

May 21, 1963

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3,090,677

CATALYTIC CONVERTER

Filed March 9, 1961

4 Sheets-Sheet 1



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May 21, 1963

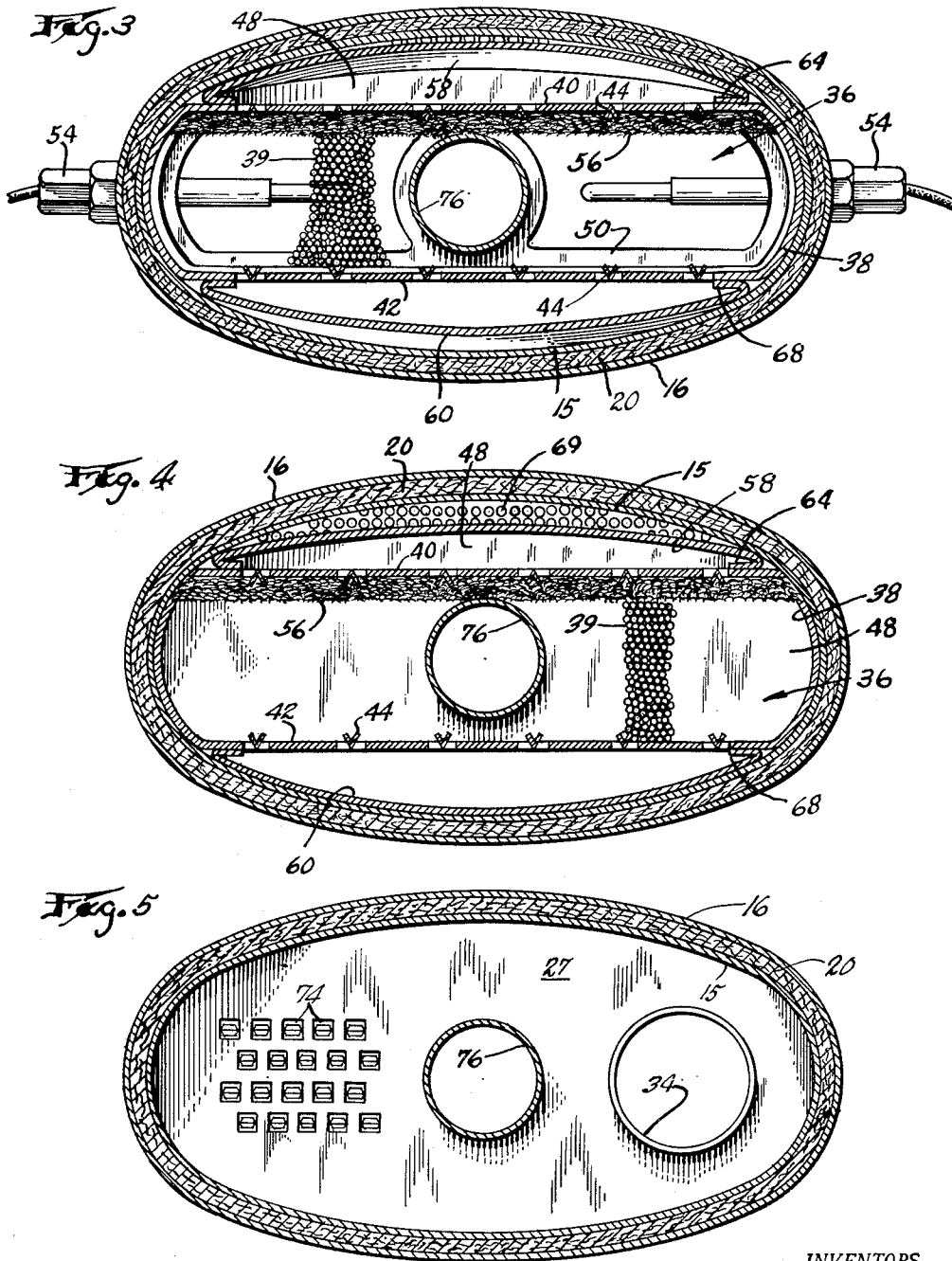
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Filed March 9, 1961

