June 15, 1965 W. W. GARY 3,189,418

CATALYTIC CONVERTER

Original Filed May 9, 1960 2 Sheets-Sheet 1

FIG. 1.

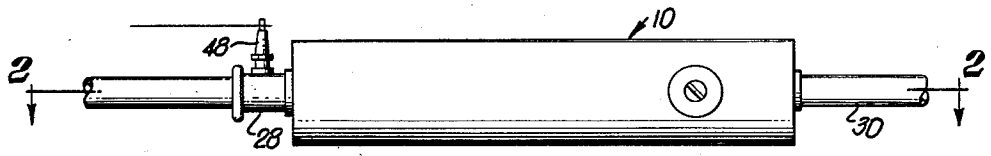


FIG. 2.

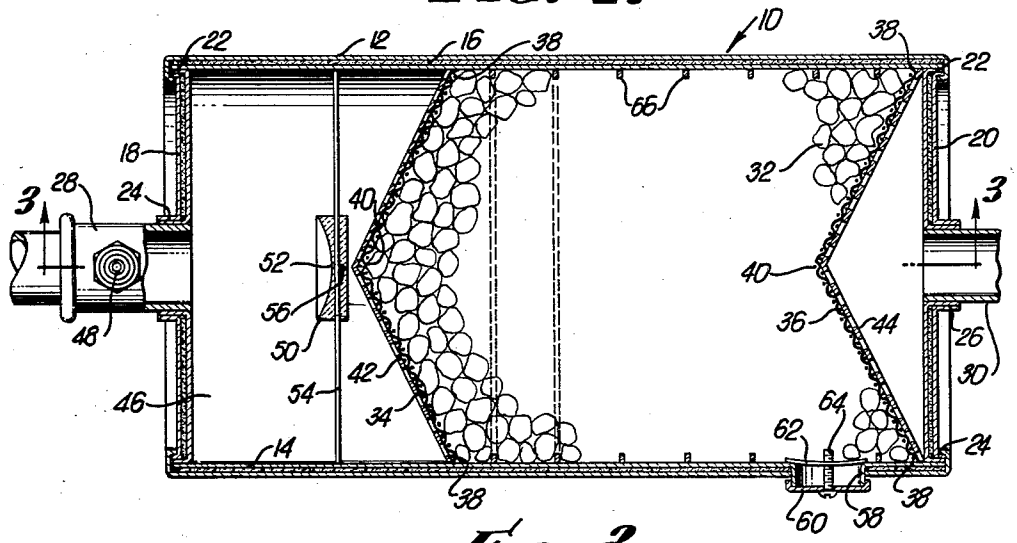


FIG. 3.

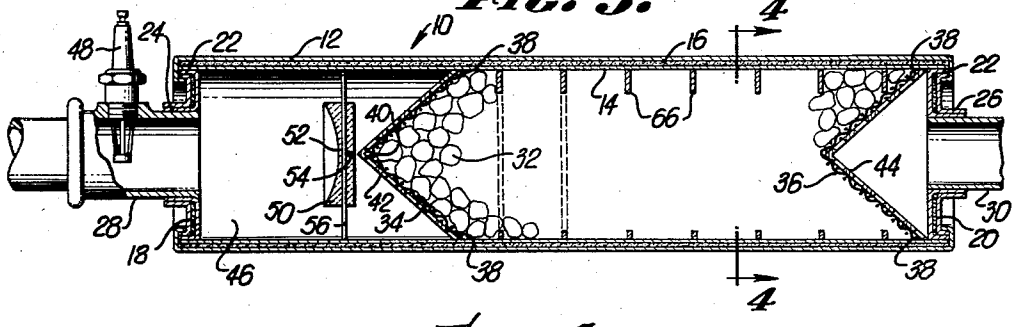
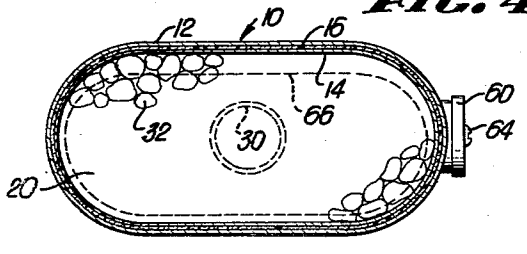


FIG. 4.



