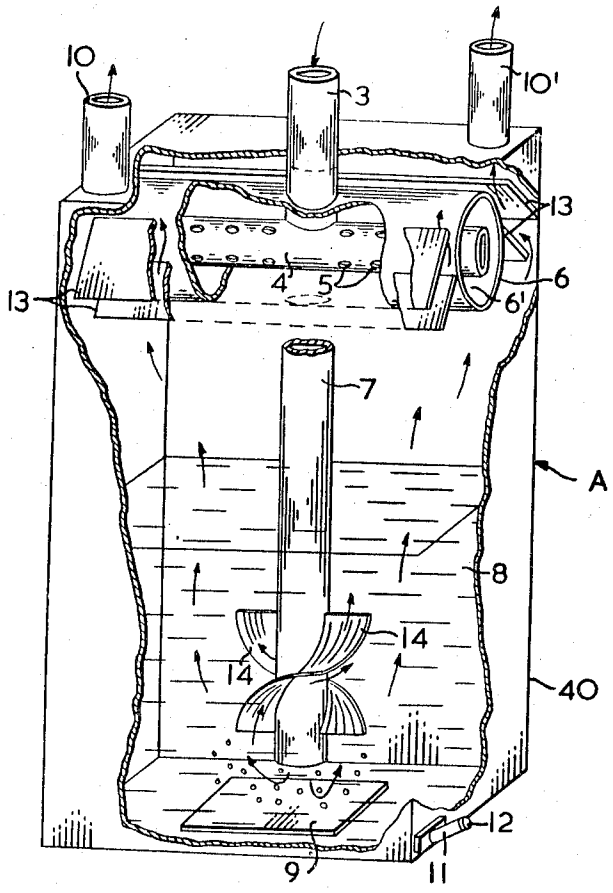
May 2, 1967 R. B. FERMOR 3,316,693

EXHAUST GAS TREATING DEVICE

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Fig 1



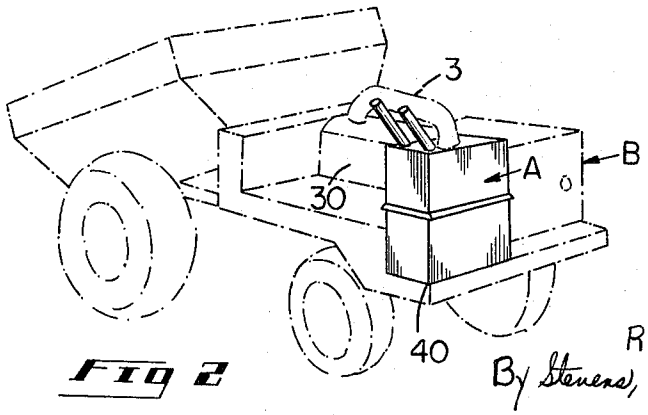


Fig 2

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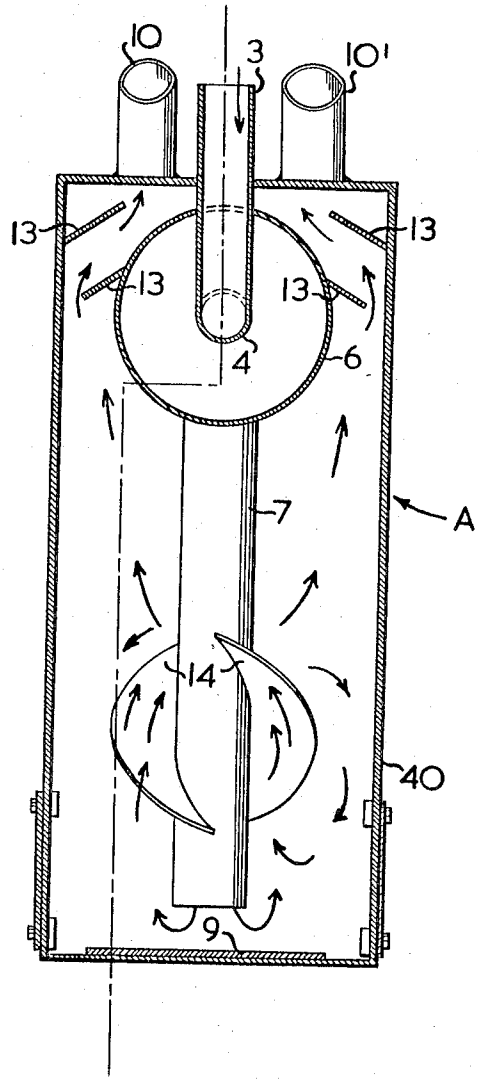
May 2, 1967 R. B. FERMOR 3,316,693

