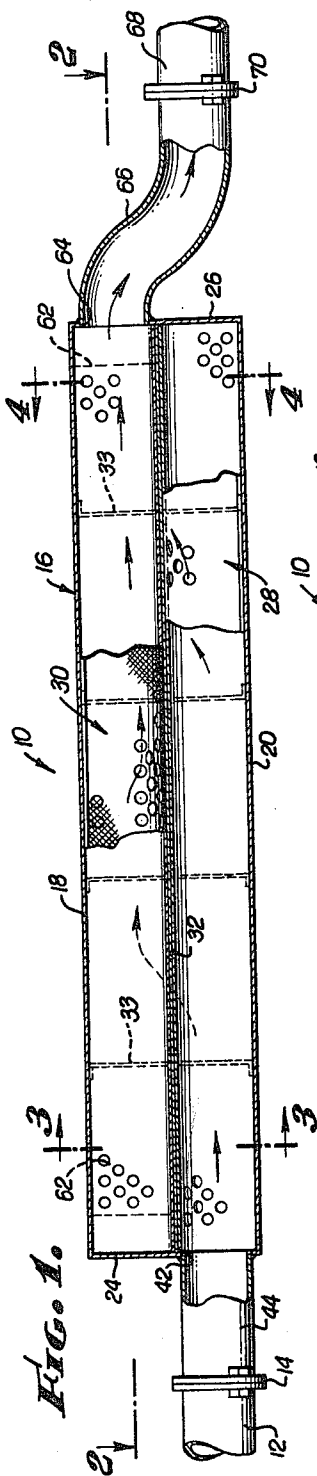
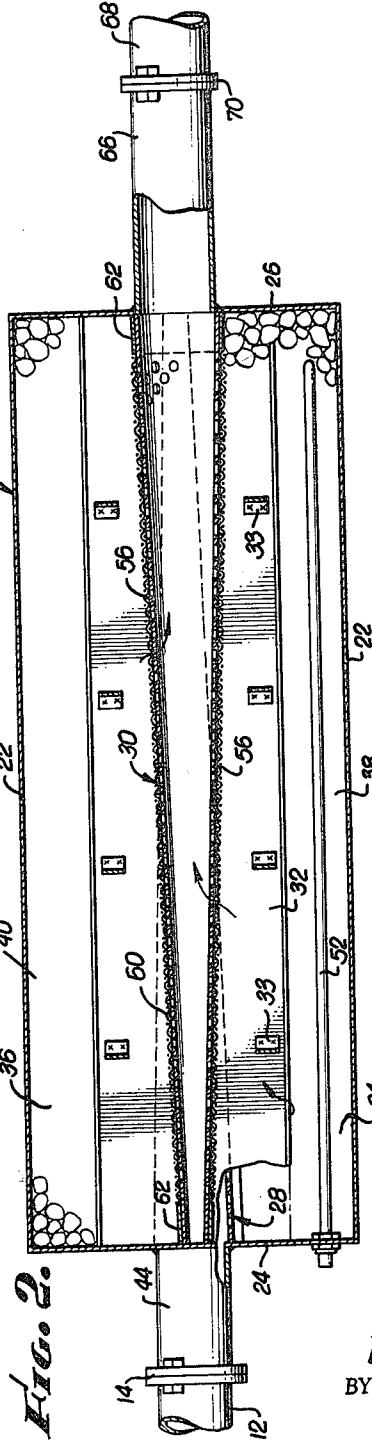
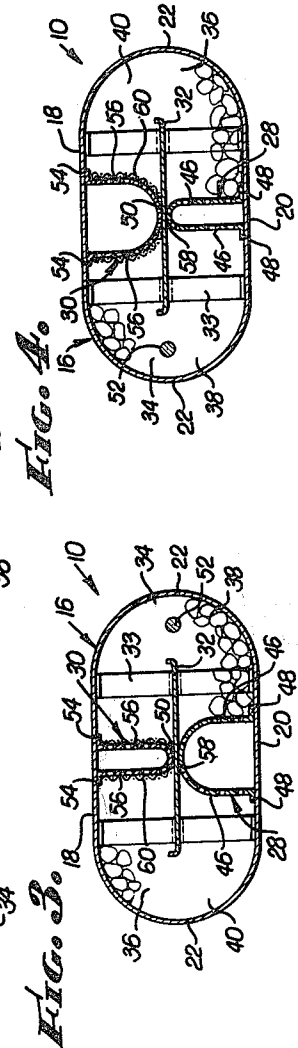