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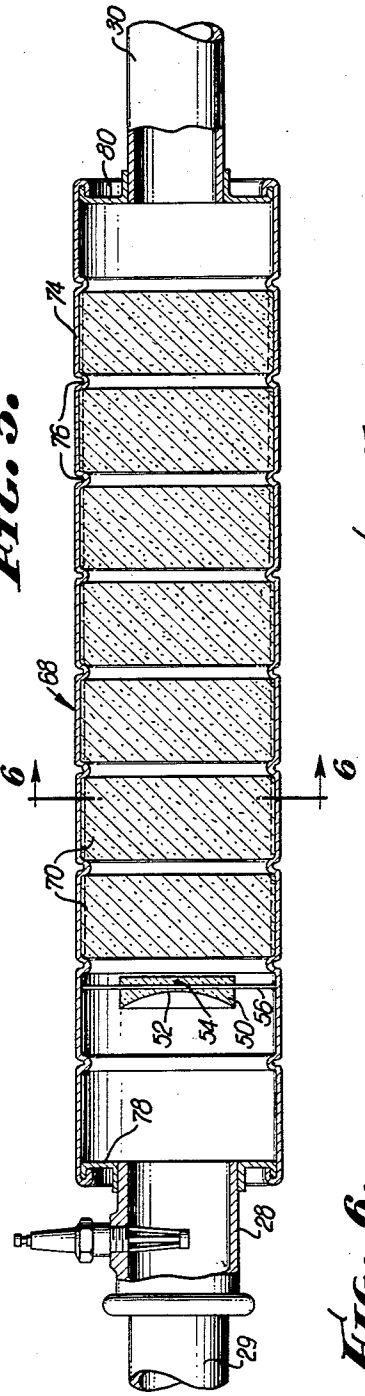


FIG. 5.

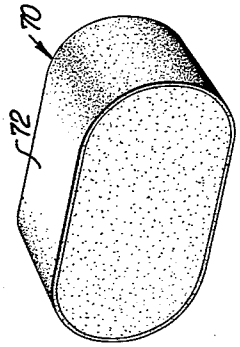


FIG. 7.

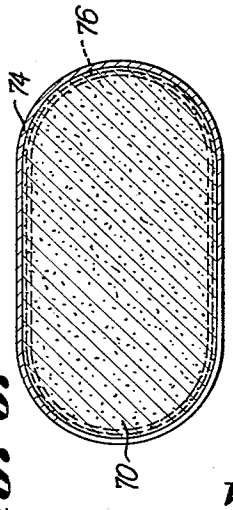


FIG. 6.

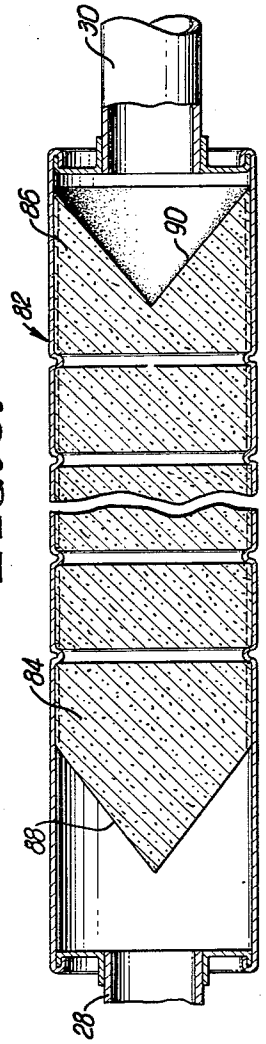


FIG. 8.

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3,189,418

CATALYTIC CONVERTER

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Application June 19, 1961, Ser. No. 117,933, which is a division of application Ser. No. 27,721, May 9, 1960, now Patent No. 3,065,595, dated Nov. 27, 1962. Divided and this application Apr. 1, 1964, Ser. No. 358,139

6 Claims. (Cl. 23—288)

The present application is a division of my copending application Serial No. 117,933, filed June 19, 1961, for "Catalytic Converter," and now abandoned; said application Serial No. 117,933 being a division of my prior application Serial No. 27,721, filed May 9, 1960, for "Catalytic Converter System for Internal Combustion Engines," issued November 27, 1962, as U.S. Patent No. 3,065,595.