EXHAUST GAS TREATING DEVICE

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Fig 3



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EXHAUST GAS TREATING DEVICE

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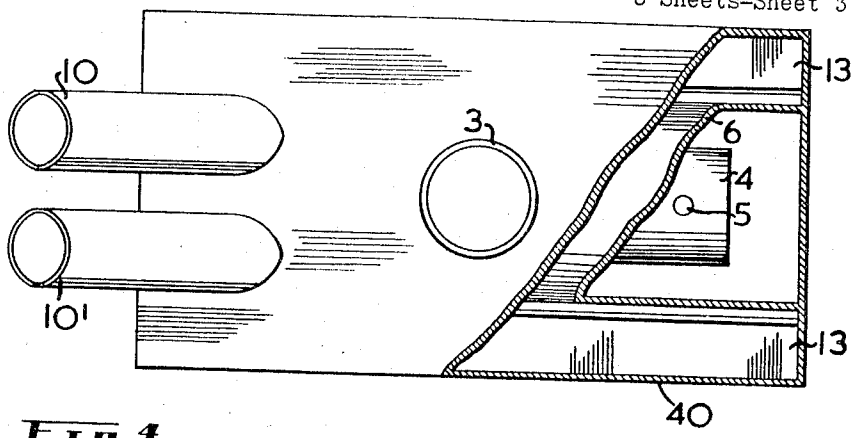