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CATALYTIC MUFFLER

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The present invention relates to catalytic mufflers employed in internal combustion engine exhaust systems for catalytically oxidizing previously unoxidized or only partially oxidized components of the exhaust gases which are harmful when released into the atmosphere, such as hydrocarbons and carbon monoxide, and it relates particularly to a novel catalytic muffler construction which permits a maximum amount of catalyst to be embodied in the muffler, which provides relatively even temperature distribution throughout the catalyst bed without damaging "hot spots" tending to develop, wherein the parts of the muffler are so constructed and arranged that the exhaust gases flow in a generally vertical path through the muffler with the concentration of the gases being relatively evenly distributed between the ends of the muffler without tending to back up and concentrate toward the rear of the muffler and without permitting the catalyst to pack down in one region of the catalyst chamber or to have bypass channels formed therethrough which would permit exhaust gases to pass through the bed untreated.

Although various devices have been proposed for use in vehicles with internal combustion engine exhaust systems for reducing or eliminating "smog"-forming and other harmful exhaust components, such as unburned or partially burned hydrocarbons and carbon monoxide, the most practical and efficient apparatus for accomplishing this appears to be the catalytic muffler which is employed in the exhaust system as a replacement for the conventional muffler. Such a catalytic muffler has a catalyst disposed therein, usually a bed of particulate catalyst material, which promotes oxidation of such previously unburned or only partially burned exhaust components, and this chemical action is exothermic, i.e., produces heat.

However, contemporary vehicles with their relatively limited road clearance impose structural limitations on catalytic mufflers, the limitations being such that the overall volume of the muffler is relatively limited, and the depth of the muffler between the top wall and the bottom wall is generally required to be less than the width between the side walls, the muffler having a generally flattened, over cross-sectional shape. These structural limitations make it difficult to provide a sufficient quantity of catalyst material in the muffler for sufficient oxidizing of the unoxidized or incompletely oxidized exhaust ingredients, while at the same time directing the flow of exhaust gases in a relatively uniform distribution throughout the catalyst without tending to pack the catalyst down in one region of the catalyst chamber and without tending to cause the formation of localized "hot spots" or bypass flow channels through the catalyst bed.

It has been found desirable in practice to have the exhaust gases flow vertically through a relatively wide, flat catalyst bed in order to make the most efficient use of the catalyst and to avoid "poisoning" of the catalyst by lead compounds which is likely to occur if the exhaust gases flow longitudinally through a catalyst bed of relatively narrow cross-section. However, prior art vertical flow arrangements in catalytic mufflers of generally flattened form usually resulted in a large waste of the available volume in the case because of excessively large plenum chambers, so that the amount of catalyst employed was seriously restricted.

Another disadvantage of most prior art catalytic mufflers, and particularly those of the vertical flow type,

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was that the exhaust gases usually were unevenly distributed as they passed through the catalyst bed, often having a flow path concentrated toward the rear of the catalyst container. This decreased the efficiency of catalyst operation, and tended to cause development of bypass channels through the catalyst, particularly when some of the catalyst was lost or reduced to "fines" due to attrition and other causes. Uneven flow through the catalyst bed also tended to cause "hot spots" to develop in the catalyst bed, and poor heat conductivity within the muffler also tended to promote the formation of such "hot spots," which can damage the catalyst, the muffler case, and possibly even underside equipment of the vehicle.

Further, prior art vertical flow catalytic mufflers usually were constructed so that the flow of exhaust gases was in a downward direction, which tended to pack the catalyst down in the bottom of the catalyst chamber, this problem occurring particularly when part of the catalyst has been lost or reduced to "fines" due to attrition or other causes.

