

July 3, 1962

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3,042,499

BURNER-MUFFLER

Filed Sept. 29, 1958

2 Sheets-Sheet 1

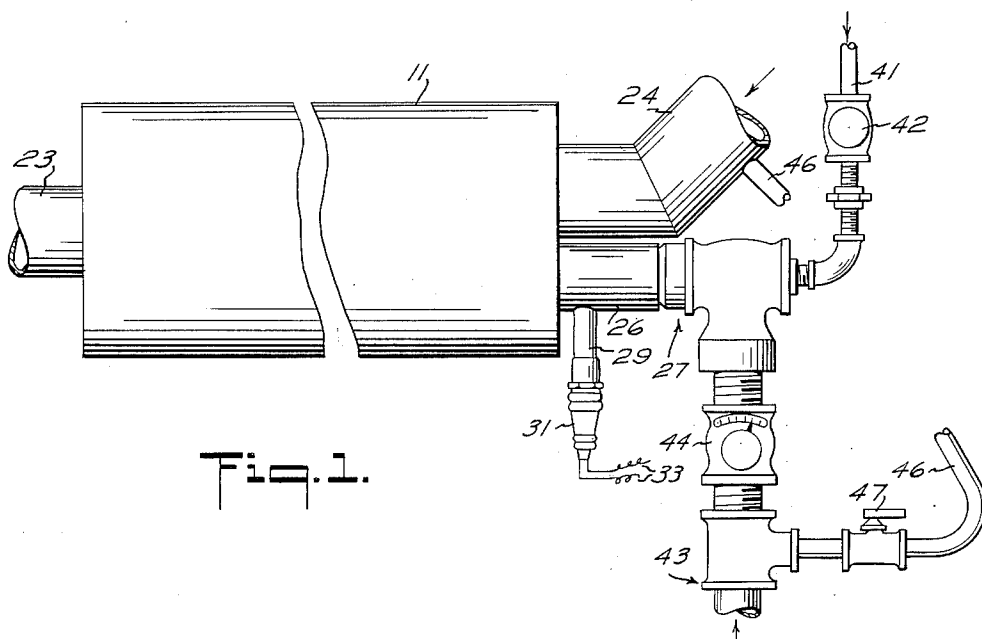


Fig. 1.

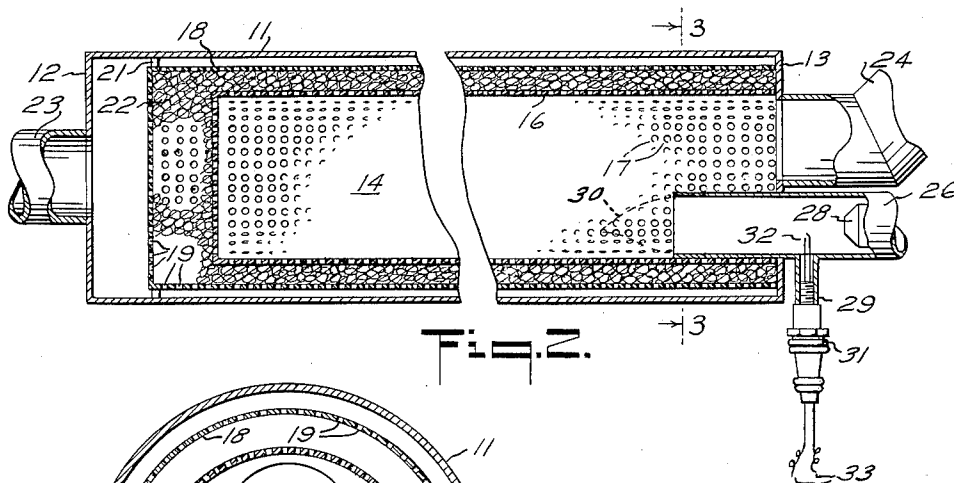


Fig. 2.

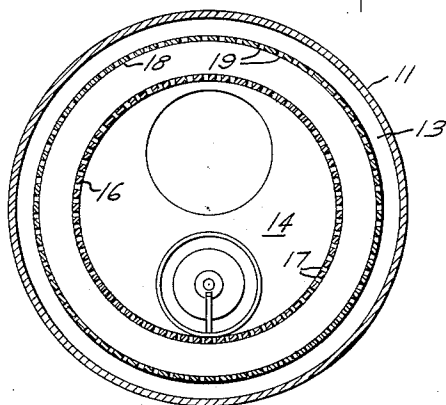


Fig. 3.