4 Sheets-Sheet 2



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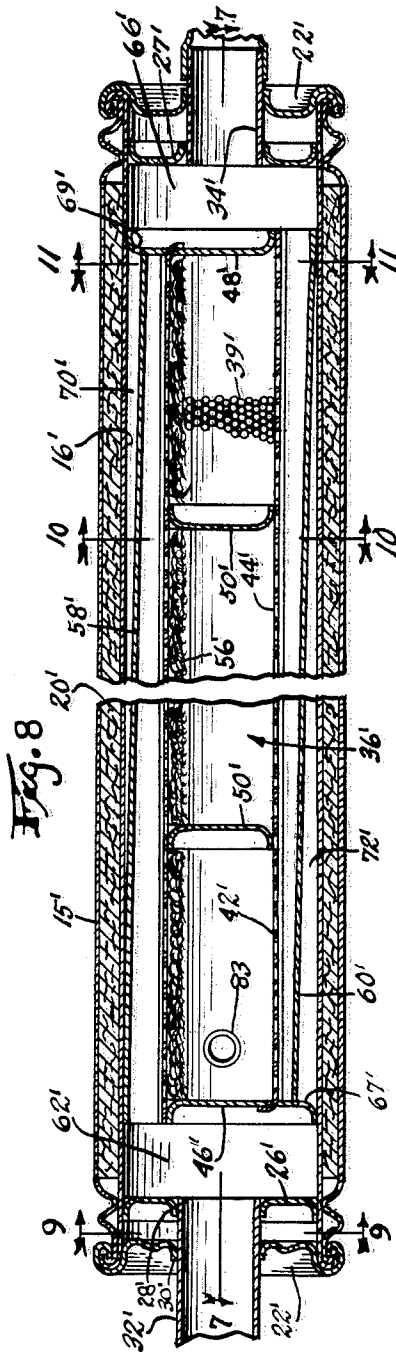
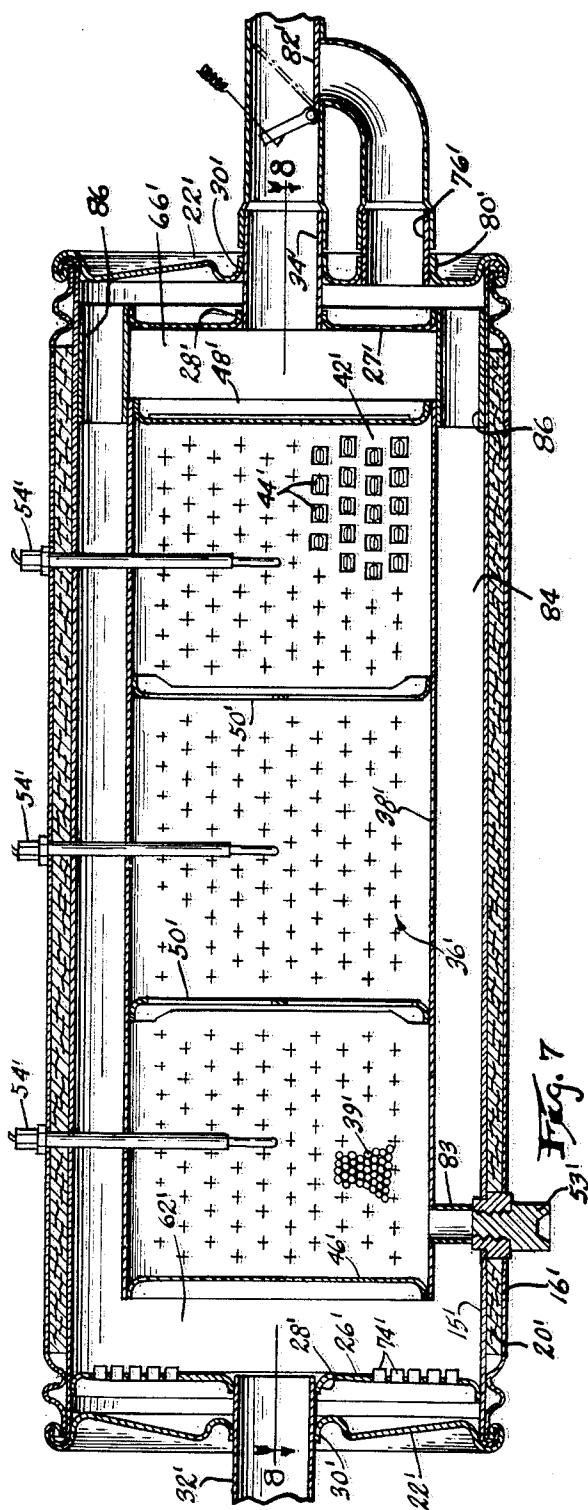
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4 Sheets-Sheet 3