Thus, it is an object of this invention to provide a catalytic muffler for internal combustion engine exhaust systems which may be substituted for the conventional muffler, wherein the parts thereof are so arranged that a maximum amount of catalyst material is embodied in the muffler, and the exhaust gases tend to flow in relatively even distribution through the catalyst without tending to concentrate in one part of the catalyst bed, and wherein the catalyst does not tend to pack down in any one region of the catalyst chamber or tend to form bypass channels therethrough, even upon the loss of a considerable quantity of the catalyst or the reduction of part of the catalyst to "fines" due to attrition or other causes.

Another object of this invention is to provide a catalytic muffler of the aforementioned character wherein there is provided an inlet plenum tube for exhaust gases which is partitioned from an outlet plenum tube by a baffle, the tubes normally being substantially surrounded by the catalyst material and being in close proximity to each other to thereby provide a relatively rapid transfer of heat to the catalyst material, and to also provide a relatively uniform temperature distribution throughout a major portion of the catalytic muffler.

A specific object of this invention is to provide a catalytic muffler of the aforementioned character wherein the walls of the inlet plenum tube converge from the forward end thereof to the rear end so as to achieve a flow pattern of exhaust gases flowing from the inlet plenum tube which is substantially laminar, resulting in there being a generally even, or uniform distribution of the exhaust gases as they flow through the catalyst material, and so as to reduce the tendency of the exhaust gases to concentrate toward the rear end of the muffler case.

Another specific object of this invention is to provide a catalytic muffler of the aforementioned character wherein the walls of the inlet plenum tube converge from the forward end thereof to the rear end for the foregoing reasons, and the walls of the outlet plenum tube diverge from the forward end thereof to the rear end so that a uniform cross-section of catalyst material is exposed to the exhaust gases.

A more specific object of this invention is to provide a catalytic muffler of the aforementioned character wherein the outlet plenum tube has shields about each end where escape paths through the catalyst material are likely to occur when the catalyst material shifts from the ends of the muffler as the result of acceleration and deceleration of the vehicle on which the catalyst muffler is mounted, the shields directing the flow of the exhaust gases into the catalyst material and away from the regions where escape paths would be likely to form.

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Another more specific object of this invention is to provide a catalytic muffler of the aforementioned character wherein the outlet plenum tube has a screen thereabout to prevent the loss of catalyst "fines" from the catalyst bed.

A yet further object of this invention is to provide a catalytic muffler of the aforementioned character wherein the exhaust gases passing through the muffler follow in a generally vertical, upwardly directed flow-path to render the catalyst material buoyant and thereby fluidize the catalyst bed, and also, the vertical upward flow of the exhaust gases continuously purges the catalyst material to remove agents which adversely affect the catalyst material.

Another object of this invention is to provide a catalytic muffler of the aforementioned character wherein even though the inlet and outlet plenum tubes are in relatively close proximity to each other, the flow path for the exhaust gases from the inlet plenum tube to the outlet plenum tube through the catalyst material is relatively extensive.

A yet further object of this invention is to provide a catalytic muffler of the aforementioned character wherein the configuration and dimensions of the catalytic muffler may be substantially the same as those of conventional mufflers, and the arrangement of the structure of the catalytic muffler provides for the utilization of a maximum quantity of catalyst material.

Further objects and advantages of the present invention will appear during the course of the following part of the specification wherein the details of construction and mode of operation of a preferred embodiment are described with reference to the accompanying drawings, in which:

FIGURE 1 is a longitudinal, vertical sectional view, partly in elevation, illustrating a catalytic muffler in accordance with the present invention.

FIGURE 2 is a horizontal sectional view, partly in elevation taken on the line 2—2 in FIGURE 1, illustrating particularly the tapered outlet plenum tube.

FIGURE 3 is a cross-sectional view taken on line 3—3 of FIGURE 1.

FIGURE 4 is a cross-sectional view taken on line 4—4 of FIGURE 1.