Fig 4

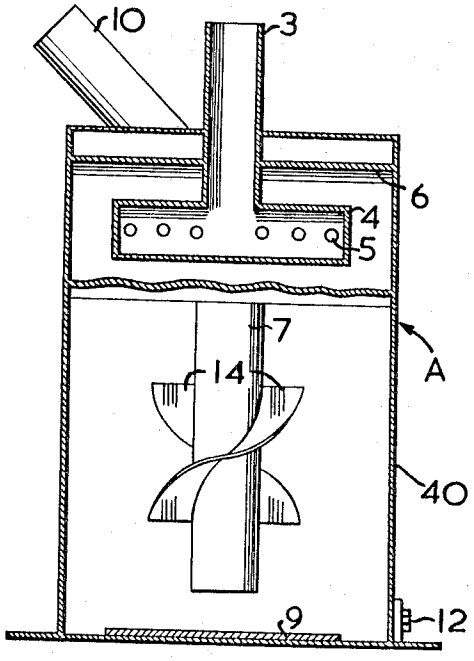


Fig 5

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EXHAUST GAS TREATING DEVICE

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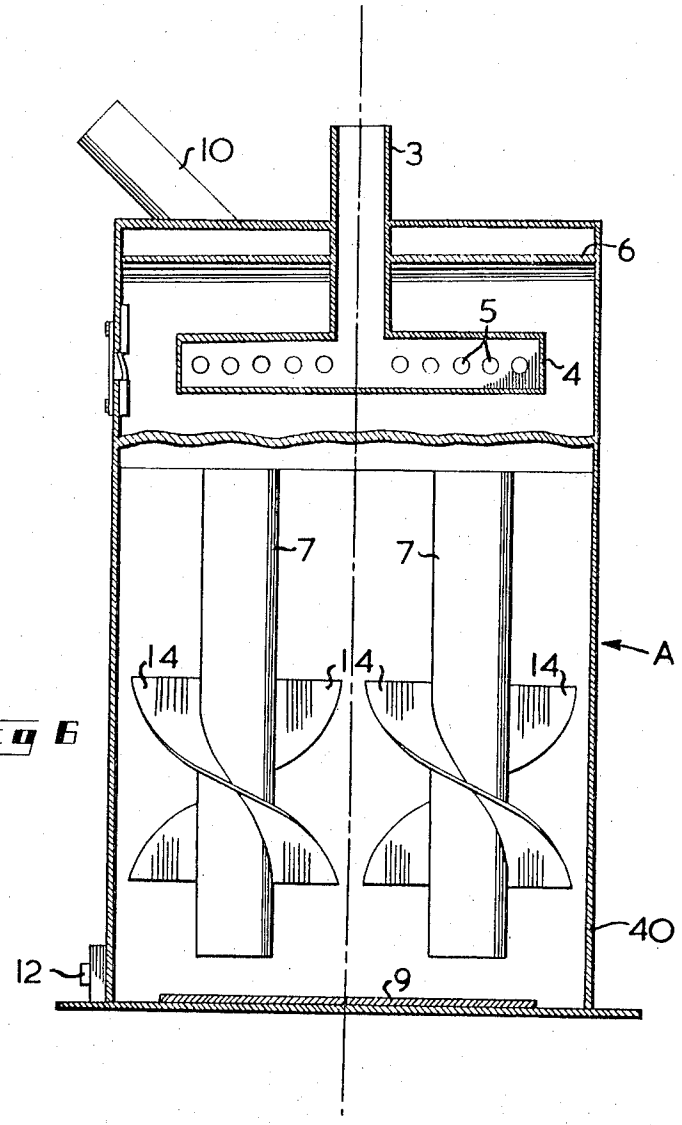


Fig 6

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EXHAUST GAS TREATING DEVICE

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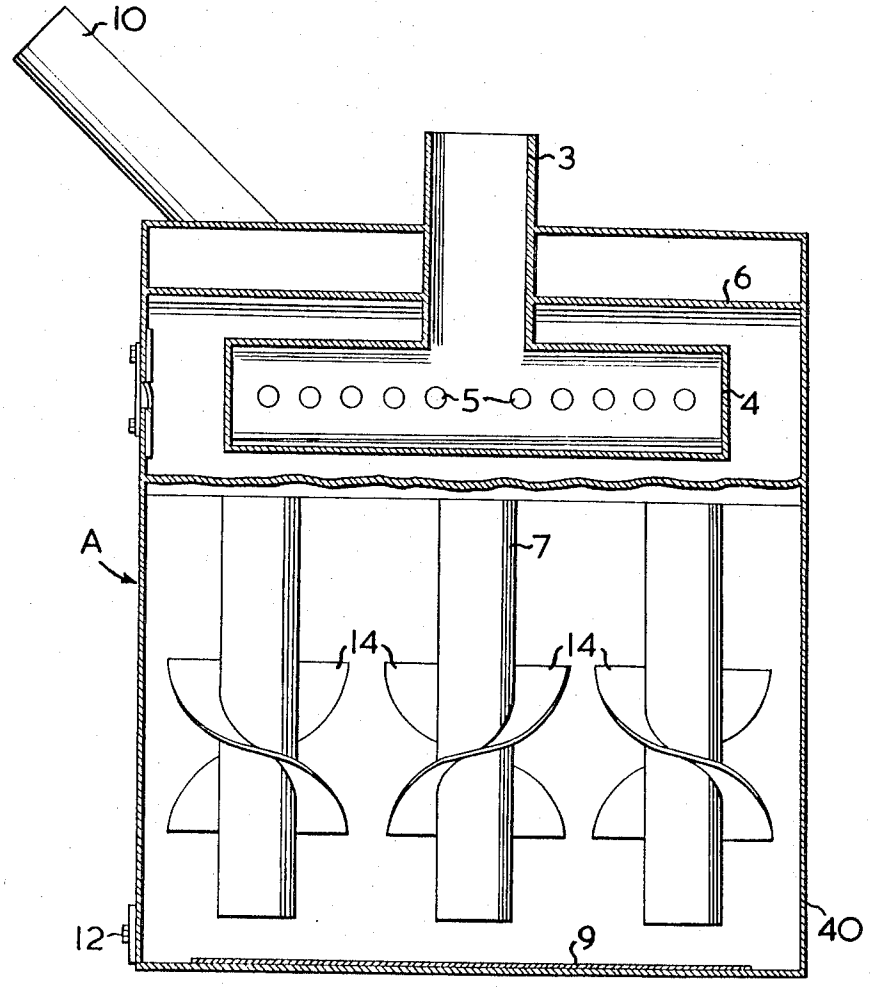


Fig 7

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Patented May 2, 1967

3,316,693

EXHAUST GAS TREATING DEVICE

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Claims priority, application Canada, Apr. 24, 1963, 873,976
6 Claims. (Cl. 55—248)

This invention relates generally to a gas scrubber and conditioner. More particularly, the invention relates to a conditioner for scrubbing and conditioning exhaust gases produced by internal combustion engines.