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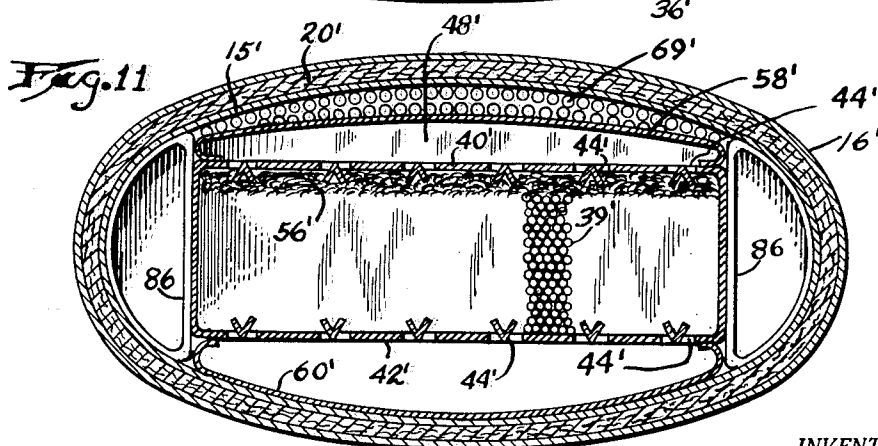
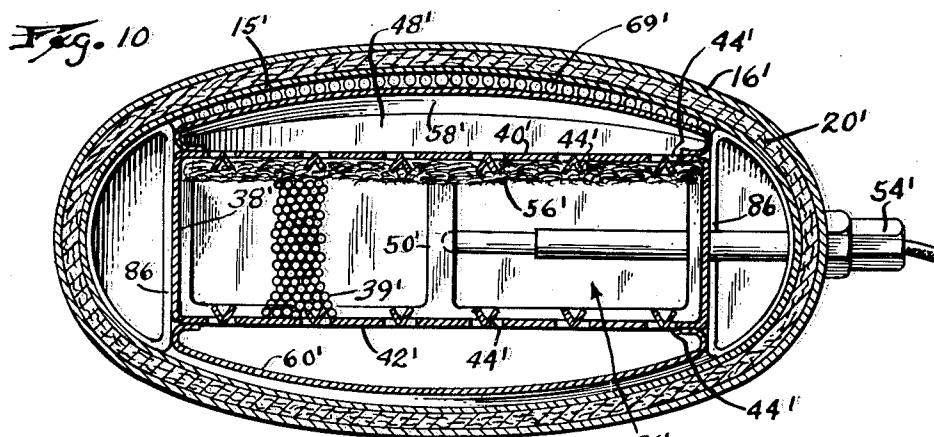
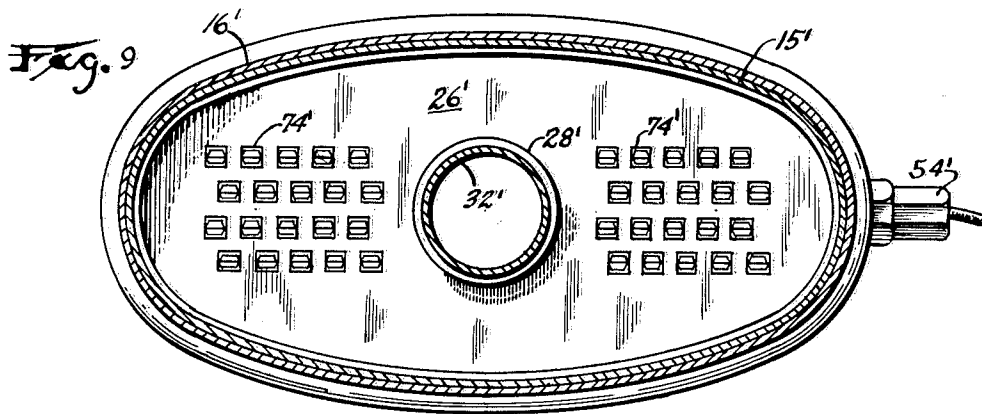
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CATALYTIC CONVERTER

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Filed Mar. 9, 1961, Ser. No. 94,607

9 Claims. (Cl. 23-288)

This invention relates to a catalytic converter for exhaust gases, and more particularly to a catalytic converter for removing the undesirable components present in the exhaust gases emanating from an internal combustion engine.

The combustion of fuel in an internal combustion engine, particularly in the internal combustion engines in automobiles, is incomplete, thereby causing a high percentage of unburned hydrocarbons and carbon monoxide to be discharged from the engine with the exhaust gases. These hydrocarbons and carbon monoxide when introduced into the atmosphere in sufficient quantities produced an atmospheric condition referred to as smog. It has been found, however, that these smog-producing pollutants can be removed from the exhaust gases by certain chemical and/or thermal treatments of the exhaust gases.

