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3,449,086

CATALYTIC MUFFLER

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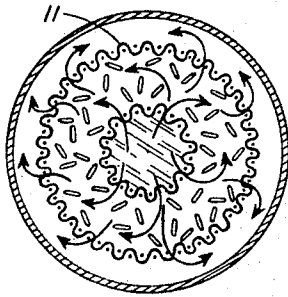
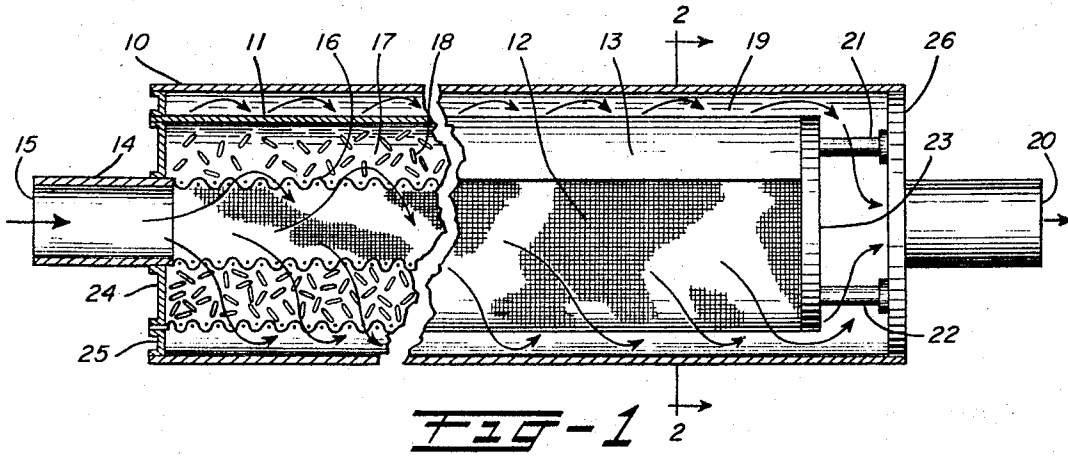


FIG-3

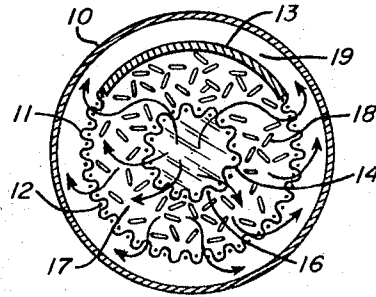


FIG-2

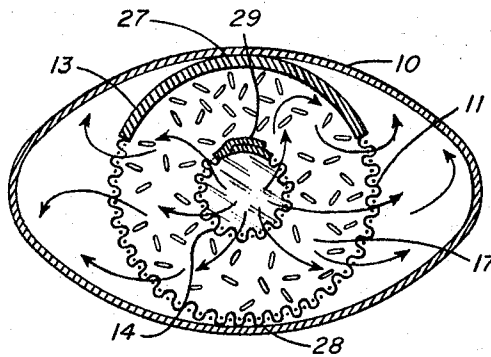


FIG-4

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CATALYTIC MUFFLER

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1 Claim

ABSTRACT OF THE DISCLOSURE

In a catalytic muffler of the radial type, wherein an annular catalyst layer is disposed horizontally between a central foraminous gas distributing pipe and an outer perforated cylindrical retaining sleeve, fluidization and channeling of catalyst at the top of the annulus are prevented by making the top of the retaining sleeve impermeate.

This invention relates to catalytic apparatus of the type employable with an internal combustion engine for oxidation of the toxic and obnoxious components of hydrocarbon combustion exhaust gases. More particularly this invention relates to a catalytic converter which is capable of being readily inserted into the exhaust system of an internal combustion engine in addition to or in place of the conventional exhaust muffler. Such converters may be inserted before or after the exhaust manifold or other convenient locations.

Automobile exhaust control has become a major concern in recent years particularly in heavily populated metropolitan centers such as Los Angeles, Calif. The reason is that exhaust gases resulting from the combustion of hydrocarbon fuels such as gasoline, diesel fuel and the like in internal combustion engines have been shown to contain mixtures of carbon monoxide, various saturated and unsaturated hydrocarbons, nitrogen oxides, and other constituents which are both poisonous and precursors of the condition now generally termed "smog." The mechanism of smog formation has been extensively studied and is now known to result from the photochemical interaction of nitrogen oxides, reactive hydrocarbons, and sunlight. The effects include a fog-like haze, high oxidant concentration in the atmosphere, mostly ozone, eye irritation, plant damage and the like.

