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(54) **Method for catalytically cleaning the exhaust gas of an internal combustion engine and exhaust gas system**

Verfahren zur katalytischen Reinigung der Abgase einer Brennkraftmaschine und Abgasvorrichtung

Méthode de traitement catalytique des gaz d'échappement d'un moteur à combustion interne et dispositif d'échappement

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- **PATENT ABSTRACTS OF JAPAN vol. 16, no. 282 (M-1269) 23 June 1992 & JP-A-40 72 414 (YAMAHA MOTOR CO LTD) 6 March 1992**

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Description

The present invention relates to a method for catalytically cleaning the exhaust gas of an internal combustion engine having a catalytic converter body disposed in a muffler of an exhaust gas system thereof. Moreover, the present invention relates also to an exhaust gas system of an internal combustion engine, particularly for performing said method.

For the purification of exhaust gas of an internal combustion engine the use of catalytic converters having catalysts, disposed in the exhaust gas system of the engine is conventional. Such catalytic converters are subject to extreme thermal conditions which shortens the lifetime of the catalysts and, moreover, also require a certain operating temperature in order to clean the exhaust gases from the engine sufficiently. Finally, there is a certain drop of chemical activity from the upstream entry side to the downstream discharge side of the catalytic converter resulting from a reduction of the oxygen content in the exhaust gas which renders combustion of the unburnt hydrocarbons at the downstream discharge side of the catalytic converter insufficient.

So far, mufflers have been equipped with a catalytic converter and also motorcycles have been equipped with such mufflers. In some cases catalytic converters have been installed on both upstream and downstream portions of the exhaust passage in order to promote the cleaning of the exhaust gas exhausted from the engine. In order to avoid the engine performance from being affected an upstream side catalytic converter should be disposed in the exhaust passage as remote as possible from the engine.

For such reasons it has already been deliberated to install two catalytic converters, i.e. an upstream side converter and a downstream side converter inside a muffler. However, this would considerably add to the size of the muffler rendering same relatively large sized.

Moreover, it is already known from a Japanese examined patent publication JP-53-412 89 that a muffler may comprise a relatively large-sized catalytic converter which is separated into an upstream part and a downstream part thereof with opposite flow conditions wherein the exhaust gas is introduced from one end either into its centre portion or into its lower half portion, reversing the exhaust gas which has passed through said portion of the catalytic converter at the other end thereof and reintroducing the flow of exhaust gas into the catalytic converter for opposite flow either along a annular peripheral portion of the catalytic converter or an upper half thereof.

However, such a design also does not only lead to a relatively bulky component but was also found to have drawbacks in view of an inefficiently cleaning activity despite the separation of the catalytic converter into upstream and downstream flow portions. As the exhaust gas is fed totally through the upstream and downstream portions of the catalytic converter, respectively, and the oxygen required for after burning of the unburnt content of hydrocarbons in the exhaust gas substantially is consumed in the upstream portion of the catalytic converter the availability of oxygen in the downstream portion became insufficient causing a drop of converter performance.

Moreover, as the upstream portion of the converter is rapidly subjected to high temperatures because of the rapid progress of the reactions and the high temperature of the exhaust gas introduced therein sometimes a problem occurred in that such a catalytic converter was susceptible to be broken by thermal distortion. On the other hand, the temperature rise in the downstream portion of the catalytic converter is less because of the unburnt content of hydrocarbons and a less rapid burning process.

Accordingly, it is an object of the present invention to provide a method for catalytically cleaning the exhaust gas of an internal combustion engine and to provide an exhaust gas system suited to perform such a method which allows a more efficient cleaning of the exhaust gas to take place and to prevent the catalytic converter body from being thermally overstressed. Finally a bulky muffler shculd be avoided.

According to the present invention the afore-indicated objective in view of its method aspects is performend in that a total flow of exhaust gas is subdivided into a plurality of partial flows of exhaust gas, a partial flow of exhaust gas is fed through a first branch of said catalytic converter body and then the recombined total flow of exhaust gas is fed through a second branch of said catalytic converter body.