In the use of combustion enignes in underground mining operations, or in restricted areas where engine exhaust gases build up rapidly, it is desirable to use means such as a scrubbing system to reduce the build-up of noxious fumes. Furthermore, the use of a scrubber lessens the possibility of mine explosions caused either by hot spots in the exhaust system or exhaust flames.

The following specific discussion of engine back pressure and scrubber water loss will assist in a full understanding of the problems involved in relation to gas scrubbers and conditioners.

Engine back pressure

In adding a scrubber to the engine exhaust, the engine back pressure will be increased, when operating, by that of the scrubber itself.

In modern internal combustion engines, improved performance has been gained by intensive study of each engine design feature. These characteristics are balanced together under working conditions to achieve optimum engine performance with the greatest operating economy and power output. The ever increasing engine operating speeds have resulted in the characteristics of detailed engine design becoming progressively more critical.

Improved performance has been gained by intensive research into piston and cylinder head design, improving engine breathing characteristics, gas flow, closer valve timing, careful port design, improved scavanging, higher compression ratios, etc. coupled with higher r.p.m.

To enjoy the benefits of these advances, therefore, both in two and four stroke engine performances, it is essential to reduce scrubber back pressure to a minimum.

A poorly designed scrubber with high back pressure characteristics is an excellent device for defeating the modern engine designers aims of improved engine performance.

Excessive back pressure will result in the rapid build-up of carbon deposits from unbalanced combustion, affect the engine performance, promote local "hot spots," and finally seriously interrupt the correct gas flow in the engine with resulting loss of engine performance, higher fuel and oil consumption and increased maintenance costs. Increasingly poor engine performance will be provoked by deteriorating fuel combustion characteristics which will, in turn, give rise to a significant increase in injurious exhaust gases from the engine.

It has been found that a well designed scrubber balanced with the corresponding engine exhaust volume, will give the following scrubber back pressure readings:

	P.s.i.
(a) Idling	0.4 to 0.5
(b) At half throttle	0.5
(c) At full throttle	0.55 to 0.65

such values do not interfere with satisfactory engine performance and maintenance.

Scrubber water loss

Approved diesel machines for mines must be capable of

reducing the exhaust gas system to 160° F. under any operating condition. It has been found under test conditions and different throttle settings, that exhaust temperature readings with the scrubber full of water should range from 97° F. to 108° F.

No water droplets should be visible on the scrubber exhaust pipes as all water should be lost as vapor only. Water droplets indicates that the exhaust gas velocities are too great in the scrubber and that too much of the water will be lost before the end of a working shift. (Under practical working conditions it is necessary to have sufficient water for a complete shift.) Scrubber water capacity must take account of water surge when the vehicle is travelling on grades, travelling and also starting and stopping. Sufficient water should be available in the scrubber just before the shift terminates. An additional scrubber water make up tank, valves and connections results in a disproportional increase in weight and increased maintenance cost compared with a light-weight scrubber, provided the scrubber is well designed. Poor scrubber design or too small a scrubber in proportion to engine exhaust volume, will inevitably increase exhaust gas velocities through the scrubber with resultant high water loss and high scrubber back pressure. In some scrubbers, to control high water loss, baffles have been added, with or without limestone beds, while water losses are reduced by these methods; scrubber back pressure will inevitably be increased. This is of course a very undesirable feature. Scrubber water losses and corrosive action will increase disproportionally as the water volume in the scrubber decreases. It is possible that high scrubber gas temperatures may tend to increase the proportion of oxides of nitrogen at the scrubber exhaust.