The catalytic muffler is a device developed to reduce or eliminate the major harmful components of these exhaust gases. These devices are generally substituted into the exhaust line of an internal combustion engine in lieu of a muffler. By the action of catalysts contained therein these devices effect oxidation of the exhaust gases so that the exit gases from the muffler contain reduced amounts of the harmful and obnoxious constituents of the exhaust gases.

While it is known that a radial design of the catalyst bed is generally advantageous for uniform distribution of the exhaust gases throughout the catalyst bed, such design gives rise to voids in the catalyst bed with increased use of the catalytic converter. U.S. Patent 3,094,394 discloses a means to maintain a radially constructed catalyst bed under constant pressure in order to minimize the formation of voids in the bed. However, despite the considerable advantages of the catalytic muffler of the foregoing patent, the displacement of the muffler from a horizontal position in natural use, as when an automobile is jolted on an uneven surface or when moving up or down a steep hill, still causes voids on the surface of the catalyst bed. These voids provide a shorter path for the exhaust gases as they pass upward through the bed and out through the perforations in the sleeve which defines the limits of the catalyst bed. The shorter path for the exhaust gases

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encourages excessive space velocity of the gas in these paths, especially at higher engine speeds. The greater space velocity causes movement of the catalyst particles and eventually violent churning and even displacement of catalyst from one sector of the bed to another. This catalyst movement is described as "fluidization" and has numerous harmful effects.

In the first place, "fluidization" causes grinding, shrinkage and premature attrition of the catalyst particles. Secondly, even under average driving conditions, channels are thereby caused to form in the catalyst bed permitting considerable quantities of the exhaust gas to pass throughout the bed without being subjected to the catalytic oxidation. These channels form more readily in vertical paths due to the natural direction of exhaust gas flow through a generally fixed system. Thirdly, much of the catalyst fails to come into contact with the exhaust gas and contact time is generally non-uniform. The net result of these harmful effects is inefficient use and premature deactivation of the catalyst and low conversion of the toxic and obnoxious components of the exhaust gases to less harmful products.

In the patented device referred to above, a spring or like means is employed to impart pressure to the catalyst bed and thereby to prevent formation of voids. The coil springs are made of a highly heat-resistant steel alloy and are preferably positioned in a refractory wool or other stabilized heat-resistant media. It will be appreciated that the heat-resistant materials necessary for proper functioning of said coil springs or other yieldable means are exceedingly expensive and difficult to manufacture and therefore will greatly increase the cost of the catalytic converter.

The present invention has for its principal object the providing of a catalytic converter and more preferably a catalytic muffler whereby more efficient use is made of the catalyst particles and optimum conversion of the toxic and obnoxious components of the hydrocarbon combustion exhaust gases is effected.

It is a particular object of the present invention to provide a catalytic muffler which is of simple construction and is easily adaptable for positioning in the exhaust line of an internal combustion engine.

It is a further object of the present invention to provide a catalytic muffler so constructed that fluidization of the catalyst particles is minimized whereby the loss in catalyst caused by grinding, abrasion, and premature attrition is substantially reduced. Further objects include providing a catalytic muffler which eliminates the need for expensive heat-resistant metal alloy spring means to confine the catalyst bed, and which maintains uniform space velocity of exhaust gas throughout the catalyst bed, and to provide a muffler device which effects good noise elimination.

These and other objects, advantages and features of the present invention will become more apparent from the detailed description thereof as particularly set forth in the accompanying drawing in which:

FIGURE 1 is a vertical longitudinal cross sectional view of the catalytic converter contemplated by this invention;

FIGURE 2 is a vertical sectional view along the line 2-2 of FIGURE 1;

FIGURE 3 is a vertical sectional view of a prior art catalytic converter of the same general design with the exception of the novel element to be described more fully hereinbelow;

FIGURE 4 is a vertical cross-sectional view of a preferred embodiment of the catalytic converter of this invention.