The present invention relates to apparatus for reducing the quantities of unburned hydrocarbons and carbon monoxide emitted from the exhaust system of internal combustion engines, and it relates particularly to a new catalytic case containing catalytic material which replaces the conventional muffler in the exhaust line of an internal combustion engine and which provides improved performance in promoting the oxidation of previously unburned hydrocarbon and carbon monoxide components of the engine exhaust.

The exhaust gases from internal combustion engines, such as those employed in automobiles and other vehicles, contain a mixture of carbon monoxide, carbon dioxide, unburned hydrocarbons, nitrogen, some of the nitrogen oxides, and under certain conditions, portions of unconsumed air. It is well established that these exhaust gases from internal combustion engines accumulate in the atmosphere and react to sunlight to form "smog" which causes eye irritation, is harmful to agricultural production, and appears to be a substantial human health hazard. The unburned hydrocarbons in the exhaust gases appear to be the principal smog producing agents, so that it is important to reduce the hydrocarbon content of the exhaust gases to an absolute minimum. Also, although the carbon monoxide content of the exhaust gases does not appear to be a smog forming agent, it is similarly important to reduce the output of this poisonous gas to a minimum. As an example of the amounts of hydrocarbons and carbon monoxide now considered acceptable for exhaust outputs, the California Legislature has recently established a new maximum effluent proposal of 275 parts per million of hydrocarbon content and 1.5% carbon monoxide content in the escaping exhaust.

Prior attempts to reduce the unburned hydrocarbon and carbon monoxide content in the internal combustion engine exhaust have taken two forms, namely, (1) "afterburners" for direct burning of the undesired materials with excess air at temperatures above 2000° F., and (2) "catalytic converters" for catalytically oxidizing or burning the unwanted materials with excess air at temperatures above about 500° F., catalytic action permitting such lower temperature burning. However, heretofore, neither the "afterburner" nor the "catalytic converter" has proved completely satisfactory under the wide variety of operating conditions which must be met. During "idle" engine operation, the volume of exhaust gases is about 6 cubic feet per minute at a temperature of around 400° F., with an abnormal concentration of gasoline when the engine is first turned on and the automatic choke is operating; while at high automobile speeds (e.g. freeway speeds) the volume of exhaust gases will exceed 100 cubic feet per minute and the temperature will range above 1300° F. The unburned hydrocarbon concentration ranges from an

average of about 600 parts per million, up to about 6,000 parts per million during deceleration.

It has been found that an "afterburner" is normally incapable of handling these wide variations in the exhaust. For example, it is difficult to provide a satisfactory firing means for an "afterburner," conventional spark plugs being subject to "blowout" when the exhaust gases are moving at high velocity, and often not properly supporting combustion under cold engine conditions or where inadequate quantities of fuel or air are present in the exhaust gases. Another problem with "afterburners" is that often additional gasoline must be injected directly into the exhaust system to initiate or to support the combustion, which wastes fuel and which can seriously shorten the life of the exhaust system.

Similar difficulties are encountered with conventional catalytic converters. One particular problem with which the present invention is concerned is that under cold engine starting conditions it often requires a considerable period of time before the catalyst reaches the necessary 500° F. or higher (preferably 900–1000° F.), in order to operate efficiently. The relatively high thermal conductivity and heat capacity of catalyst beds heretofore employed in catalytic converters have caused the warm-up problem to be particularly difficult.

It is accordingly an object of the present invention to provide a novel catalytic converter for an internal combustion engine exhaust system comprising a case having a catalyst bed therein, the catalyst bed at its upstream or inlet side having a portion projecting upstream from the main body of the catalyst bed and exposing a relatively small volume of the catalyst to the incoming exhaust gases, whereby said exposed catalyst is more quickly heated by the incoming exhaust gases so as to assist in setting off the catalyst reaction at relatively low temperatures.