Desired characteristics of an efficient conditioner

Previously known scrubbing systems tend to consume excessive quantities of scrubbing liquid besides being bulky, inefficient, and complex. The use of prior art scrubbers also result in a high back pressure being placed on the engines. This markedly reduces engine performance since present-day engines are designed to operate within certain critical limits. If the exhaust gases of gasoline, diesel, or other internal combustion motors are properly conditioned, they may find more extensive use where previously more expensive and less adaptable types of drive systems were thought to be necessary. Diesel motors with their well known advantages of low fuel costs, simplicity, and operating reliability, could thus be utilized in locations not previously thought possible; for example the use of internal combustion motors in underground mining operations where normal exhaust systems are dangerous because exhaust flames, hot exhaust gases, or hot spots in the exhaust system could ignite explosive gases present in the mines, resulting in fatal explosions. It is also desirable particularly with underground use, to remove as much as possible of the noxious materials present in the exhaust gases so as to permit operation of engines in confined spaces.

In the construction of exhaust gas conditioners a number of important factors should be taken into consideration. For example, engine back pressure must be reduced to a minimum, otherwise engine performance will be adversely affected since increased back pressure results in less complete fuel combustion with a consequent increase in noxious gases, as well as carbon build-up in the engine. In exhaust gas conditioners which utilize a liquid, the liquid losses must be reduced to a reasonable minimum so as to allow a maximum operating period before maintenance is necessary. In addition, the exhaust gases expelled from the conditioner should also be directed away from the vicinity of any personnel around the machine and

should be prevented from recirculating through the engine. The construction of the gas conditioner or scrubber must also be such that it may easily be mounted on a motorized vehicle without impairing the operator's visibility, without requiring alteration of the structural design, or without interfering with vehicle handling characteristics.

A satisfactory exhaust gas conditioner should also be constructed with the minimum expense, be resistant to corrosion so that it will be easy to maintain and service, and should also be highly efficient to occupy the minimum of space.

The present invention meets these requirements. It is, in fact, a general object of this invention to fill the need for a system which will overcome the drawbacks of prior devices and will also satisfy the requirements and problems apparent from the above discussion.

The present invention fills this need and provides a scrubbing system which may be used to reduce the emission of noxious fumes and the danger of mine explosions caused by hot exhaust gases.

A further general object of this invention is to provide an exhaust gas treating device for internal combustion engines which will cool the exhaust gases, trap exhaust gas flames, and remove noxious elements from the exhaust gases.

Other objects and advantages of the invention will become apparent from the following description.

According to the present invention a conditioner system for the exhaust gases from a diesel engine or the like comprises a housing, means adapted to introduce gases into the conditioner, a perforated flame tube positioned both to receive the gases and adapted to reduce exhaust gas pulsations, a gas expansion chamber formed around said flame tube, a body of gas conditioning liquid in the base of the housing, conduit means adapted to receive exhaust gases from said flame tube and exhaust them in said liquid, generally outwardly extending vanes on said conduit means, said vanes being positioned generally in the upwardly flowing path of gas bubbles exhausted from said conduit means whereby said gas bubbles impinge upon said vanes causing deviation from their normal upward path thereby extending the gas-liquid contact within the system and an exhaust outlet to the atmosphere for the gas so condiioned.

A preferred embodiment of the invention is illustrated in the following diagrams in which:

FIGURE 1 is a partly cut-away perspective view showing a preferred embodiment of the invention;

FIGURE 2 is a perspective view of one form of the invention mounted on a vehicle;

FIGURE 3 is an end view of the present invention;

FIGURE 4 is a plan view of an alternative form of the present invention;

FIGURE 5 is a cross-sectional view of an alternative form of the invention of FIGURE 4;

FIGURE 6 is a sectional view of an alternative form of the invention employing a pair of down flow pipes; and

FIGURE 7 is a sectional view of an alternative form of the invention employing three down flow pipes.

The scrubber illustrated generally at A may be mounted on a vehicle B as shown in FIGURE 2. An engine exhaust tube **3** extends from an engine **30** through a scrubber housing **40**. The exhaust tube **3** is connected to a generally horizontal perforated flame tube **4** which is mounted within an annular casing **6**. An expansion chamber **6'** is thus formed between the tube **4** and the casing **6**. A generally vertically disposed flow tube **7** extends downwardly from the flame tube **4** into scrubbing liquid **8** contained in the lower area of the scrubber housing **40**. Helical vanes **14** are mounted on the flow tube **7**. Deflector plates **13** may be mounted in the housing **40** and the expansion chamber **6'** as shown in FIGURES 1 and 3. The plates **13** are constructed and designed to deflect the gas into the exhaust pipes **10** and **10'**.

