamber from said manifold, the partition providing a surface for heat exchange between the water of said reservoir and said exhaust gases, said partition being foraminated along the bottom portions thereof to divide the partially cooled and expanded exhaust gases into small gaseous streams adapted to bubble up through the water contained in said reservoir, a baffle positioned above the top surface of said reservoir adapted to be impinged by bubbles of said exhaust gas emerging from the water in said reservoir containing entrapped water so as to release the water therefrom, a compartment disposed above said baffle containing fragmented material for entrapment in the voids thereof of water entrained in said exhaust gases not having been so removed by said baffle, said compartment having side walls and at bottom which are foraminated, a chamber within said housing disposed over said reservoir and communicating with said compartment, an exhaust pipe extending from said chamber to ambient, and a return pipe from said chamber to said reservoir, the end of said return pipe extending below the level of the water in said reservoir for returning water to said reservoir which has become entrapped in said last named chamber.

2. A conditioner for removing irritating and noxious constituents from the exhaust gases of a Diesel engine or the like which comprises a housing having therein a reservoir adapted to contain water, a vertical partition spaced from one of the side walls of said housing, said partition defining one wall of said reservoir and a chamber with one wall of said housing, a manifold connected to said chamber and having means therein for diverting exhaust gases in directions alongside said partition, said chamber providing for expansion of exhaust gases from said engine, web members spacing said partition from the said one wall of said housing and having openings extending therealong for equalizing the velocity of the gases entering said chamber from said manifold, the partition providing a surface of heat exchange between the water of said reservoir and said exhaust gases, said partition being foraminated along the bottom portions thereof to divide the partially cooled and expanded exhaust gases into small gaseous streams adapted to bubble up through the water contained in said reservoir, a baffle positioned above the top surface of said reservoir adapted to be impinged by bubbles of said exhaust gas emerging from the water in said reservoir containing entrapped water so as to release the water therefrom, a compartment disposed above said baffle containing fragmented material for entrapment in the voids thereof of water entrained in said exhaust gases not having been so removed by said baffle, said compartment having side walls and a bottom which are foraminated, a chamber within said housing disposed over said reservoir and communicating with said compartment, and an exhaust pipe extending from said chamber to ambient.

3. A conditioner for removing irritating and noxious constituents from the exhaust gases of a Diesel engine or the like which comprises a housing having therein a reservoir adapted to contain water, a vertical partition spaced from one of the side walls of said housing, said partition defining one wall of said reservoir and a chamber with one wall of said housing, said chamber providing for expansion of exhaust gases from said engine, the partition providing a surface for heat exchange between the water of said reservoir and said exhaust gases, said partition being foraminated along the bottom portions thereof to divide the partially cooled and expanded exhaust gases into small gaseous streams adapted to bubble up through the water contained in said reservoir, a baffle positioned above the top surface of said reservoir adapted to be impinged by bubbles of said exhaust gas emerging from the water in said reservoir containing entrapped water so as to release the water therefrom, a compartment disposed above said baffle containing fragmented material for entrapment in the voids thereof of water entrained in said exhaust gases not having been so removed by said baffle, said compartment having side walls and a bottom which are foraminated, a chamber within said housing disposed over said reservoir and communicating with said compartment, an exhaust pipe extending from said chamber to ambient, and a return pipe from said chamber to said reservoir, the end of said return pipe extending below the level of the water in said reservoir for returning water to said reservoir which has become entrapped in said last named chamber.

4. A conditioner for removing irritating and noxious constituents from the exhaust gases of a Diesel engine or the like which comprises a housing having therein a reservoir adapted to contain water, a vertical partition spaced from one of the side walls of said housing, said partition defining one wall of said reservoir and a chamber with one wall of said housing, said chamber providing for expansion of exhaust gases from said engine, the partition providing a surface for heat exchange between the water of said reservoir and said exhaust gases, said partition being foraminated along the bottom portions thereof to divide the partially cooled and expanded exhaust gases into small gaseous streams adapted to bubble up through the water contained in said reservoir, a baffle positioned above the top surface of said reservoir adapted to be impinged by bubbles of said exhaust gas emerging from the water in said reservoir containing entrapped water so as to release the water therefrom, a compartment disposed above said baffle containing fragmented material for entrapment in the voids thereof of water entrained in said exhaust gases not having been so removed by said baffle, said compartment having side walls and a bottom which are foraminated, a chamber within said housing disposed over said reservoir and communicating with said compartment, and an exhaust pipe extending from said chamber to ambient.