In accordance with the present invention, a catalytic converter is provided comprising in concentric arrange-

ment a cylindrical housing having an inlet end and an outlet end, a longitudinally extending cylindrical sleeve within said housing, a longitudinally extending cylindrical tube centrally positioned within said sleeve between said inlet end and said outlet end and extending from said inlet end, the portion of said tube within said sleeve being perforated. Catalyst particles for oxidizing hydrocarbon combustion exhaust gases are disposed within a first zone defined by the area between said sleeve and said tube. The area between the outer surface of the sleeve and the inner surface of the housing define a second zone for passage of the catalytically oxidized exhaust gases to the outlet end of the housing from where it passes through the tailpipe to the atmosphere.

Capping elements are provided for sealing off the ends of said tube and said first zone which are adjacent to the outlet end. The capping means may be, for example, a suitable plate-like member disposed about the ends of the central tube and the first zone so as to close off the inlet exhaust tube as well as the catalyst bed which is defined by the first zone. Alternatively, either or both capping elements may be yieldably attached in a manner such as that described in U.S. Patent 3,094,394, wherein the capping element closing off the inlet exhaust tube acts as a relief means whereby when the catalyst bed reaches a predetermined and undesirable intense heat, said capping element will be released permitting the combustion exhaust gases to flow directly through the device without benefit of contact and oxidation by the catalyst bed. Also as described in U.S. Patent 3,094,394, the capping element for closing the catalyst bed defined by the first zone may be removable to facilitate replacement of spent catalyst.

That which essentially distinguishes the present invention from the foregoing U.S. patent is a blanked off pre-shaped upper longitudinally extending sector of the longitudinally extending cylindrical sleeve, which sleeve serves to confine the catalyst bed around the central longitudinally extending cylindrical tube. In the aforementioned patent said cylindrical sleeve is disclosed as being perforated. However, it has now been discovered that important advantages are derived from blocking or blanking off the portion of the cylindrical sleeve which is disposed above the central cylindrical tube while retaining the perforated character of the remainder of the sleeve.

Various means may be employed to effect the blanking or blocking off of the upper sector of the cylindrical sleeve. Thus, in the construction of the sleeve, perforation may be avoided in the area concerned. Alternatively, when a fully perforated sleeve has been manufactured, metal foil or a curved heat-resistant metallic section may be fitted over or under the perforated upper sector.

The area of the sleeve which is blanked or blocked off may be defined by degrees of arc of a cross-section of said sleeve. From about 20 to 120 degrees of arc and preferably from about 40 to 100 degrees of arc will be suitable. The terms "blanked off" and "blocked off" are intended to be interchangeable and describe obvious equivalents of this invention.

While catalytic mufflers of this invention are described as being cylindrical and as being of symmetrical design, it should be noted that the term "cylindrical" as employed herein also contemplates catalytic converters having elliptical configurations. In all of the converters of this invention, the construction may further be described as being "radial" in that the catalyst bed extends outwardly from the center of the device where the exhaust gases enter. This radial arrangement favors uniform operation conditions, faster warm-up times, and maximum flexibility of construction as set forth in U.S. Patent 3,094,394.

Referring to the drawings, FIGURE 1 is a specific illustrative embodiment of a catalytic muffler of this invention. The catalytic muffler therein shown comprises a cylindrical housing 10, preferably of a high grade heat-

resistant steel, though in general steels or metals and preferably light weight metals able to resist temperatures of up to 750° C. may be employed. Said cylindrical housing encloses a longitudinally extending cylindrical sleeve 11 having perforations 12 over its lower surface and a blanked or blocked off upper sector 13. Said sleeve surrounds an inner longitudinally extending cylindrical inner tube 14 centrally positioned within said sleeve and having an inlet end 15 suitable for attachment to an automobile exhaust manifold and an outlet end (not shown) which may be closed by a capping element (not shown). Said capping element may be permanently affixed or yieldably attached by a suitable heat-fusible element which at a predetermined "overheat" temperature becomes molten, enabling the capping means to be opened merely by the pressure of unoxidized exhaust gases contacting the same. Said longitudinally extending cylindrical inner tube has perforations 16 over substantially the entire surface of the tube contained within said sleeve. The perforated character of the sleeve and inner tube may take many obvious forms, e.g., metal screens or sheet metal punctured to the requisite extent. Said sleeve and said inner tube define between their surfaces a cylindrical first zone 17 for enclosure of catalyst particles 18. Said cylindrical housing and said sleeve define between their surfaces a cylindrical second zone 19 which serves to carry catalytically oxidized exhaust gases to the outlet end 20 of the catalytic converter. It will be seen that elements such as 21 and 22 are supporting means for the annular capping element 23. Said supporting means may be yieldably affixed to permit displacement of said capping element and replenishment of the catalyst bed enclosed behind said capping element. Annular end plates 24 and 25 provide suitable enclosing means for said first and second zones, respectively, adjacent the inlet end of said inner tube 14. Annular retaining means 26 forms an end plate enclosing the catalytic converter.