It is therefore the general object of our invention to provide a catalytic converter which will remove the smog-producing pollutants from the exhaust gases of an automobile internal combustion engine. More specifically, it is an object of our invention to provide a catalytic converter which will remove a high percentage of the undesirable pollutants in an exhaust gas stream, which can be adjusted to control the amount of removal of said pollutants, and which will effect a removal of such pollutants substantially immediately upon engine start-up. It is a further object of our invention to provide such a catalytic converter which can be economically manufactured largely from sheet-metal, which will hold a large quantity of material for converting said pollutants to non-noxious by-products, which will have limited space requirements, and which will produce minimal back pressures.

In accordance with the preferred form of our invention, there is provided an insulated outer shell having its ends closed by a pair of end caps supporting inlet and outlet conduits at the opposed ends of the converter. A conversion chamber adapted to hold a catalytic material is mounted within said shell, said chamber having its pair of opposed major faces perforated for gas flow therethrough. A pair of baffle plates are mounted on the ends of the conversion chamber to close the same, and extend beyond the cross-sectional extent of said chamber for connection to the outer shell to thus form a pair of plenum chambers interposed between the ends of the chamber and the shell. Conveniently, means may be provided in the conversion chamber for increasing the rate of activation and/or the rate of conversion effected by the catalytic material.

Desirably, the movement of the exhaust gases into and out of the conversion chamber is directed by inlet and outlet ducts interposed between the conversion chamber and shell and connected at one of their ends to one of said baffle plates. The inlet duct has its inlet end open to one of said plenum chambers and its opposite end connected to one of the baffle plates, and the outlet duct has its outlet end open to the opposite plenum chamber and its opposite end connected to the other of said pair of baffle plates. Conveniently, the portion of the baffle plates interposed between the inlet and outlet ducts and the shell are perforated whereby the voids between said inlet and outlet ducts and the shell will serve as sound

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attenuating chambers for attenuating the noise level of the exhaust gases passing through the converter.

A by-pass tube is mounted in the baffle plates and extends from the plenum chamber at the inlet end of the converter through the conversion chamber to project outwardly through the end cap at the outlet end of the converter. Outside the extent of the converter said by-pass tube connects with the outlet conduit which is provided with a control valve mounted upstream to said connection to thus direct the exhaust gas movement either through the conversion chamber in which case the exhaust gases are subjected to the conversion action of the catalytic material, or through the by-pass tube in which case the exhaust gases are not subjected to the action of said catalytic material.

Other objects and features of our invention will become apparent from the more detailed description which follows and from the accompanying drawings, in which:

FIG. 1 is a longitudinal horizontal section taken on the line 1-1 of FIG. 2, and showing a catalytic converter embodying our invention;

FIG. 2 is a longitudinal vertical section taken on the line 2-2 of FIG. 1;

FIG. 3 is an enlarged vertical cross-section taken on the line 3-3 of FIG. 2;

FIG. 4 is an enlarged vertical cross-section taken on the line 4-4 of FIG. 2;

FIG. 5 is an enlarged vertical cross-section taken on the line 5-5 of FIG. 2;

FIG. 6 is an enlarged fragmentary section showing the interconnection between the shell sidewalls and one of the end caps;

FIG. 7 is a longitudinal horizontal section taken on the line 7-7 of FIG. 8, and showing a modified form of the converter shown in FIG. 1;

FIG. 8 is a longitudinal vertical section taken on the line 8-8 of FIG. 7;

FIG. 9 is an enlarged vertical cross-section taken on the line 9-9 of FIG. 8;

FIG. 10 is an enlarged vertical cross-section taken on the line 10-10 of FIG. 8; and

FIG. 11 is an enlarged vertical cross-section taken on the line 11-11 of FIG. 8.

As shown in FIGS. 1 and 2, our converter is housed in an elongated shell construction comprising an inner shell 15 and an outer shell 16, the shell 16 having circumferentially extending beads 18 adjacent each of its ends to provide a spacing between the intermediate stretches of the shells 15 and 16 for holding a layer of insulation 20. As shown in FIG. 6 the shells 15 and 16 abut each other at their ends and are rigidly connected as by common roll seams 24 to a pair of end caps 22 closing the ends of the shells. As shown in FIGS. 1 and 2, a pair of partitioning walls 26 and 27 are mounted on the inner walls of the inner shell 15 slightly inwardly from the end caps 22. Each of the walls 26 and 27 is provided with a shouldered aperture 28 disposed in alignment with a corresponding shouldered aperture 30 formed in each end cap 22. The openings in the wall 26 and its adjacent end cap 22 support an inlet conduit 32 extending inwardly from the end of the converter and terminating inwardly of the wall 26, and the axially offset openings in the wall 27 and its adjacent end cap 22 support an outlet conduit 34 extending outwardly from the converter from a point inwardly of the wall 27.