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2 Sheets-Sheet 2

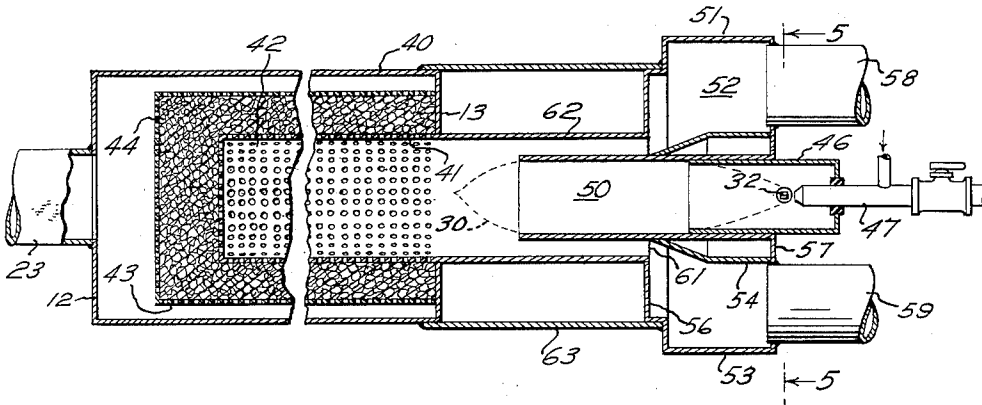


Fig. 4.

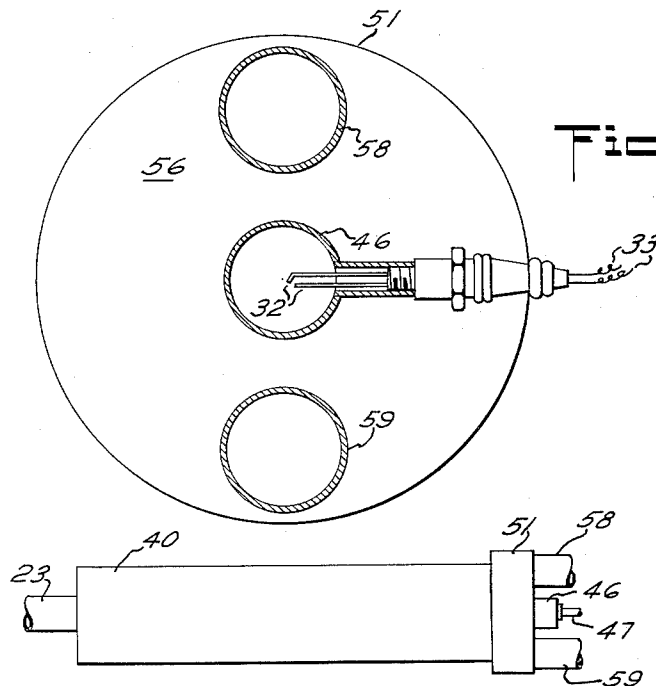


Fig. 5.

Fig. 6.

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BURNER-MUFFLER

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2 Claims. (Cl. 23—277)

The present invention relates to an improved combined combustion and muffler element and comprises a continuation-in-part of my copending patent application Serial No. 712,962, filed February 3, 1958, for an Exhaust Gas Purifier, now Patent No. 2,956,865, issued October 18, 1960.

In combustion engines there are produced certain exhaust gas products which are highly undesirable. In particular, incompletely burned fuel is exhausted from combustion engines in the interest of good engine operation and as a result the exhaust gases are noisome, odiferous, unsightly and sometimes poisonous. As it does not appear feasible to operate combustion engines upon a cycle wherein every bit of entering fuel is completely burned there has resulted an increasing pollution of the air from the large number of combustion engines employed. In particular, highly populated areas wherein a large number of trucks, buses, and automobiles are concentrated there has arisen air pollution problems of such a degree as to seriously endanger the health of the populace.

Although automotive combustion engines are almost universally equipped with exhaust mufflers for reducing the volume of noise, the more serious problem of unclean exhaust gases is widely ignored. While noise muffling poses only a relatively minor problem, the cleansing of exhaust gases to economically remove smoke and noxious fumes and substances is much more difficult as cleansing means of extensive and complicated nature are known; however, these are limited in applicability to large installations and provide no solution to the problem of cleansing the exhaust gases of a multitude of separate and unrelated engines.

In the cleansing of exhaust gases for automotive combustion engines it is necessary to provide satisfactory operation under a wide variety of conditions from engine idling to acceleration and deceleration as well as steady high speed conditions. In accordance with the teachings of my above referenced copending patent application, the present invention operates to further burn exhaust gases after scavenging of same from an engine and as no power need be derived from this further burning it is possible to continue same to substantial completion. In this manner normal exhaust gas constituents such as carbon monoxide, hydrocarbons and aldehydes are fully eliminated.