Another object of the invention is to provide a catalytic converter of the character described wherein said portion of the catalyst bed which projects upstream of the main body of the catalyst bed is sharply pointed, and preferably of generally conical configuration.

Another object of the present invention is to provide a catalytic converter of the character described for an internal combustion engine exhaust system, wherein the catalyst bed is composed of particulate catalyst material, the exhaust gases flowing into and out of the catalyst bed through porous metallic members defining the upstream and downstream sides or ends of the bed, respectively, said porous member at least on the upstream side of the bed having a sharply pointed, preferably conical, portion directed upstream and containing said exposed portion of the catalyst.

A further object of the invention is to provide a novel catalytic case of the character described which contains a catalyst bed comprising a porous ceramic catalytic block, said portion of the catalyst bed which projects upstream from the main body of the bed being an integral part of the block.

Other 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 side elevation view showing a catalyst case according to the present invention, with connecting exhaust line portions upstream and downstream of the case.

FIGURE 2 is a horizontal sectional view, partly in elevation, illustrating the internal details of construction of the catalytic case shown in FIGURE 1.

FIGURE 3 is a vertical section along the line 3—3 in FIGURE 2, with portions in elevation, further illustrating

the internal construction of the catalytic case shown in FIGURE 1.

FIGURE 4 is a transverse, vertical section along the line in FIGURE 3.

FIGURE 5 is a longitudinal vertical section, partly in elevation, illustrating an alternative form of the present invention wherein the catalyst bed comprises a plurality of porous ceramic blocks rather than being a particulate catalyst bed as in the form of the invention shown in FIGURES 1–4.

FIGURE 6 is a transverse, vertical section along the line 6—6 in FIGURE 5.

FIGURE 7 is a perspective view of one of the porous ceramic blocks employed in the catalytic case of FIGURE 5.

FIGURE 8 is a fragmentary longitudinal vertical section illustrating a catalytic case similar to that shown in FIGURE 5, but with modified front and rear porous ceramic catalyst blocks, wherein the forwardmost block has a forwardly projecting conical portion, and the rearwardmost block has a complementary conical recess.

Referring to the drawings, and at first particularly to FIGURES 1–4 thereof, the catalytic case 10 there illustrated includes cylindrical outer and inner metal shells 12 and 14, respectively, with an insulation layer 16 between shells 12 and 14. Any desired insulation material may be employed in layer 16, as, for example, glass wool, woven kaowool, asbestos or the like. The outer and inner shells 12 and 14 may be rolled together with a sheet of the insulation material between them to form the cylindrical portion of the case. For economy and durability, I prefer to employ mild steel for the shells 12 and 14, and it is best that the steel be aluminized to prevent rust and corrosion. Stainless steel could also be used, but would be more expensive.

I employ the double-shell, insulated case because of the fact that burning of both hydrocarbons and carbon monoxide in my device is likely to cause temperatures as high as 1700° F. to be produced in the case at times, and the double insulation case protects underside equipment of the automobile, such as brakes, from damage which might otherwise occur from such temperatures, and also protects against car-occupant discomfort. This insulated case also protects against splashing of road water, snow and the like upon an abnormally hot outer surface.

The double wall of the case is approximately ¼ inch thick, and it is preferable to have a flat, oval shape for the cylindrical case as best shown in FIGURE 4 so as to minimize flat surfaces or sides which under internal pressure would tend to bow and enlarge the internal volume of the catalyst case. In order to provide adequate volume for the catalyst bed and forward combustion chamber, I prefer to employ a cylindrical case having internal dimensions of approximately 5 inches high by 12 inches wide by about 24 inches long.

The forward and rear heads 18 and 20 of the case are, like the cylindrical portion of the case, preferably of a double-walled insulated construction, and are provided with peripheral flanges 22 so that the ends of the outer metal shell 12 may be crimped around the flanges 22 to secure the forward and rear heads 18 and 20 in position.