5. The invention as defined in claim 4 wherein said reservoir communicates with a closed standpipe having communication with means sensitive to the level in said standpipe for operation of circuit means closing the supply of air to said Diesel engine.

6. A conditioner for removing irritating and noxious constituents from the exhaust gases of a Diesel engine or the like which comprises a housing having therein a reservoir adapted to contain water, a vertical partition spaced from one of the side walls of said housing, said partition defining one wall of said reservoir and a chamber with one wall of said housing, a manifold connected to said chamber and having means therein for diverting exhaust gases in directions alongside said partition, said chamber providing for expansion of exhaust gases from said engine, the partition providing a surface for heat exchange between the water of said reservoir and said exhaust gases, said partition being foraminated along the bottom portions thereof to divide the partially cooled and expanded exhaust gases into small gaseous streams adapted to bubble up through the water contained in said reservoir, a baffle positioned above the top surface of said reservoir adapted to be impinged by bubbles of said exhaust gas emerging from the water in said reservoir containing entrapped water so as to release the water therefrom, a compartment disposed above said baffle containing fragmented material for entrapment in the voids thereof of water entrained in said exhaust gases not having been so removed by said baffle, said compartment having side walls and a bottom which are foraminated, a chamber within said housing disposed over said reservoir and communicating with said compartment, an exhaust pipe extending from said chamber to ambient, and a return pipe from said chamber to said reservoir, the end of said return pipe extending below the level of the water in said reservoir for returning water to said reservoir which has become entrapped in said last named chamber.

7. A conditioner for removing irritating and

noxious constituents from the exhaust gases of a diesel engine or the like which comprises a walled housing, a vertical partition spaced from one of the walls of said housing so as to divide said walled housing into two side by side walled chambers, one of said chambers being substantially smaller than the other and being connected to the exhaust manifold of said engine so as to enable exhaust gases to be expanded therein, the second of said chambers containing a body of liquid, said vertical partition providing a surface for heat exchange between the liquid of said second chamber and said exhaust gases and being foraminated along the bottom portions thereof to divide the partially cooled and expanded exhaust gases into small gaseous streams which bubble up through the liquid contained in said second chamber, a baffle positioned above the top surface of said second chamber arranged to be impinged by bubbles of said exhaust gas emerging from the liquid in said second chamber containing entrapped liquid so as to release the liquid therefrom, a compartment disposed above said baffle containing intersticed material for entrapment in the interstices thereof of liquid entrained in said exhaust gases not having been so removed by said baffle, said compartment having side walls and a bottom which are foraminated for return of liquid from said intersticed material to said second chamber, a further chamber disposed over said second chamber and communicating with said compartment, an exhaust pipe leading from said compartment to ambient, and a return pipe from said further chamber to said second chamber, the end of said return pipe extending below the level of the liquid in said second chamber.

8. A conditioner for removing irritating and noxious constituents from the exhaust gases of a Diesel engine or the like which comprises a walled housing, a vertical partition spaced from one of the walls of said housing so as to divide said walled housing into two side by side walled chambers, one of said chambers being substantially smaller than the other and being connected to the exhaust manifold of said engine so as to enable exhaust gases to be expanded therein, the second of said chambers containing a body of liquid, said vertical partition providing a surface for heat exchange between the liquid of said second chamber and said exhaust gases and being foraminated along the bottom portions thereof to divide the partially cooled and expanded exhaust gases into small gaseous streams which bubble up through the liquid contained in said second chamber, a baffle positioned above the top surface of said second chamber arranged to be impinged by bubbles of said exhaust gas emerging from the liquid in said second chamber containing entrapped liquid so as to release the liquid therefrom, a compartment disposed above said baffle containing intersticed material for entrapment in the interstices thereof of liquid entrained in said exhaust gases not having been so removed by said baffle, said compartment having side walls and a bottom which are foraminated for return of liquid from said intersticed material to said second chamber, and an exhaust pipe leading from said compartment to ambient.

9. The invention as defined in claim 8 wherein said second chamber communicates with a standpipe, and wherein means are provided sensitive to the level in said standpipe for operation of circuit means controlling the operation of said Diesel engine.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,867,325	Neville	July 12, 1932
2,017,481	Von Opel	Oct. 15, 1935
2,612,745	Vecchio	Oct. 7, 1952

FOREIGN PATENTS

Number	Country	Date
249,464	Great Britain	Aug. 14, 1925
466,321	Great Britain	May 26, 1937