The present invention combines the functions of noise muffling and additional combustion or burning in a single unit readily adapted for installation upon automobiles and the like in the place of conventional mufflers. In order to insure optimum operation during all stages of engine operation, the present invention provides for a steady air flow therethrough as well as a small but steady auxiliary fuel flow so that a constant ignition flame is provided. Whatever the type of engine operation, steady state or changing, the ignition flame herein persists, to maintain the exhaust temperature in the burner muffler thereof sufficient for complete burning or reacting of exhaust gases. Particular advantage herein lies in the provision of structure capable of sustaining a desired minimum temperature level without regard to engine operating conditions so that in no instance is it possible for exhaust gas to escape without undergoing complete combustion.

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It is an object of the present invention to provide means for completing the combustion of engine exhaust gas.

It is another object of the present invention to provide a muffler unit having auxiliary combustion means operative under all conditions of engine operation.

It is a further object of the present invention to provide an improved automotive muffler having means supporting a continuous flame therein for completing burning of exhaust gases.

It is yet another object of this invention to provide a burner muffler exerting minimum obstruction to gas flow therethrough and having protected flame means with independent air supply for completing combustion of exhaust gases entering the muffler.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the preferred forms of the invention which is illustrated in the drawings accompanying and forming part of the specification. It is to be understood, however, that variations in the showing made by the said drawings and description may be adopted within the scope of the invention as set forth in the claims.

The invention is illustrated in the accompanying drawings wherein:

FIGURE 1 is a side view of the burner-muffler with coupled piping.

FIGURE 2 is a sectional view in a median plane along the axis of the burner-muffler of FIGURE 1.

FIGURE 3 is a transverse sectional view taken on the plane 3—3 of FIGURE 2.

FIGURE 4 is a sectional view in a median plane along the axis of an alternative embodiment of the invention.

FIGURE 5 is a transverse sectional view taken on the plane 5—5 of FIGURE 4.

FIGURE 6 is a side elevational view of the unit shown in FIGURES 4 and 5, but on a reduced scale.

Considering now one preferred embodiment of the invention in some detail and referring to FIGURES 1-3 of the drawings there will be seen to be provided an outer cylindrical shell 11 having integral end plates 12 and 13 secured thereto as by welding to form a rigid structure. Axially on the shell 11 there is defined a reaction chamber 14 by an inner tube 16 secured as by welding to the front end plate 13 and extending well short of the other end plate 12. This inner tube has a closed end and is provided with a large number of small closely spaced perforations 17 for the passage of gas radially outward therethrough. An intermediate tube 18 is disposed concentrically about the inner tube 16 immediately interior of the shell 11 and is firmly secured, as by welding, to the front end plate 13. This intermediate tube is longer than the inner tube and also has a closed end thus displaced from the inner tube, while a large number of closely spaced perforations 19 are also formed in the intermediate tube. The shell and tubes are all rigidly mounted upon the end plate 13 to preserve the spacing therebetween, although spacing lugs 21 may be provided outwardly from the intermediate tube to engage the shell 11 and fix the relative disposition of shell and tube.

As it is intended to maintain burning within the chamber 14, there is provided a mass of porous refractory material 22 packed between the tubes 16 and 18 and a suitable material has been found to be foundry slag. This refractory packing 22 serves the purpose of heat insulation about the chamber and also of noise muffling while at the same time presenting a minimum resistance to gas flow therethrough.

Connections to the burner-muffler include an outlet pipe 23 communicating with the interior of the outer shell 11 through the end wall 12 and adapted to carry away gas from the burner-muffler, and may, for example, con-

sist of a conventional automotive exhaust tail pipe or be adapted for attachment to same. An exhaust gas inlet pipe 24 communicates with the reaction chamber 14 through the front end plate 13, terminating as here shown at this end plate, so that exhaust gas from an engine discharges therethrough directly into the reaction chamber 14. The inlet pipe 24 is located off-center in the end plate 13 and formed so as to direct exhaust gas longitudinally into and through the reaction chamber. A burner tube 26 extends through the end plate 13 and longitudinally into the chamber. As will be understood the combined cross sectional area of the perforations in the inner tube and as well as that of the perforations in the intermediate tube, are each at least equal to that of the cross-sectional area of the pipe 24, so that no back pressure will be produced in the exhaust line.