Interposed between the walls 26 and 27 and spaced therefrom is a conversion chamber 36. As shown in FIG. 3, the side walls 38 of the conversion chamber 36 abut and mate with the inner wall of the shell 15 to thus support the conversion chamber 36 within the shell with its upper and lower walls 40 and 42 in spaced relation to the upper and lower stretches of said shell. The upper

and lower walls 40 and 42 of the chamber 36 are provided with louvered openings 44 which thus permit movement of the exhaust gases through said chamber. As shown in FIGS. 1 and 2, the ends of the chamber 36 are closed by a pair of baffle plates 46 and 48 which are rigidly secured to the inner shell 15 to thus further support the chamber within said shell. Conveniently, additional baffle plates 50 are rigidly mounted on the interior of the chamber 36 and provide cross-braces therefor.

The conversion chamber 36 is adapted to be filled with a catalytic material 39 which may be introduced into the chamber 36 through a fill opening extending through the shell and chamber side walls and closed by a plug 53. However, such catalytic materials are commercially available in a size and shape such that they will not fall out of the chamber through the louvered openings 44. The catalytic materials which are now available are heat-activated and heat-destroyed, and they are adapted to effect an oxidation of hydrocarbons and carbon monoxide into carbon dioxide and water vapor with the evolution of heat. Examples of such catalysts are vanadium pentoxide, nickel oxide, copper oxide, platinum, etc.

Since these catalytic materials are heat-activated, and in order that they may be activated immediately upon engine start-up, it is frequently desirable to employ a pair of glow plugs 54 connected to suitable sources of energy and embedded in the catalyst. Thus, upon energization of the glow plugs 54, they heat the catalyst to a temperature to activate it to effect conversion, but once the conversion begins, the heat evolved from such conversion will maintain the catalyst at an elevated temperature and the glow plugs 54 may be de-energized.

In certain applications it may be desirable to preheat the exhaust gases prior to their flow through the catalyst to thus effect a greater degree of conversion of the noxious pollutants. To this end, a heat exchanger 56, conveniently in the form of a layer of ceramic, steel wool, or the like is interposed between the upper conversion chamber wall 40 and the top of the catalyst bed, the heat exchanger 56 being supported in the chamber by the catalyst bed.

To uniformly distribute the flow of the exhaust gases through the conversion chamber, we provide elongated inlet and outlet ducts 58 and 60. As shown in FIG. 2, the inlet end of the inlet duct 58 is disposed in alignment with the baffle plate 46 and opens into an inlet plenum chamber 62, the ends of which are formed by the baffle plate 46 and the partitioning wall 26. The inlet end of the duct 58 abuts the shell 15 partially around its inner circumference with the longitudinally extending edges of said duct being turned inwardly as at 64 and secured to the upper face of the conversion chamber wall 40. The duct 58 slopes downwardly from the shell 15 with its opposite end being rigidly secured to the baffle plate 48 intermediate the shell 15 and the upper chamber wall 40. Conversely, the outlet end of the duct 60 abuts the shell 15 partially around its inner circumference adjacent the outlet end of the converter and is in open communication with an outlet plenum chamber 66, the ends of which are formed by the baffle plate 48 and the partitioning wall 27. The outlet duct 60 has its longitudinally extending edges bent inwardly as at 68 and rigidly secured to the lower conversion chamber wall 42. The outlet duct 60 slopes upwardly from its abutment with the shell 15 with its opposite end rigidly secured to the baffle plate 46 intermediate the shell 15 and the lower conversion chamber wall 42. Such construction provides a chamber inlet of constantly decreasing volume and a chamber outlet of constantly increasing volume to thus cause the exhaust gases to pass through the conversion chamber uniformly throughout its length and width for effecting a maximum utilization of the catalyst and an efficient conversion of the exhaust gas pollutants.