In this way it is not the total amount of exhaust gas which flows into the catalytic converter body or a part thereof but it is only a partial flow of said exhaust gas whereas another flow part or some other flow parts pass through another or several other parts of the catalytic converter body thus, balancing the thermal load of the converter and leaving sufficient amounts of oxygen still to be present at the different parts of the ccnverter to perform a more complete combustion of the unburnt hydrocarbonie constituents of the exhaust gas.

According to a preferred embodiment of the present invention in the muffler of the exhaust gas system a part of the incoming flow of exhaust gas is branched off of the total flow of exhaust gas, said part being fed through an upstream cleaning catalyst and, then, the recombined total flow of exhaust gas is fed through a downstream cleaning catalyst disposed in said muffler.

Morevoer, it is preferred that a pre-cleaning of a part of the total flow of exhaust gas takes place at the area of the first branch of the catalytic converter body and that said pre-cleaned part of the exhaust gas is then recombined with the rest of the total flow of the exhaust gas to be fed through the second branch of the catalytic converter body disposed in said muffler. In this way, recombination of a pre-cleaned part with the remainder part of the total flow of exhaust gas takes place, said

pre-cleaned part was fed through a portion of the catalytic converter body only while then recombination of the two flows of exhaust gas takes place for feeding said partially treated flow, total flow of exhaust gas to the remainder part of the catalytic converter body which defines a downstream part thereof. In this way not only balanced thermal and burning conditions are obtained but also a very slanted muffler construction can be obtained.

According to another preferred method aspect of this invention a part of the catalytic converter is subject to a part of the crossectional volume of the total flow of exhaust gas whereas downstream of the catalytic converter recombination takes place to feed the remainder portion of the catalytic converter body. This, preferrably, can be obtained by either partially disposing the catalytic converter body into a part of the crosssection of the exhaust pipe or, for example, by branching off a partial flow of exhaust gas from the exhaust pipe by a separate guide means and feeding a part of the cross-section of the catalytic converter body therewith.

In order to perform the afore-indicated objectives in terms of an exhaust gas system which comprises an exhaust pipe extending into a muffler which accommodates a catalytic converter body and which has a plurality of exhaust gas receiving expansion chambers, the present invention sets forth an improvement in that the catalytic converter body comprises a first branch passageway through which a partial flow of an incoming total flow of exhaust gas is fed, and a second branch passageway through which the recombined total flow of exhaust gas is fed.

Accordingly the exhaust gas is partly cleaned by the catalytic converter body when passing through a part of the catalytic converter body (upstream portion) whereas the total volume of exhaust gas is further cleaned when passing through the remainder part of the catalytic converter body. Accordingly the partially pre-treated total volume of exhaust gas is introduced in a downstream side part of the catalytic converter body with a sufficient amount of oxygen left therein so that the cleaning performance of the catalytic converter body will not be deteriorated even though a single catalytic converter body is only used to clean the exhaust gas in two stages. Therefore a superior cleaning effect can be obtained even beyond a structure of two catalytic converters disposed in an exhaust passage whereas the muffler is prevented from becoming bulky.

Morover, the temperature difference along the catalytic converter is considerably reduced because the exhaust gas is efficiently cleaned in both sections of the catalytic converter body without over-stressing the entry portion thereof. Moreover, because the heat of the exhaust gas at the first branch passageway of the catalytic converter body is transmitted through heat conduction to the second branch passageway of the catalytic converter body temperature difference along the converter is reduced. Thus, malfunctin of the catalytic converter body due to thermal overstress can be avoided. Moreover, balanced conditions for buring unburnt hydrocarbon constituents also adds to a more equal temperature profile along the catalytic converter.

Finally, since the first branch passageway of the catalytic converter body (through which the branched off partial flow of the exhaust gas flows) is disposed to the exhaust gas at a more upstream position where the exhaust gas has a relatively high temperature the cold starting cleaning capabilities of the catalytic converter body are improved as the exhaust gas can be cleaned even in a more early stage after starting of the engine. Moreover, as the exhaust gas is sent to the second branch passageway of the catalytic converter body in a already partly cleaned and heated condition its temperature drop is small. Therefore, the exhaust gas can also efficiently be cleaned even in the second downstream stage of the catalytic converter body.