Exhaust gases having unoxidized and only partially oxidized components therein are delivered from an internal combustion engine to catalytic muffler 10 through exhaust pipe 12, the exhaust pipe being fastened to catalytic muffler 10 by a typical flange connection 14. Catalytic muffler 10 includes an elongated case 16 which is oval-shaped in cross-section, see FIGURES 3 and 4, and which embodies a relatively flat top wall 18, a relatively flat bottom wall 20, a pair of substantially semi-cylindrical side walls 22, a front or forward wall 24, and a rear or back wall 26.

Disposed in case 16 is an inlet plenum tube 28 which is partitioned from an outlet plenum tube 30 by a horizontal baffle plate 32. Baffle plate 32 is supported in case 16, substantially midway between top wall 18 and bottom wall 20 by struts 33. Plenum tubes 28 and 30 are in vertical alignment with inlet plenum tube 28 being lowermost, and together with baffle plate 32, the plenum tubes are coextensive in length with case 16. Additionally, plenum tubes 28 and 30 are equally spaced inwardly from both side walls 22 so as to vertically partition case 16 into a pair of substantially identical compartments 34 and 36, each of which has substantially the same volume as the other, and each of which is filled with a catalyst material, preferably in particulate form, so as to provide a pair of spaced catalyst beds 38 and 40, which may be considered a single catalyst bed, all of which will hereinafter be described in more extensive detail.

Forward wall 24 of case 16 encloses the forward end of compartments 34 and 36, and rear wall 26 encloses the rear end of the compartments so as to prevent the loss of

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catalyst material. However, the forward wall has an opening 42 therein which is spaced midway between side walls 22 and adjacent bottom wall 20, the opening 42 providing access to inlet plenum tube 28. Welded or otherwise fastened to forward wall 24 and communicating with inlet plenum tube 28 is an extension 44 which is connected with exhaust pipe 12 at flange connection 14.

It is preferred that exhaust gases flow into inlet plenum tube 28, which, as before mentioned, is the lowermost of the plenum tubes, so that the exhaust gases flowing from inlet plenum tube 28 flow generally upwardly through catalyst beds 38 and 40 and into outlet plenum tube 30 from where they are discharged. Inlet plenum tube 28 is generally U-shaped in cross-section and tapers from the forward end to the rear end with the legs 46 of inlet plenum tube 28 converging toward the rear end so that the rear end of inlet plenum tube 28 is narrower than the forward end. The open side of inlet plenum tube 28 is closed by bottom wall 20, and each leg of inlet plenum tube 28 has an outwardly extending flange 48 thereon which is employed to fasten inlet plenum tube 28 to case 16 by welding or other suitable means. The bight 50 of inlet plenum tube 28 is adjacent to baffle plate 32.

Exhaust gases flowing into inlet plenum tube 28 tend to flow toward the rear end thereof, and since inlet plenum tube 28 is tapered, in the aforementioned manner, the flow pattern of the exhaust gases flowing from inlet plenum tube 28 and through the catalyst beds 38 and 40 to the outlet plenum tube 30 is substantially laminar, thereby producing a substantially uniform distribution of exhaust gases throughout catalyst beds 38 and 40. The taper of inlet plenum tube 28 reduces the tendency of the exhaust gases to flow toward the rear end.

Exhaust gases flowing from inlet plenum tube 28 are treated by the catalyst material of catalyst beds 38 and 40 to oxidize those components of the exhaust gases not previously oxidized. Most, if not all, catalysts employed in catalytic mufflers produce an exothermic reaction when reacting with exhaust gases, i.e., heat is produced. As a result there is an acceptable temperature operating range, and when this range is exceeded due to unusual quantities of combustible materials being exposed to the catalyst, damage to the catalyst, catalytic converter and vehicle can occur, as before mentioned. Changes of temperature of catalyst beds 38 and 40 react on a temperature sensing probe 52 which actuates mechanism, not shown, to increase or reduce the quantity of air which is mixed with the exhaust gases, and in this way, the temperature of catalyst beds 38 and 40 is controlled.

Temperature sensing probe 52 may be any suitable thermo-mechanical device capable of actuating a valve, as for example a coaxial rod and tube arrangement wherein the rod and tube have different coefficients of thermal expansion.