As shown in FIG. 2, the baffle plate 46 extends down-

wardly from the chamber 36 and is secured to the shell 15, with the portion of said plate interposed between the outlet duct 60 and the shell 15 being provided with a plurality of perforations 67. Conversely, the baffle plate 48 projects upwardly from the conversion chamber 36 and is secured to the shell 15, with the portion of said baffle plate disposed between the inlet duct 58 and shell 15 being provided with a plurality of perforations 69. Thus, the space between the inlet duct 58 and the shell 15 forms a sound attenuating chamber 70 disposed in operative communication with the outlet plenum chamber 66 by means of the perforations 69, and the space between the outlet duct 60 and the shell 15 forms a second attenuating chamber 72 disposed in operative communication with the inlet plenum chamber 62 by means of the perforations 67. As shown in FIGS. 1 and 5, additional sound attenuation of the exhaust gas noises is achieved by providing a plurality of louvered openings 74 in the partitioning walls 26 and 27 to acoustically couple the spaces between said partitioning walls and the end caps 22 with the inlet and outlet plenum chambers 62 and 66. As will be apparent, the chambers 70 and 72 as well as the chambers provided by the walls 26 and 27 also serve as thermal insulating barriers to thus maintain the catalyst at efficient operating temperatures.

As previously explained, the oxidizing-type catalysts which are now available are subject to heat destruction. If the exhaust gases have excessive percentages of hydrocarbons and carbon monoxide, which may result from a malfunction of the engine, then the heat produced by their conversion may produce temperatures in the conversion chamber 36 high enough to destroy the catalyst. Therefore, in order to avoid such destruction it is necessary to control the flow of the gases through the converter and thus control the temperatures of the catalyst. To this end, we provide a by-pass tube 76 supported on shouldered openings formed in the baffle plates 46, 50, and 48 and aligned openings 78 and 80 in the partitioning wall 27 and its adjacent end cap 22. As shown in FIG. 1, the tube 76 extends from the inlet plenum chamber 62 through the conversion chamber 36 and outwardly through the outlet end of the converter for connection to the outlet conduit 34 outside the extent of the converter. To direct the flow of gas through the tube 76, or through the conversion chamber 36, we provide a control valve 82 mounted in the outlet conduit 34 upstream from its connection to the by-pass tube 76 and controlled by any suitable temperature sensing device. With the valve in its full line position shown in FIG. 1, the exhaust gases enter into the inlet plenum chamber 62, flow down the inlet duct 58, through the conversion chamber 36 where the pollutants are converted to carbon dioxide and water vapor, out the outlet duct 60 and plenum chamber 66, and then exit the converter through the outlet conduit 34. When the valve 82 is moved into its dotted line position shown in FIG. 1, the exhaust gases move from the inlet plenum chamber 62 directly into the by-pass tube 76 to pass through the converter and into the outlet duct 34 without having been subjected to any action of the catalyst.

In the modified form of our converter shown in FIGS. 7-11, there is provided inner and outer shells 15' and 16' separated by an insulating layer 20', and having their ends closed by a pair of end caps 22'. A pair of transverse partitioning walls 26' and 27' are secured to the inner shell 15' inwardly of the end caps 22'. The walls 26' and 27' and their adjacent end caps 22' are provided with shouldered openings 28' and 30' respectively, which support inlet and outlet conduits 32' and 34' for conveying the exhaust gases into and out of the converter.

A conversion chamber 36' having closed side walls 38', and opposed top and bottom walls 40' and 42' provided with louvered openings 44', is carried within the shell 15' inwardly from the partitioning walls 26' and 27'.

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The ends of said chamber are supported on, and closed by, a pair of baffle plates 46' and 48' rigidly connected to the inner shell 15'.

As with our other modification, the chamber 36' is adapted to hold a catalytic material 39' which will convert the pollutants in the exhaust gases into carbon dioxide and water vapor. In order to support the weight of the catalyst, the chamber 36' may be provided with longitudinally spaced cross-braces 50'. Also, as with our other modification, the rate of activation of the catalyst may be increased by heat-radiating glow plugs 54' extending inwardly through the shells 15' and 16' into the interior of the chamber 36'. The efficiency of the catalyst may also be improved by the provision of a heat exchanger 56' supported on the catalyst immediately below the upper chamber wall 40' in a position such that it will absorb the heat of the catalyst bed and preheat the gases entering the conversion chamber. Conveniently, the catalyst may be introduced into the chamber 36' through a fill pipe 83 extending outwardly from the chamber 36' and the outer shell 16' and closed by a threaded plug 53' received in a fitting mounted in the converter shell.