According to a preferred embodiment of the new exhaust gas system the catalytic converter body comprises a single catalytic converter body disposed within said muffler.

A preferred disposal of the catalytic converter body is that it partially projects into an end portion of the exhaust pipe through a recessed side wall of said pipe. In this way a part of the total flow of exhaust gas passes through that part of the catalytic converter which projects into the exhaust pipe. According to yet another alternative embodiment of the present invention the catalytic converter is disposed laterally outwardly of the exhaust pipe and a exhaust gas passageway means is provided branching off of the exhaust pipe upstream of the catalytic converter to lead a part of the exhaust gas to an upstream part of the catalytic converter which, on the other hand, establishing a downstream portion of said branching of guiding exhaust gas passageway means. At the downstream side of the catalytic converter then more preferrably, a recombination of said partial flow of pre-cleaned exhaust gas with the remainder untreated parts of the exhaust gas volume is performed.

According to yet another preferred embodiment of the present invention said muffler comprises a plurality of expansion chambers which are separated by recessed baffle plates and are disposed successively along a longitudinal axis of the muffler.

In this way a very slanted design of the muffler is specifically promoted.

Advantageously the catalytic converter is disposed to connect an upstream expansion chamber to a more downwardly disposed expansion chamber of the muffler reaching a downstream expansion chamber from which an exhaust gas discharge extends forward outside.

According to a specifically preferred design of the muffler of the exhaust gas system the outlet of the exhaust pipe opens into the rearmost expansion chamber from which a reverse flow of the exhaust gas forwardly is established through a centre expansion chamber, then through a main portion of the catalytic converter to a front expansion chamber and then to the downstream

expansion chamber toward outside.

Other preferred embodiments of the present invention are laid down in the further sub-claims.

In the following the present invention is explained in greater details by means of several embodiments thereof in conjunction with the accompanying drawings, wherein:

Figure 1 is a side view of a motor scooter provided with an exhaust gas system according to an embodiment of the present invention,

Figure 2 is a vertical sectional view of a muffler of said exhaust gas system comprising a catalytic converter according to a first embodiment of the present invention,

Figure 3 is a cross sectional view taken along the line III-III in Figure 2,

Figure 4 is a cross sectional view showing another example of a catalytic converter,

Figure 5 is a vertical sectional view similar to that of Figure 2, showing another embodiment of the muffler, and

Figure 6 is a cross sectional view along the line IV-IV of Figure 5.

A first embodiment of the exhaust gas system of an internal combustion engine, specifically used for a motor scooter and performing the new exhaust gas cleaning method is explained therein after referring to Figures 1 to 3. In said drawing a motor scooter 1 comprises an internal combustion engine 2 forming a swing-type unit for driving a rear wheel 3. Said internal combustion engine 2 is supported on a frame 1a of the motor scooter 1 for vertical swinging. Said engine 2 is oriented such that its cylinder may be directed generally forwardly so as to be accommodated in a space saving manner. A container box lc is installed under a drivers seat 1b.

Connected to an exhaust port (not shown) of the internal combustion engine 2 is an exhaust gas pipe 4 terminating into a muffler 5 disposed on a rear end portion of the exhaust pipe 4. The exhaust pipe 4 extends rearwardly under the engine 2 from a lower portion of the forwardly directed cylinder of the engine 2.

The muffler 5 is composed of muffler bodies 6, 7 formed separately as left and right halves and a catalytic converter 8 is accommodated within this space defined through said muffler bodies 6, 7 as shown in Fugures 2 & 3. Each muffler half 6 or 7 is shaped generally circularly in cross section and such that its diameter may gradually reduce towards its front end rear ends, respectively.

Each muffler half body 6 or 7 comprises flanges 6a, 7a formed along its margins. The muffler 5 is formed and assembled by seam-welding of these flanges 6a, 7a to each other after installing the catalytic converter body 8 and buffle plates 9, 10 & 11 (described hereinafter) are disposed spaced along the longitudinal axis of the muffler half bodies 6 & 7. The exhaust pipe 4, more specifically the end portion 4b thereof is inserted and secured on the muffler 5 with its outlet opening 4c to the rear end of the interior of the muffler 5.