Temperature sensing probe 52 is disposed in catalyst bed 38 substantially midway in the flow path of the exhaust gases from inlet plenum tube 28 to outlet plenum tube 30. Therefore, although probe 52 is located to one side of case 16, it is in a position to obtain an average sampling of the temperature occurring within catalyst bed 38 and the temperature of catalyst bed 38 is also representative of the temperature of catalyst bed 40.

Catalyst beds 38 and 40 may have a substantial loss of catalyst material due to attrition or other causes, and the exhaust gases flowing from inlet plenum tube 28 to outlet plenum tube 30 must still flow through and be thoroughly treated by the catalyst material in order to pass from inlet plenum tube 28 to outlet plenum tube 30, and no escape paths are available which would enable the exhaust gases to pass from inlet plenum tube 28 to outlet plenum tube 30 without being treated.

The upward flow of the exhaust gases from inlet plenum tube 28 through catalyst beds 38 and 40 to outlet plenum tube 30 renders the catalyst beds buoyant and

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thereby fluidizes the catalyst beds. Also, the vertical upward flow of the exhaust gases continuously purges the catalyst material to remove agents which poison the catalyst material, and agents which reduce the effectiveness and activity of the catalyst material, such as certain lead compounds found in exhaust gases formed from combustion of "anti-knock" gasolines.

Exhaust gases flowing through catalyst beds 38 and 40 are required to flow around baffle plate 32 which has a greater width than the width between the legs of inlet plenum tube 28. As a result, the exhaust gases are required to assume a horizontal as well as an upward vertical flow path in order to pass around baffle 32.

Outlet plenum tube 30 is, preferably, substantially identical to inlet plenum tube 28, i.e., it is U-shaped in cross-section and tapered from one end to the other, but the taper is the reverse of that of inlet plenum tube 28, the result being that catalyst beds 38 and 40 have a uniform cross-section from end to end so that the exhaust gases flowing through the catalyst beds are exposed to a substantially equal quantity of catalyst material. Outwardly extending flange 54 on each leg 56 of outlet plenum tube 30 is employed to fasten outlet plenum tube 30 to top wall 18 by welding or other suitable means, thus closing the open side of outlet plenum tube 30. The bight 58 of outlet plenum tube 30 is positioned adjacent to horizontal baffle plate 32. Although it is preferred that outlet plenum tube 30 be substantially identical to inlet plenum tube 28, it is to be understood that outlet plenum tube 30 can be of uniform width from end to end.

Thus it may be seen, because of the relatively close proximity of the plenum tubes to each other and to baffle plate 32, that heat from hot exhaust gases entering inlet plenum tube 28 is efficiently conducted or transferred to baffle plate 32 and outlet plenum tube 30, and this heat is also efficiently transferred to catalyst beds 38 and 40. Because of this, and because the plenum tubes 28 and 30 and catalyst beds 38 and 40 are coextensive, a relatively uniform temperature is maintained throughout the catalyst beds, and the occurrence of "hot spots" is generally avoided.

Formed about plenum tube 30 and generally coextensive in length therewith is a screen 60 which prevents individual catalyst particles from blocking or masking off respective individual perforations in the plenum tube 30. The screen 60 does, however, permit catalyst "fines" to pass therethrough and thus be blown out of the catalyst bed instead of tending to block the flow of gases. The "fines" referred to are relatively finely divided particles of catalyst material which may be formed by attrition or otherwise caused to be present in catalyst beds 38 and 40, and which tend to be blown into the region of outlet plenum tube 30 by the upwardly flowing exhaust gases.

Also formed about each end of outlet plenum tube 30 is a shield 62 which directs exhaust gases into catalyst beds 38 and 40 when there is a shifting of the catalyst beds away from front wall 24 or back wall 26. For instance, when catalytic muffler 10 is installed on a vehicle, the material of catalyst beds 38 and 40 is subjected to accelerations and decelerations. If case 16 is less than full of catalyst material, the material will tend to pile up against either the forward wall 24 of case 16 or rear wall 26. The result is that an escape path for the exhaust gases might be formed in the absence of shields 62 adjacent that wall where there is an absence of catalyst material.