The heads 18 and 20 are provided with proper openings defined within axial connection flanges 24 and 26, respectively. If the present catalytic case 10 is to be employed in a system which also includes direct ignition means for burning previously unoxidized or incompletely oxidized exhaust ingredients, then it is preferred to provide a spark plug mounting sleeve 28 which is integrally attached within the connection flange 24 of forward head 18 as by welding. A rear portion 30 of the exhaust pipe which opens to the atmosphere is integrally connected within the connection flange 26 of rear head 20, as by welding.

It has been found in practice that the catalyst bed itself should preferably have an axial depth at least twice its mean cross-sectional diameter, and in the catalyst case shown in FIGURES 1–4 I employ a catalyst bed depth of about 14½ inches. The catalyst bed 32 is contained in the inner metal shell 14 of the case between axially spaced front and rear conical screens 34 and 36, respectively. The front and rear screens 34 and 36, respectively, point forwardly, or upstream, and are of identical shape so that the axial depth of the catalyst bed is uniform across the bed. For a catalyst case of the preferred dimensions set forth above, I prefer to employ conical screens 34 and 36 which have an axial depth of about 3 inches from the base 38 to the point 40 of each screen. The bases 38 of screens 34 and 36 are positioned directly against the inner wall of the inner metal shell 14.

The conical screens 34 and 36 are preferably composed of a stainless steel screen having a mesh on the order of between about 15–20 wires to the inch. Such screen material has adequate strength and surface stability, and still is fine enough so that the relatively large catalyst particles will not "blind" the screen from the rapid passage of the exhaust gases therethrough.

The conical screens 34 and 36 do not have sufficient structural strength to support themselves, and are accordingly backed up by respective perforated conical plates 42 and 44 to which screens 36 and 38 are attached, preferably by spot welding. The conical plates 42 and 44 are integrally secured to the inner metal shell 14, as by welding. The catalyst particles are actually contained by the screens 34 and 36 so that the particles cannot "blind" the perforations in the conical plates 42 and 44. Thus, the front conical screen 34 is secured to the rear or downstream side of the front perforated plate 42, while the rear screen 36 is secured to the forward or upstream side of the rear plate 44. I have found in practice that a rear perforated plate 44 composed of mild steel holds up very well, but that it is preferable to provide front perforated plate 42 of stainless steel, or possibly aluminized steel, because of the blasts of fire in the ignited exhaust from the spark plug where direct ignition burning occurs upstream of the catalyst case, which not only causes high temperatures but also causes the front perforated plate 42 to go through very sudden shock temperature changes and stresses.

It will be noted that the front conical plate 42 is disposed considerably downstream or to the rear of the forward head 18 of the case, thus providing a chamber 46 in the case forward of the catalyst bed, this chamber being a combustion chamber when direct ignition means is employed upstream of the catalytic case. Expansion of the gases ignited upstream of the catalytic case 10 into the combustion chamber 46, and the intrusion into the combustion chamber 46 by the forwardly pointing conical plate 42 and screen 34 cause a great deal of gas turbulence in chamber 46 to promote combustion and to provide a relatively uniform distribution of the exhaust gases as they enter the exposed frontal area of the catalyst bed. I have found that where the catalytic case 10 is employed in connection with a system which also utilizes direct ignition burning, by placing the spark plug 48 in the exhaust line just ahead of the chamber 46 rather than in chamber 46, the plug is more intimately associated with the exhaust gases, due to the narrow channel through which the gases pass, to provide the most effective ignition. Accordingly, the spark plug 48 has been shown mounted on the plug mounting sleeve 28.

The principal advantage of employing the conical catalyst retainer screens is that a small volume of the catalyst in the apex of the front cone is, in effect, exposed to the heat of the incoming exhaust gases which pass through chamber 46 so that it is quickly heated to the 500 or more degrees F. required for effective catalytic action, thus "kicking-off" the catalyst reaction in the catalyst bed 32. By this means, effective catalyst action occurs within about the first minute after a cold engine is started.