In operation the scrubber A may be mounted on vehicle B. It should be positioned so as to interfere as little as possible with the maneuverability of the vehicle. The vehicle exhaust gases pass from the engine through the exhaust tube **3** and into the perforated flame tube **4** as can be seen from FIGURE 1. The flame tube **4** has perforations **5** formed therein which may be drilled, for example, in what may be loosely termed the top and side areas of the flame tube **4**. Both ends of the tube **4** are closed. The combined area of the perforations **5** is greater than the area of the opening in the tube **3** which entrains the exhaust gases from the engine into the tube **4**. This feature ensures that back pressure losses are reduced to a minimum. The function of the tube **4** is to reduce exhaust gas pulsations to a minimum, thus producing as steady a gas flow as possible through the scrubber. From the flame tube **4** the exhaust gases pass into the expansion chamber **6'**. There the gases are expanded before entering the generally vertical flow tube **7** which extends into the scrubbing liquid **8**. The gases are bubbled through the liquid **8** in the manner indicated in FIGURE 1. A flap valve may also be positioned at one end of the gas chamber if this appears desirable at the time of use. Such a valve is desirable to stop the sucking back of fluid into the engine should the engine backfire on starting. This feature may be more necessary when fitted to scrubbers serving engines having only one or two cylinders. It may be noted that due to the area of the perforations in the flame tube **4** the exhaust gases are permitted to flow quickly into the expansion chamber where they expand and create a pressure drop between the flame tube **4** and the expansion chamber, thereby minimizing back pressure losses in the engine. The action of expansion also causes a certain amount of thermodynamic cooling of the exhaust gases as they expand upon entry into the chamber **6'**.

As indicated the gases then enter the scrubbing liquid **8** at the bottom of the housing through the flow tube **7** and then reverse upwardly through the scrubber liquid after striking the protector plate **9** as can be seen from the arrowed path defined in FIGURE 1. The plate **9** is desirable to protect the base of the scrubber from corrosion which is found to be at its greatest at this point since the mixture of gas and liquid is at its hottest in this area. The mixture of gases and liquid then follow a generally upward path defined by the arrows and impinges upon the helical vanes **14** which impart a generally spiral or swirling motion to the exhaust bubbles and so lengthen the contact path. This ensures maximum contact between the gas and the liquid. The helical vanes may be welded to the outside of the flow tube **7**. Helical vanes shaped after the fashion of those in FIGURE 3 are believed likely to be more effective than vanes such as those shown in FIGURE 5 for example. The swirling motion caused by contact with the helical vanes also prevents the liquid from escaping through the exhaust pipes **10** and **10'** and gives the maximum cooling effect to the gases with minimum scrubber height and back pressure. This is found to be an important feature and one which was not taught by the prior art. The gases are then passed through the deflection plates **13**, past the expansion chamber **6'** and so out through the exhaust pipe **10** to the atmosphere. The deflectors permit the formation therein of condensation from the water in the scrubber. The condensation drops back from the deflectors into the body of water. Without the deflectors the condensation would tend to be exhausted through the scrubber. This would of course be undesirable.

The scrubber may be filled with liquid to a predetermined level approximately two inches above the top of the helical vanes. It seems clear that the more water there is present in the scrubber the more back pressure may be developed. Additionally if the water is too high in the scrubber there is a danger that it cover the exhauster back through the pipes **10** and **10'**. A fluid

drain pipe 11 is also provided having a cap 12 for periodical liquid drainage from the scrubber.

The present invention has been developed to reduce vehicle engine back pressure to a minimum and to gain the greatest reduction in vehicle exhaust temperatures possible in relation to weight and cost of construction. Aluminum for construction has been found to be a most suitable material for both lightness and resistance to corrosion. Steel construction can also be used, but the materials are heavy and may therefore be objectionable and corrosion may prove to be a marked disadvantage. An aluminum scrubber for scrubbing vehicle exhaust gases should last approximately three times longer than one built of steel. The present scrubber may also be applied to scrubbing gases other than vehicle gases using water with other chemical additives or other fluids with various chemical contents.