The oxidizing catalyst may be any of a plurality suitable for use for this purpose such as, for example, an iron oxide-chromium oxide catalyst prepared from 85 to 97% of Fe_2O_3 and 0.5 to about 15% of Cr_2O_3 . Alternatively such catalysts may be of the type described in U.S. Patent 2,912,300.

In operation, hydrocarbon combustion exhaust gases enter the catalytic converter by inlet tube 14 and pass radially into the catalyst bed defined by first zone 17. Since the upper sector 13 of cylindrical sleeve 11 is blanked or blocked off, the normal preferential flow of exhaust gas is deflected away from the catalyst bed encompassed by the blanked off sector to the adjacent and lower sectors of the catalyst bed. During this flow of hydrocarbon combustion exhaust gases, the toxic and obnoxious components of said gases are substantially oxidized by passage over the catalyst particles. Following catalytic conversion, the natural direction of flow of the oxidized gases is into second zone 19 and thence out through the outlet end 20 into the atmosphere or into a suitable conduit for emission into the atmosphere.

FIGURE 2 represents a vertical sectional view along the line 2—2 of FIGURE 1 and shows illustratively the concentric cylindrical arrangement of the housing 10, sleeve 11 and exhaust gas inlet tube 14 and particularly the blanked off or blocked off upper sector 13 of said sleeve. It will be seen that the exhaust gas flow is deflected by said blanked or blocked off sector, thereby preventing the normal preferential channeling of exhaust gas out through the top of the catalytic bed as well as the aforementioned fluidization of the catalyst bed.

FIGURE 3 shows a similar vertical cross-section of a prior art catalytic converter having the same concentric arrangement of elements but lacking the blanked off or blocked off upper sector of sleeve 11. It will be seen from FIGURE 3 that the absence of the blanked off sector favors exhaust gas flow through the top of the catalyst bed thereby causing fluidization of catalyst par-

ticles with the churning and consequent inefficient utilization of said particles.

FIGURE 4 shows in vertical cross-sectional illustration a preferred embodiment of the present invention wherein housing 10 has an elliptical shape and is in close proximity or affixed, e.g., by welding, to the sleeve 11 at points 27 and 28. It will also be seen that longitudinally extending cylindrical tube 14 has a blanked off or blocked off upper sector 29 whereby the flow of exhaust gas is further deflected from the upper area of catalytic bed 17 enclosed by blanked off sector 13. Said blanked off sector 29 of central tube 14 may be a consequence of the manufacture of said central tube wherein a metal screen or perforated metal sheet is rolled to form a cylinder and the edges are overlapped and welded together. It will be appreciated that the elliptical shape of the housing of FIGURE 4 reduces the vertical space required for the catalytic converter. This is an important consideration in the design of mufflers for modern, low slung automobiles.

The utilization of the improved catalytic converter of this invention substantially eliminates fluidization of catalyst particles and the channelling of exhaust gas flow vertically through the top of the catalyst bed. The beneficial consequences are longer catalytic life, greater uniformity in exhaust gas flow around catalyst particles, and more complete oxidation of hydrocarbon combustion exhaust gases. Furthermore, the blanked off upper sector of the catalyst bed serves as a catalyst reservoir for replenishment of spent catalyst in the lower sectors of the bed and insulates the underside of the automobile adjacent the muffler against the heat of the catalytic chamber. Other numerous modifications and advantages of this

invention will be apparent and obvious and therefore no limitation should be set thereon except insofar as set forth in the appended claim.

I claim:

1. A catalytic muffler for oxidizing hydrocarbon exhaust gases which comprises:

an annular layer of particulate catalyst confined horizontally between a central foraminous gas-distributing pipe disposed longitudinally thereof and an outer annular retaining sleeve concentric with said pipe,

said sleeve having a gas-deflecting blanked off upper sector which in cross section describes from about 20 to 120 degrees of arc but which sleeve is perforate throughout the remainder of its circumference

whereby the normal preferential channeling of exhaust gas through the top of the catalyst annulus and the resulting fluidization of catalyst particles is eliminated.

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23-2.2; 60-30