To protect the apex portion of the front cone from high

temperature oxidation which might otherwise occur as a result of the direct impingement of the high temperature exhaust flow against the cone apex, and further to provide a means for diverting the lead oxide "dust" and fine "road silt" which may be contained in the exhaust stream toward the inner wall of the case so that these finely divided particles will not "blind" the catalyst bed, a heat resistant protective disc or button 50 may be supported forward of the cone apex in a central position within the case. The disc or button 50 may be composed of any suitable heat and chemical resistive material, such as relatively non-porous ceramic, quartz or the like or suitable metal such as nichrome. In order to enhance the deflection of the lead oxide particles so that a maximum thereof will be deposited on the inner wall of the case, and also to provide a receptacle for retaining a substantial quantity of the relatively "tacky" deposited material on the button itself, I prefer to provide a concave forward face 52 on the button 50.

Although the disc or button 50 may be supported in any convenient manner, a presently preferred means is to provide a pair of metal rods 54 and 56, which may be of welding rod stock, if desired, the rods extending at right angles to each other through a pair of diametral holes through the disc, with the ends of rods 54 and 56 being welded to the inner wall of the case.

With further reference to the catalytic case 10 shown in FIGURES 1–4, it is easier to introduce the particulate catalyst into the case after the case has been completely constructed, and it is therefore desirable to provide an opening 58 through the case wall which may merely be punched out, the opening 58 communicating with the inside of the case just forward of the rear screen 36. After the catalyst has been loaded, the opening 58 may be covered by a suitable cap 60. Cap 60 may be attached to the case by inserting a bar 62 across the inside of opening 58, with a screw 64 extending through the cap 60 and threadedly engaged to bar 62.

A plurality of axially spaced ribs 66 extend inwardly of the inner case shell 14 into the catalyst bed 32. These ribs 66 extend all of the way around the inner shell 14. The portions of ribs 66 which extend across the top wall of shell 14 are preferably about ¾ inch wide so as to serve not only as case stiffeners but also to serve as baffles to prevent channeling of the gases through the catalyst bed in the event of any catalyst shrinkage. The remaining portions of ribs 66 at the sides and bottom of shell 14 may only be about ¼ inch wide, serving primarily to stiffen the case against deformation.

A presently preferred particulate catalyst material in the catalyst bed 32 and preferred methods of making same are described in said parent application Serial No. 27,721, now U.S. Patent No. 3,065,595. Briefly, it is preferred that a particulate catalyst have a mean particle diameter of about 0.17 inch, with the particle size range preferably between about 0.15 inch and about 0.24 inch. The catalyst particles comprise a carrier base which has a porous, clay-like, unglazed surface that is impregnated with active catalytic material, the carrier base being resistant to "heat fracturing" or shrinking during use so as to prevent voids where gases may by-pass without catalytic contact. It is also preferred that the particles have a low heat capacity so that the catalytic bed will heat quickly from a "cold" start, and the catalyst should be a poor heat conductor, so that it will not dissipate the heat of reaction too quickly and will remain at a higher effective temperature during operation, such low heat capacity and conductivity being secured by using a base material of low density, with the active catalytic material only impregnated to a relatively small surface depth, on the order of about ten thousandths of an inch. Examples of good base materials are "Kaolin" as processed by Minerals and Chemicals, and commercially available in spheres called "Kaospheres," this material being practically pure kaolin (45% Al_2O_3, 55% SiO_2), this material preferably being preshrunk before use. Another good particulate base is "Celite," as made by Johns-Manville, this being diatomaceous earth which is pure silicon oxide, such particles not appearing to undergo any appreciable shrinkage at operative temperatures of the converter; and it is preferable to provide a thin coating of finely divided kaolin or other highly porous clay material on the surfaces of these particles.

The active catalytic chemicals are available in a wide selection, although oxides of multi-valent metals are the presently preferred active catalytic agents for hydrocarbon and carbon monoxide oxidation because they maintain high activity during use, they are relatively unsusceptible to poisons such as lead, phosphoric acid, boron and sulfur, and because they are relatively cheap. Oxides of such multi-valent metals as iron, chromium, copper, cobalt, manganese, molybdenum, nickel, platinum and palladium are effective. A preferred combination is ferric oxide which is promoted with a quantity of chromic oxide and also copper oxide, the copper oxide aiding the low temperature activity of the catalyst.