Within the muffler 5 four expansion chambers (A,B, C and D) are formed by means of three fixed baffle plates 9,10 and 11) which are penetrated by the exhaust pipe 4. The rearmost expansion chamber (D) to which the rear end opening 4c of the exhaust pipe 4 faces is communicated to a centre expansion chamber C through an opening 11a formed through the baffle plate 11 and said central expansion chambers C, in turn is communicated to the frontmost expansion chamber A through the catalytic converter 8 supported through the cross-walls or separating baffle plates 9,10.

In other words said muffler (5) is provided with a reversing passage having a catalytic converter (8) installed in it as a bridging member and is formed such that the length of the exhaust pipe may be become as long as possible.

The foremost expansion chamber A into which a front portion of the catalytic converter 8 (actually, under flow conditions, it is the downstream side of the catalytic converter 8) opens is communicated to a downstream expansion chamber B (which is bypassed through the catalytic converter 8) through a communicating pipe 12 supported by the foremost baffle plate 9. The downstream expansion chamber B, in turn, is communicated to the exterior of the muffler 5 through an exhaust discharge pipe 13 which penetrates the baffle plates 10 and 11 and the muffler body 6 to be supported by said elements.

The catalytic converter 8 is formed generally cylindrically as shown in Figures 2 & 3 penetrating the baffle plates 9 and 10 to be supported by same bridging the downstream expansion chamber B to connect the centre expansion chamber C fluidly to the more downwardly disposed, forward expansion chamber A.

The catalytic converter 8, in a cross sectional direction, comprises an upstream part 8A and a downstream part 8B, said upstream part 8A projecting into the end portion 4b of the exhaust pipe 4. Accordingly said end portion 4b of the exhaust pipe 4 is partly cut-out to allow the catalytic converter 8 to be inserted through said recess for partially projecting into the exhaust gas flow channel as defined by the exhaust pipe b. Along the portion of contact between the periphery of the catalytic converter 8 and the recessed cut-out portion of the exhaust pipe 4 an intimate connection is formed sealingly by welding. As shown in Figure 2 the catalytic converter 8, specifically its upstream part 8A, projecting into the rear end 4b of the exhaust pipe 4 is disposed and oriented such that there is a smooth permability for the exhaust gas from an entry side of said upstream part 8A

to an outlet side thereof.

Each of the two baffle plates 9,10 supporting the catalytic converter 8 has a generally gourd-shaped hole formed therethrough as shown in Figure 3 and the downstream expansion chamber B is partitioned from the adjacent expansion chambers A and C by sealingly leading said catalytic converter 8 and the exhaust pipe 4 through said gourd-shaped holes.

It is desirable to set the cross sectional area of the projecting part 8A of the catalytic converter 8 facing the exhaust gas within the rear end 4b of the exhaust pipe 4 to be smaller than two thirds of the total cross section of the catalytic converter 8. Moreover, the cross section of said projecting part 8A of the catalytic converter 8 should be smaller than two thirds of the cross section of the exhaust pipe 4 at that region so as to set the quantity of volume of exhaust gas flowing through said projecting upstream portion 8A of the catalytic converter 8 projecting into the exhaust pipe 4 to be smaller than two thirds of the total quantity of exhaust gas flowing through said exhaust pipe 4. If a too large amount of exhaust gas would be allowed to flow through the projecting upstream portion 8A of the catalytic converter 8 a greater part of unburnt hydrocarbons contained in the exhaust gas would be burnt in that portion and the quantity of oxygen still contained in the exhaust gas for after-burning in the downstream part 8B of the catalytic converter 8 would be inevitably reduced.

In the cross section of Figure 3 one configuration of the catalytic converter 8 is shown having a honeycomb-shaped structure. Figure 4 shows another embodiment of the catalytic converter 8. In said Figure 4 the central portion is shown in a larger scale in order to facilitate understanding and explanation of the structure of said other embodiment of a catalytic converter 8 which, of course, could also be used in the embodiment of Figure 3 instead of the catalytic converter 8 having a net-like honeycomb-shaped structure.