To control the flow of the exhaust gases through the conversion chamber 36', we provide an inlet duct 58' mounted along the edges of the upper chamber wall 40'. One end of said duct is secured to the inner shell 15' adjacent the inlet end of the converter and opens into an inlet plenum chamber 62' formed by the baffle plate 46' and the partitioning wall 26'. The opposite end of the duct is connected to the baffle plate 48' whereby said duct forms an inlet passage for the chamber 36' of constantly decreasing volume. An outlet duct 60' is mounted on the lower wall 42' of the conversion chamber with one of its ends abutting the inner shell 15' and disposed in open communication with an outlet plenum chamber 66' formed by the baffle plate 48' and the partitioning wall 27'. The opposite end of the duct 60' is rigidly secured to the baffle plate 46' adjacent the inlet end of the converter and thus forms an outlet passage of constantly increasing volume. In this manner, the ducts 58' and 60' provide a uniformly distributed flow of exhaust gases through the chamber 36'.

As with the other modification of our invention, the baffle plate 46' is provided with a plurality of perforations 67' interposed between the outlet duct 60' and the shell 15' whereby the space 72' between said duct and shell serves as an insulating and sound attenuating chamber. Similarly, the baffle plate 48' is provided with a plurality of perforations 69' interposed between the duct 58' and the shell 15' whereby the space 70' between said duct and shell also serves as an insulating and sound attenuating chamber. The partitioning wall 26' may also be provided with louvered openings 74' to operatively interconnect the space between said partitioning wall and the adjacent cap 22 with the inlet plenum chamber 62' whereby said space may also serve as an insulating and sound attenuating chamber.

The primary distinction between the modification shown in FIGS. 7-11 and the modification shown in FIGS. 1-6 resides in the structure for by-passing the exhaust gases around the chamber 36'. In both modifications, the outer shells of the converter are elliptical, and the conversion chambers are generally rectangular. In the modification shown in FIGS. 1-5 the conversion chamber 36 extends laterally across and abuts the lateral edges of the shell on its long axis, whereas in the modifications shown in FIGS. 7-11, the lateral extent of the conversion chamber 36' is less than the long axis of the elliptical outer shell so that the space between the chamber side walls 38' and the inwardly presented wall of the shell 15' forms a pair of by-pass passages 84 for conducting the exhaust gases around the conversion chamber 36'.

As shown in FIG. 7, a pair of semielliptical pipes 86 are interposed between the chamber 36' and the shell 15'

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in alignment with the by-pass passages 84. The partitioning wall 27' is carried between the pipes 86 so that said pipes form continuations of the by-pass flow passages 84 which terminate in the space between the partitioning wall 27' and its adjacent end cap 22'. The by-passed exhaust gases leave the converter through a by-pass tube 76' carried in a shouldered opening 80' formed in the end cap 22' at the outlet end of the converter. The by-pass tube 76' connects with the outlet conduit 34' downstream from a by-pass control valve 82' mounted in said outlet conduit and activated by any suitable temperature sensing means. Thus, with the valve 82' in its full line position shown in FIG. 7, the exhaust gases will flow through the conversion chamber 36' wherein the noxious pollutants will be converted into carbon dioxide and water vapor, and with the valve in its dotted line position shown in FIG. 7 said exhaust gases will by-pass the chamber 36' to flow along the passages 84 and pipes 86 and exit the converter through the by-pass tube 76'.

As will be understood, in the modification shown in FIGS. 7-11 the by-passed exhaust gases flow through the converter adjacent its exterior and are thus subjected to the cooling effect of the air moving over the exterior of the converter. This produces a more effective cooling of the exhaust gases than with the modification shown in FIGS. 1-6, and thus effects a more rapid cooling of the catalyst carried within the conversion chamber 36'. However, when gases are not flowing through the by-pass it forms a pair of insulating volumes which prevent the edges of the catalyst from becoming excessively cooled by the radiation and conductive effects of the shell surfaces.

While we have shown both modifications of our invention as employing elliptically shaped shells, our invention also contemplates the employment of any type shell and conversion chamber configuration in which substantial portions of the conversion chamber will be spaced from walls of the enclosing shell.