Combustion within the chamber 14 is initiated and maintained through the burner tube 26 which extends a considerable distance into the reaction chamber 14. This burner tube connects exteriorly of the shell with a burner unit 27 provided with a burner nozzle 28 which extends into the burner tube. A short side pipe 29 communicates with the burner tube outside the shell and is threaded to receive a spark plug 31 having electrodes 32 extending into the burner tube in front of the nozzle 28. Suitable electrical power supply means (not shown) provides spark plug energization through leads 33 to cause an ignition spark between the spark plug electrodes 32 whereby a suitable combustible mixture emitted from the nozzle 28 is ignited.

In the interest of insuring continuous combustion in the chamber 14 there is provided an external air and fuel mixture to the burner 27 and as may be seen in FIGURE 1 a fuel line 41 connects from the burner 27 through a needle valve 42 to a fuel supply, not shown. An air line 43 connects the burner 26 through a control valve 44 to a source of pressurized air, such as a battery driven compressor, providing a constant air flow independent of engine operation. Also associated with the air system, is a small secondary line 46 which connects air line 43 through a shut-off valve 47 to the exhaust gas inlet 24 for reasons described below.

In operation there is supplied to the burner 27 a flow of air through the air line 43 and a flow of fuel through the fuel line 41, and the air and fuel are intimately mixed in the burner 27 and ejected through the nozzle 28 as a highly combustible mixture. The fuel mixture from the nozzle 28 is ignited by a spark between the spark plug electrodes 32, preferably synchronized with engine ignition in a conventional manner. There is thus produced a steady adjustable flame 30 in the burner tube 26 and this flame extends through the burner tube into the reaction chamber 14. As exhaust gas from the engine passes through the exhaust inlet pipe 24 to enter the chamber the gas is ignited by the aforementioned flame extending from the burner tube 26. By the addition of air to the exhaust gas through the secondary air line 46 the combustibility of the exhaust gas is increased so that the exhaust gas is fully burned within the chamber. The fully burned gas from the chamber escapes radially from the chamber to pass through the inner and intermediate tubes 16 and 18 respectively and the refractory material 22 therebetween so as to then pass out of the shell via the exhaust outlet 23.

Owing to the varying conditions of engine operation there is a highly variable exhaust gas flow through the burner-muffler including conditions of very large quantity flow. By the present invention the burner flame is maintained in an efficient condition and fully protected from extinguishment. This is due largely to the fact that not only is there provided a very considerable distance between the burner nozzle and the outlet orifice of tube 26 into chamber 14, but a large portion of the tube extends through such chamber. By reason of said length of the tube, ample opportunity is afforded the mixture in the tube to

become thoroughly intermixed and provide a flame of considerable length in the tube and adjacent the orifice. Furthermore, since a large portion of the tube is positioned directly within the reaction chamber, the efficient ignition and burning of the mixture in the tube and the production of a strong flame will be assured. Of very considerable importance is the relationship in the positioning of the tube 26 and the discharge orifice thereof in relation to the entry of the exhaust gas into and the flow thereof through the reaction chamber. As will be evident from FIGURE 2, the direction of flow of exhaust gas and the projection of the flame in the burner tube are parallel and therefore the force of the incoming gas stream will not be directed at the flame, and at the same time the tube will provide a complete shield for the flame in the tube. Thus the flame will be practically immune from interference by the gas flow and will be continuous and substantially independent of engine operation. It may be also noted, the fuel and air supplied to the burner nozzle supports combustion in itself without the necessity of other combustible gas being present so that during engine deceleration when excessively rich exhaust gas enters the burner-muffler the flame will nevertheless persist.

An alternative embodiment of the invention illustrated in FIGURES 4 and 5 is particularly adapted for use with engines undergoing severe acceleration or deceleration wherein very wide variations in exhaust gas flow pressure or mixture results. In this structure the outer cylinder 40 has within it an apertured inner tube 41 defining a reaction chamber 42 and an apertured intermediate tube 43 encompassing the porous refractory material 44 about the inner tube. The burner tube 46 extends along the longitudinal axis of reaction chamber 42 and is provided with an extension 50 which projects into the chamber. The burner 47 is spaced a considerable distance from the chamber as in the above described embodiment. Exhaust gas is directed into the reaction chamber from an exhaust gas manifold 51 having an annular exhaust gas chamber 52 disposed in part about the extension tube 50. This chamber 52 is formed by annular outer and inner walls 53 and 54 of the manifold, and the wall 54 is tapered inwardly to join with the outside of the extension tube 50 at a point well back from the orifice or open end thereof. Transverse walls 56 and 57 define the inner and outer ends of the manifold chamber 52.