The catalytic converter 8 according to Figure 4 is also formed cylindrically with a wound honeycomb-like cross section by winding a flat band foil 8a and corrugated band foil 8b spirally lapping one above the other. When assembling the catalytic converter 8 as shown in Figure 4 first, both surfaces of either the flat foil 8a or the corrugated foil 8b are covered with a thin flat plate-like solder and the solder covered foil is piled over the other foil with their front ends trued up and nipped together with a chig to form a band-like material which, when being wound up, forms a wound honeycomb-like structure. Then the flat foil 8a and the corrugated foil 8b are wound up around themselves together with the solder and the foils thus formed cylindrically are soldered on each other by heating said wound bobbin in a furnace.

After winding such a cylindrical member spirally it is soaked in a suspension mixed with catalytic metals such as platinum, palladium copper, chromium, iron, nickel etc., and with aluminium so that the catalysts may be carried by the column-like spirally wound member.

For adhering the catalysts to the column-like support member to carry same not only the fore-described method can be used but one of various conventional methods can be applied, for example a method in which the wound up cylindrical support structure at first is coated only with aluminium and then is subject to carry catalytic metals as catalysts.

In the muffler 5 constructed as described above and shown in Figure 2, the exhaust gas discharged from the engine 2 enters from the exhaust pipe 4 through the rear end 4b thereof and the outlet opening 4c into the rearmost expansion chamber D and the muffler 5 and is reversed from there into the centre expansion chamber C through an opening 11a of the baffle plate 11. Partly, the exhaust gas flowing into the expansion chamber D through the exhaust pipe 4 passes through said projecting upstream part 8A of the catalytic converter 8 projecting into the exhaust pipe 4 (or the rear end 4b thereof) and is cleaned in that upstream part 8A. Since the catalytic converter 8 is designed to have a honeycomb-like gas cleaning structure and its gas flowing portions are partioned from each other (as derivable from the different cross sections of the two embodiments shown in Figures 3 & 4), the exhaust gas in the exhaust pipe 4 will never leak out into the downstream expansion chamber B bypassed by the catalytic converter 8. Accordingly the total flow of exhaust gas fed from the expansion chamber D to the centre expansion chamber C is in a partly cleaned state.

Moreover, said upstream part 8A of the catalytic converter 8 projecting into the exhaust pipe 4 is heated by the exhaust gas having a relatively high temperature. Preferably when a catalytic converter 8 having a structure as shown in Figure 4 is used, the heat is conducted to the downstream part 8B on the side of the expansion chamber B through the flat foil 8a and the corrugated foil 8b. I.E. when the catalytic converter 8 as shown in Figure 4 is employed the overall temperature of the catalytic converter 8 rises and is distributed more evenly across the catalytic converter 8 and the exhaust gas is sufficiently cleaned from an early stage at once after engine starting.

The exhaust gas supplied from the rear expansion chamber D to the centre expansion chamber C through the opening 11a of the baffle plate 11 then passes through the remainder downstream part 8B of the catalytic converter 8, is cleaned there and is discharged from the outlet of the downstream part 8B of the catalytic converter 8 facing to the foremost expansion chamber A thereinto, is reversed therein and flows from the expansion chamber A into the downstream expansion chamber B through the communicating pipe 12 and is discharged therefrom and out of the muffler 5 through the exhaust gas discharge pipe 13.

Thus, through the muffler 5 comprising the catalytic converter 8 the exhaust gas is partly cleaned by the upstream part 8A of the catalytic converter 8 projecting into

the exhaust pipe 4 and is recombined downstream of said upstream part 8A of the catalytic converter 8 to be discharged from the outlet 4c into the expansion chamber C in a partly cleaned condition. Then the total flow of exhaust gas is completely cleaned passing through the downstream part 8B of the catalytic converter 8 from the central expansion chamber C. Therefore, as the exhaust gas is introduced from the central expansion chamber (C) into the catalytic converter 8 (namely the downstream part 8B thereof) in a state with a sufficient content of oxygen still present therein the cleaning performance of the catalytic converter means will not be lowered although exhaust gas is cleaned in two stages by allowing a part of the total flow of exhaust gas to pass through the upstream part 8A of the catalytic converter and by passing through the recombined total flow of exhaust gas through the downstream part 8B of the catalytic converter 8 establishing said cleaning in two stages by said single catalytic converter 8.