We claim as our invention:

1. In a catalytic converter for removing noxious pollutants from an exhaust gas stream, an outer shell having its ends closed by a pair of end caps, wall-forming means mounted within said shell inwardly from each of said end caps, the wall-forming means adjacent at least one of said end caps being perforated to form a sound attenuating chamber adjacent at least one end of said shell, gas inlet and outlet conduits carried in said end caps and wall-forming means and disposed in open communication with the interior of said shell adjacent its opposed ends, means mounted in said shell and forming a conversion chamber adapted to hold a catalyst for removing the noxious pollutants from the exhaust gases, said means having a pair of opposed perforated wall surfaces spaced from the adjacent wall portions of said shell, an inlet duct connected to one of said pair of wall surfaces and an outlet duct connected to the other of said pair of wall surfaces, one end of said inlet duct being in open communication with the inlet conduit and connected to the adjacent wall portion of said shell and the opposite end of said inlet duct being connected to a first baffle plate extending between said shell and conversion chamber, one end of said outlet duct being in open communication with said outlet conduit and connected to the adjacent wall portion of said shell and the opposite end of said outlet duct being connected to a second baffle plate extending between said shell and conversion chamber, said opposite ends of said inlet and outlet ducts being connected to said first and second baffle plates at points spaced from said shell, and means forming a by-pass passage operatively interconnecting said inlet and outlet conduits whereby the exhaust gases may pass through the converter without passage through the catalyst.

2. The invention as set forth in claim 1 in which said first and second baffle plates are perforated between their

respective connections to said inlet and outlet ducts and the shell.

3. In a catalytic converter for removing noxious pollutants from an exhaust gas stream, an outer shell having its ends closed by a pair of end caps, gas inlet and outlet conduits in open communication with the interior of said shell adjacent its opposed ends, means mounted in said shell inwardly from said end caps and forming a conversion chamber adapted to hold a catalyst for removing the noxious pollutants from the exhaust gases, duct means interposed between said shell and conversion chamber and connected thereto for conducting the exhaust gases from said inlet conduit to said conversion chamber and from said conversion chamber to said outlet conduit, the major portions of said duct means being spaced from said shell and having openings formed therein to form a pair of sound attenuating chambers between said conversion chamber and shell, and means forming a by-pass operatively inter connecting said inlet and outlet conduits whereby the exhaust gases may pass through the converter without passage through said catalyst.

4. The invention as set forth in claim 3 in which said shell comprises an inner and outer member abutting each other at their ends and secured to said end caps by common fastening means, said inner and outer members being spaced from each other intermediate their ends and housing an insulating layer therebetween.

5. The invention as set forth in claim 3 with the addition that heat-retaining means are mounted in said conversion chamber and extend over the face of said chamber immediately adjacent said duct means conducting exhaust gases from said inlet conduit.

6. The invention as set forth in claim 3 in which said conversion chamber-forming means has a first pair of opposed curved sides in mating abutment with a pair of opposed curved portions of inner face of said shell and a second pair of opposed sides spaced from the adjacent portions of the inner face of said shell, and said duct means are interposed between said second pair of opposed sides and said adjacent portions of the inner face of the shell.

7. The invention as set forth in claim 3 in which said means forming the by-pass comprises an imperforate tube mounted in said chamber and extending therethrough, said tube being rigidly connected to said shell and chamber and having one of its ends in open communication with said inlet conduit within said converter and its opposite end projecting outwardly from the converter and

connected to said outlet conduit, and valve means for selectively controlling the flow of exhaust gases through said tube.

8. The invention as set forth in claim 3 in which a pair of sides of said chamber are spaced from said shell to form a pair of passages extending longitudinally along a pair of opposed sides of the converter throughout the major extent thereof, and said means forming the by-pass comprises a pair of conduits connected to said chamber and shell and in open communication with said pair of passages, a third conduit connected to said shell and said outlet conduit in open communication with said pair of conduits and outlet conduit, and valve means for controlling the flow of exhaust gases through said passages.

9. In a catalytic converter for removing noxious pollutants from an exhaust gas stream, an outer shell having its end closed by a pair of end caps, wall-forming means mounted in said shell inwardly from each of said end caps, the wall-forming means adjacent at least one of said end caps being perforated to form a sound attenuating chamber, gas inlet and outlet conduits, shell carried in said end caps and wall-forming means and disposed in open communication with the interior of said shell adjacent its opposed ends, means mounted in said shell and forming a conversion chamber adapted to hold a catalyst for removing the noxious pollutants from the exhaust gases, and duct-forming means for conducting the exhaust gases from said inlet conduit to said conversion chamber and from said conversion chamber to said outlet conduit, said duct-forming means being oriented with respect to said conversion chamber to define a gas inlet and a gas outlet for said conversion chamber having, respectively, progressively smaller and larger cross-sectional extents from the end of said conversion chamber adjacent the inlet conduit to the end of said chamber adjacent the outlet conduit, the major portions of said duct-forming means being spaced from said shell and having openings formed therein to form a pair of sound attenuating chambers between said conversion chamber and shell.

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