Admission of exhaust gas is afforded through means of a pair of diametrically opposed inlet pipes 58 and 59 leading from dual exhaust passages from the engine, such pipes extending into openings in outer wall 57 of the manifold. Burner tube 46 also extends through wall 57, and extension 50 of tube 46 is secured to such wall and projects through an enlarged annular opening 61 in transverse wall 56. The opening 61 provides a discharge passage from manifold chamber 52 to reaction chamber 42 and the cross-sectional area of such passage is no less than the combined cross-sectional area of the two exhaust pipes 58 and 59. As will be seen from FIGURE 4, the inner tube 41 is formed with an imperforate portion 62 extending from walls 13 to 57 and forming on the exterior thereof a continuation of passage 61. To provide for structural rigidity a cylindrical wall 63 is preferably attached to casing wall 40 and an offset portion of wall 56. Desirably substantially all of the parts are formed of stainless steel and secured together by welding.

As an example of suitable dimensions for a highly satisfactory muffler-burner constructed in accordance with the embodiment of FIGURES 4 and 5, the cylinder casing 40 may be formed of a diameter of about six inches and a length of some 26 inches. The spacing of the tubes within the casing is such as to provide a reaction chamber of approximately three inches in diameter and two feet long. With the orifice of the burner tube extending preferably at least eight inches from the nozzle 47, the extension of such tube into the reaction chamber 42 is desirably in the order of four inches. The spark plug electrodes 32

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are set just forwardly of the nozzle so that there is provided almost eight inches of flame from the spark plug to the orifice of the burner tube. As will be clear the exhaust gas flowing through passage 61 passes the open end or orifice of the burner tube in a hollow cylindrical stream that will not tend to swirl across the orifice or interfere with the flame portion within the tube or the portion projected into reaction chamber 42.

As to the general operation and purifying action of the muffler-burner of the present invention, which is substantially set forth in the aforesaid pending application, it will be understood that exhaust gas entering the reaction chamber 42 through the exhaust inlet passage 61 is ignited in the chamber by the flame extending from the burner tube whereby gas combustion continues substantially to completion. A relatively hot flame is produced in the chamber 42, preferably in excess of 1900 degrees Fahrenheit and of the order of 2200 degrees. With this temperature, not only is poisonous carbon monoxide burned to harmless carbon dioxide but aldehydes and other undesirable exhaust gas constituents are practically eliminated. The fully burned gases escape radially from the chamber 42 through the porous refractory material 44 and thence into the annular space between the outer shell 40 and perforated tube 43, from whence the gases exhaust through the exhaust pipe 23. A very strong noise-muffling action is provided by the refractory material which further serves as a heat insulator about the reaction chamber. In addition, the operation of the burner-muffler seems to remove particles and burning fuel from the exhaust by completing combustion thereof so that no sparks can be emitted from the unit.

What is claimed is:

1. An exhaust gas cleanser comprising a cylinder with a closed end and having an exhaust outlet extending therefrom, a pair of concentric radially perforated tubes disposed within said cylinder for defining within the inner tube a reaction chamber and with the outer tube extending axially beyond the inner tube towards said closed end, a gas pervious heat insulating material disposed between said tubes, an annular exhaust gas manifold, a tubular wall extending axially from the inner of said two tubes into connection with an end of said manifold, inlet means on said manifold for connection to engine exhaust, a

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burner tube disposed coaxially within said tubular wall and concentric with said manifold and defining with said tubular wall an annular passage through which gases from said manifold pass, a burner disposed axially of and within said burner tube and directed to spray a combustible mixture through said tube toward said reaction chamber, and ignition means within said burner tube adjacent said burner for forming a flame which traverses said tube to enter said reaction chamber axially of said exhaust gas flow.

2. In an exhaust gas purifier of the type including an elongated reaction chamber having one substantially closed end wall and a second end wall including a gas inlet for receiving exhaust gas, a body of refractory material defining a plurality of gas passages disposed about said chamber in communication therewith whereby gas flows out of the chamber through said body, an outer casing radially spaced from said body defining with the latter an expansion chamber having an opening therein for discharge of gas, a nozzle arranged to be supplied with combustible vapor and positioned for directing same into said chamber, and igniter means positioned for igniting said vapor directed into said chamber whereby the ignited vapor heats and burns exhaust gas within said chamber, the improvement comprising a burner tube adjacent said gas inlet and having a forward position projecting longitudinally into said reaction chamber a substantial distance beyond said exhaust gas inlet, said burner tube also having a portion without said reaction chamber, and means mounting said nozzle and said igniter means within said burner tube in the portion exterior of said reaction chamber.

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