Scrubber size may be proportioned according to the volume of gas to be scrubbed. The number of scrubber cells (tube 7, vanes 14, etc.) required may also be varied according to the gas volume to be scrubbed. A marked feature of the present scrubber is the low liquid loss under working conditions. This is especially important when vehicles are used underground.

FIGURES 6 and 7 show scrubbers employing a plurality of down flow pipes with helical vanes. These are sometimes referred to as cells by those skilled in the art. A multi-cell scrubber may be more advantageous for certain cases. For example a rectangular multicell scrubber has been found to be the most suitable shape for the larger diesel units. In the case of smaller diesel units a cylindrically shaped single cell scrubber has certain advantages. It has a better overall efficiency than the rectangular shaped scrubber of equal capacity and is also of stronger construction and less liable to damage as there are no corners to it. Scrubber construction is also simpler. In the larger scrubbers, a height of forty-four inches is convenient for most vehicle mounting applications and is a reasonable balance for water height and water droplet control. A width of twenty-one inches is suitable for vehicle scrubber location. Scrubber length and corresponding volume is dependent on the gas velocities needed to control varying engine exhaust capacities and the number of scrubber cells required. It is essential that the vehicle operator's vision is not impeded.

The advantages of the present scrubber over the prior art will now be apparent. These advantages have already been well recognized by men skilled in the art.

I claim:

1. A conditioner system for the exhaust gases from a diesel engine or the like comprising:
(a) a housing;
(b) means adapted to introduce gases into the housing;
(c) said means adapted to introduce gases into the housing including a perforated flame tube;
(d) a gas expansion chamber formed around said flame tube comprising an annular casing mounted generally concentrically and longitudinally of said flame tube which permits gases emitted from said flame tube to expand;
(e) a body of gas conditioning liquid in the base of the housing;

(f) conduit means connected to and in communication with said expansion chamber and adapted to receive exhaust gases from said expansion chamber and exhaust them into said liquid;
(g) the lower end of said conduit means being submerged in said conditioning liquid;
(h) outwardly extending vanes of generally helical formation on said conduit means;
(i) said vanes being positioned below the liquid level and in the upwardly flowing path of the gas bubbles exhausted from said conduit means, whereby said gas bubbles impinge upon said vanes causing deviation from their normal upward path, thereby extending the gas-liquid contact within the system;
(j) an exhaust outlet from said housing to the atmosphere for the gas so conditioned including means for guiding the flow to atmosphere of condition gases leaving said liquid;
(k) said guiding means comprising a baffle assembly disposed above the surface of said liquid, including a first set of baffles attached to said annular casing extending out from said casing and terminating short of said housing and a second set of baffles extending out from said housing in overlying relation to said first set of baffles and terminating short of said annular casing.

2. A conditioner system as defined in claim 1, wherein said conduit means includes a tube which is of substantially vertical disposition.

3. A conditioner system as defined in claim 1, wherein said perforated flame tube is closed at both ends.

4. A conditioner system as defined in claim 1, including a protector plate located on the base of said housing and positioned to contact the liquid-gas flow caused by the exhaust emission from said conduit means.

5. A conditioner system as defined in claim 1, wherein said means adapted to introduce gases into the housing includes an opening and the total area of perforations in said flame tube is greater than the area of said opening.

6. A conditioner system as defined in claim 1, wherein said perforated flame tube is of a generally horizontal disposition when the conditioner system is in a normal operating position.

References Cited by the Examiner

UNITED STATES PATENTS

661,276	11/1900	Reenstierna.	
1,144,342	6/1915	Andrews	261—123 X
1,223,684	4/1917	Fleming	55—256
2,508,297	5/1950	Ruth	55—255
2,686,399	8/1954	Stoltz	55—25 X
2,745,646	5/1956	Stoltz	261—123
2,777,536	1/1957	Thomas et al.	55—248
2,787,119	4/1957	Giambruno.	
2,911,289	11/1959	Forry	60—30 X

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