The foregoing description of presently preferred catalyst particles is by way of example only, and it is to be understood that any particulate catalyst can be employed in the catalyst bed 32.

In FIGURES 5–8, I have illustrated an alternative embodiment of my catalytic converter which employs one or more porous ceramic blocks that are impregnated throughout with active catalytic material. Referring at first to FIGURES 5, 6 and 7, the catalytic case 68 contains a plurality of ceramic blocks 70. These blocks 70 are preferably provided in a flat oval shape with axis dimensions of about 4½ inches high and about 9 inches wide, with an axial depth or thickness of about 2 to 2½ inches for each block, the catalytic case 68 having a corresponding shape so that these blocks will be securely held in the case. It will be noted that the cross-sectional area of these porous blocks is somewhat smaller than the corresponding cross-sectional area of the catalyst bed 32 where the particulate catalyst is employed, as best shown in FIGURES 2, 3 and 4. The smaller size is permitted by the increased efficiency of the porous ceramic block type of catalyst. Even with this reduced size, the ceramic block catalyst will have many times the effective catalyst surface area therein as compared with the particulate catalyst without having a back pressure any greater than that normally encountered in a conventional muffler, and will therefore function more efficiently and for a longer period of time than a particulate catalyst. This greatly increased surface area in the porous ceramic catalyst is permitted because the web partition walls within the ceramic blocks may be provided with a thickness of only about 0.020 inch or less, whereby the entire supporting ceramic material throughout the blocks may be impregnated with catalyst, substantially all of the catalyst being usefully exposed within a depth of about 0.010 inch or less on opposite sides of these thin web partition walls. It has been found in practice that in any catalyst bed, either particulate or of the block type, the catalytic activity only occurs within surface regions on the order of about 0.010 inch in depth, so that in the case of the particulate catalyst, most of the internal structure of the individual particles is not useful in the catalytic reaction.

The ceramic catalyst blocks are preferably constructed from clay material normally used for making ceramic brick or porous porcelains, and are usually formed by soaking the ceramic slip into a carbonaceous or organic porous structure, removing the excess slip from the structure by squeezing or alternatively by blowing with air, or sucking by vacuum, leaving the slip in a thin layer on the porous structure, so that upon drying and firing at a temperature on the order of about 2000° F. the thickness of the membranes of ceramic material remaining after burning out the carbonaceous or organic porous structure will

be approximately 0.020 inch or less. This results in rigid, non-shrinkable structures having the desired high porosity and thin partition walls. Nevertheless, because of the very thin honeycomb walls throughout the blocks, they are relatively fragile, and it is accordingly desirable to provide a reinforcing ceramic layer 72 of reduced porosity and increased strength about the periphery of each of the blocks. This peripheral layer 72 may be made by painting each block around its edge surface with an air hardening cement such as "Sauereisen" or "Harwaco" bond, or may be provided in the original manufacture of the blocks by incorporating less or no "burnout" material in the peripheral edges.

The active catalytic chemicals embodied in the ceramic block type of catalyst will normally be the same as those briefly described above in connection with the particulate catalyst.

Presently preferred structures, compositions and methods of making the ceramic catalyst blocks are fully described in said parent application Serial No. 27,721, now U.S. Patent No. 3,065,595. It is to be understood that any suitable porous block type of catalyst may be employed in the catalytic case 68.

The catalyst blocks 70 may be placed in the catalytic case 68 by rolling the case shell 74 around the blocks 70 with the blocks laid side-by-side. It is preferable to space the consecutive blocks slightly apart to permit crimping of the case shell 74 between adjacent blocks to form shallow intervening ribs 76. These crimped ribs 76 serve to seal each block in place so that gases will not by-pass around the blocks, which is particularly important in the event of any shrinkage of the blocks. The ribs 76 have the further advantage that if one block is damaged, it will be self-contained. Also, by thus separating the individual blocks, gas diffusion will occur between the blocks, retarding possible channeling of the exhaust gases.

Although the catalyst case shell 74 may be insulated, if desired, this is not necessary with the porous blocks because of the extremely low heat conductivity of the blocks, and because the cemented, non-adsorptive peripheral edges of the blocks serve as an insulating medium.