Treated exhaust gases flowing from discharge plenum tube 30 are received in a rearwardly extending tubular extension 66 which communicates with discharge plenum tube 30 through an opening 64 in rear wall 26. Extension 66 is connected to exhaust discharge pipe 68 by a typical flange connection 70.

While the instant invention has been shown and described herein in what is conceived to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope of the

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invention, which is therefore not to be limited to details disclosed herein, but is to be accorded the full scope of the claims.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A catalytic muffler for treating exhaust ingredients produced by an internal combustion engine which comprises an elongated, generally cylindrical case having a front end, a rear end, a top wall, a bottom wall and a pair of side walls, the depth of the case between the top wall and bottom wall being materially less than the width of the case between the side walls whereby the case has a flattened oval cross-sectional shape, a perforate inlet plenum tube in said case connected at one end to said front end of the case and adapted to receive exhaust ingredients flowing from the engine into said catalytic muffler through an opening in said front end of the case, a perforate outlet plenum tube in said case connected at one end to said rear end of the case and from which treated exhaust ingredients flow from said catalytic muffler through an opening in said rear end of the case, an imperforate baffle generally horizontally disposed in the case between said plenum tubes, said plenum tubes being generally horizontally oriented and disposed in generally parallel, vertically spaced relationship, one over the other, with one tube above the baffle and the other below the baffle, said plenum tubes and baffle being generally coextensive in length with the case with the width of the baffle being greater than the horizontal width of said tubes, and the inlet plenum tube being substantially uniformly tapered from the front end to the rear end with the narrow end of the inlet plenum tube being the rear end so as to reduce the tendency of the exhaust ingredients to concentrate toward the rear end of the inlet plenum tube, and a bed of catalyst material substantially filling the case and encompassing substantially all surfaces of said plenum tubes exposed in the case and said baffle, said plenum tubes being impervious to the passage of said catalyst material thereinto but the perforations in said tubes permitting exhaust ingredients to flow from said inlet plenum tube through said catalyst material into said outlet plenum tube, said baffle preventing the exhaust ingredients from flowing directly from the inlet plenum tube to the outlet plenum tube and directing the exhaust ingredients along an extended flow path through the catalyst material, one of the plenum tubes extending vertically along its length from proximate the baffle to proximate the top wall of the case and the other plenum tube extending vertically along its length from proximate the baffle to proximate the bottom wall of the case, each plenum tube having a substantially uniform height along its length, and the taper of said inlet plenum tube being provided by a substantially uniformly varying width thereof, whereby said case is vertically partitioned to provide a pair of spaced compartments on opposite sides of said plenum tubes in which the catalyst material is disposed.

2. A catalytic muffler according to claim 1, wherein the inlet plenum tube is below the baffle and the outlet plenum tube is above the baffle, whereby the exhaust ingredients flow generally upwardly through the catalyst bed, rendering the catalyst bed buoyant and fluidized so as to continuously purge the catalyst bed of agents which adversely affect the catalyst material.

3. A catalytic muffler as defined in claim 1, wherein said outlet plenum tube is substantially uniformly tapered from the front end to the rear end with the narrow end of the outlet plenum tube being the front end so as to provide a catalyst bed having a substantially uniform cross-sectional area throughout the length of the case to thereby expose substantially all portions of the exhaust ingredients to an equal quantity of catalyst material.

4. A catalytic muffler as defined in claim 1, wherein said plenum tubes and said baffle are substantially centrally positioned and spaced substantially an equal dis-

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tance from each side wall of the case, whereby said compartments are substantially equal.

5. A catalytic muffler as defined in claim 1, wherein said outlet plenum tube is substantially uniformly tapered from the front end to the rear end with the narrow end of the outlet plenum tube being the front end, the taper of said outlet plenum tube being provided by a substantially uniformly varying width thereof.

6. A catalytic muffler as defined in claim 1, wherein said outlet plenum tube has imperforate shields about each end which direct the exhaust ingredients into said catalyst material in the event the catalyst material shifts away from the ends of said case.

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