As with the particulate catalyst case, it is desirable to support the heat resistant protective disc or button 50 centrally within the ceramic block catalyst case 68 in the chamber ahead of the first block 70, to throw out as much as possible of the particulate lead oxide and road silt in order to protect the following catalytic surfaces in the blocks. The catalytic case 68 is completed by front and rear end heads 78 and 80, respectively.

In FIGURE 8 I have illustrated a catalyst case 82 which contains modified front and rear porous catalyst blocks 84 and 86, respectively. The front block 84 has a conical forward portion 88, while the rear block 86 has a complementary conical recess 90 at its rear end. The conical shape of the forward block 84 provides the same advantage as the conical forward portion on the particulate catalyst bed, namely, to provide quick heating so as to give a "kick-off" to the catalyst reaction, and to cause turbulence of the entering gases. As in the case of the particulate catalyst, the complementary rear conical recess 90 causes the catalyst bed depth to be uniform across its entire cross-sectional area. Although the ceramic disc or button has not been shown in FIGURE 8, it may be employed in front of the cone tip of block 84, if desired.

While the instant invention has been shown and described herein in what are conceived to be the most practical and preferred embodiments, it is recognized that departures may be made therefrom within the scope of the invention, which is therefore not to be limited to the details disclosed herein, but is to be accorded the full scope of the claims.

What I claim is:

1. A catalytic converter for an internal combustion engine exhaust system which comprises a case having an inlet opening to admit exhaust ingredients into the case and an outlet opening to permit exhaust ingredients to flow out of the case, the case including wall means defining a flow channel in the case through which the exhaust gases flow from said inlet opening to said outlet opening, and a catalyst bed in said case disposed in said flow channel so that the exhaust gases flowing through said flow channel from said inlet opening to said outlet opening pass through the catalyst bed, the catalyst bed having an upstream surface through which the exhaust gases enter the catalyst bed and a downstream surface through which the exhaust gases leave the catalyst bed, said flow channel including a substantial clearance between said inlet opening and said upstream surface of the catalyst bed, a portion of the catalyst bed at said upstream surface projecting upstream from the main body of the catalyst bed into said clearance so as to expose a small volume of the catalyst to the incoming exhaust gases before the exhaust gases pass through the main body of the catalyst, whereby under cold engine starting conditions said projecting portion of the catalyst bed will be more quickly heated by the exhaust gases than the main body of the catalyst so as to accelerate initiation of catalytic activity in the bed.

2. A catalytic converter as defined in claim 1, wherein said projecting portion of the catalyst bed is sharply pointed.

3. A catalytic converter as defined in claim 1, wherein said projecting portion of the catalyst bed is generally conical in shape.

4. A catalytic converter for an internal combustion engine exhaust system which comprises a catalytic case having an inlet opening to admit exhaust ingredients into the case and an outlet opening to permit exhaust ingredients to flow out of the case, the case including wall means defining a flow channel in the case through which the exhaust gases flow from said inlet opening to said outlet opening, a catalyst bed comprising particulate catalyst material in said case disposed in said flow channel so that the exhaust gases flowing through said flow channel from said inlet opening to said outlet opening pass through the catalyst bed, the catalyst bed having an upstream surface defined by a first porous retainer member in the case through which the exhaust gases pass to enter the catalyst bed, and a downstream surface defined by a second porous retainer member in the case through which the exhaust gases pass to leave the catalyst bed, said flow channel including a substantial clearance between said inlet opening and said first retainer member, a portion of said first retainer member projecting into said clearance so as to define a portion of the catalyst bed which projects upstream from the main body of the catalyst bed so as to expose a small volume of the catalyst to the incoming exhaust gases before the exhaust gases pass through the main body of the catalyst, whereby under cold engine starting conditions said projecting portion of the catalyst bed will be more quickly heated by the exhaust gases than the main body of the catalyst so as to accelerate initiation of catalytic activity in the bed.

5. A catalytic converter as defined in claim 4, wherein said projecting portion of said first retainer member is sharply pointed.

6. A catalytic converter as defined in claim 4, wherein said projecting portion of said first retainer member is generally conical in shape.

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