Moreover, specifically by means of employing a catalytic converter 8 having a structure shown in cross section Figure 4 the temperature difference across the catalytic converter 8 between its upstream part 8A projecting into the exhaust pipe 4 and its downstream part 8B extending outside of the exhaust pipe 4 and subject to the total flow of exhaust gas which is in a partly precleaned state becomes smaller as the exhaust gas is sufficiently cleaned in both sections 8A, 8B of the catalytic converter 8. A more even distribution of temperature is triggered also by the fact that the heat of the exhaust gas flowing through the exhaust pipe 4 and from the heated wall portions of the rear end 4b of the exhaust pipe 4 in contact with the catalytic converter 8 is transmitted from said upstream part 8A to the downstream part 8B of the catalytic converter 8 by heat conduction with very low heat resistance. Said more even temperature profile results from the fact that the exhaust gas is sufficiently cleaned generating heat also with a sufficient amount of oxygen in the downstream part 8B of the catalytic converter 8 so that a temperature difference between the upstream and downstream parts 8A, 8B of the catalytic converter is reduced.

Although an upstream end of the exhaust pipe is positioned on the lower side of the engine and its overall length is apt to become shorter when a container box is installed under the seat 11b of the motor scooter 1 disposing the engine to such that its cylinder is directed forward as shown in Figure 1, the effective length of the exhaust pipe 4 can be expanded and sufficiently assured by means that a reversing passage can be formed in the muffler 5 utilising the catalytic converter 8 within said flow passage.

Another embodiment of the present invention is shown in Figures 5 and 6 which differs from the aforedescribed embodiment of Figure 2 substantially in that the catalytic converter 8 does no longer project into the exhaust pipe 4 but is in its entirety disposed separately laterally of the exhaust pipe establishing a sub-divided upstream and downstream regions 8A, 8B of the catalytic converter by means of a specific exhaust gas passage means 21 through which a branched off partial flow of exhaust gas is fed to the upstream part 8A of the catalytic converter 8.

In the embodiment of Figures 5 and 6 the same reference numerals denote the same parts as in the preceding embodiment and, so far a repeated description thereof is not considered to be necessary again.

As already indicated above and shown in Figures 5 and 6, the catalytic converter 8 is disposed outside of the exhaust pipe 4 laterally thereof. The baffle plates 9 and 10 supporting the catalytic converter 8 are formed similar to that used in the embodiment of Figure 4.

The reference numeral 21 denotes an exhaust gas passageway means 21 for introducing a part of the exhaust gas from the exhaust pipe 4 into the upstream part 8A of the catalytic converter 8. As shown in Figure 6 said passageway means 21 guiding a partial flow of the exhaust gas to the upstream part 8A of the catalytic converter 8 is formed in an inversed U-shaped cross section and is welded onto the outer surface of the exhaust pipe 4 at the lower end portions of two side walls 21a extending downwards in Figure 6. The rear end of the side wall 21a is pushed against and welded on the baffle plate 9. The connections between the side walls 21a with the exhaust pipe 4 and the baffle plate 9 are sealed by welding.

An upper wall 21b of said exhaust gas introducing passageway means 21 extends from a position opposite to an exhaust gas outlet port 4a opening through the wall of the exhaust pipe 4 to a front end portion of the catalytic converter 8 with a rear upwards inclination. The rear end of the upper wall 21b is positioned at the front end of the catalytic converter 8 below a centre of same as shown in Figures 5 and 6, thus defining the upstream part 8A and the downstream part 8B of the catalytic converter 8.

Through the gas introducing passageway means 21 a portion of the total flow of exhaust gas through the exhaust pipe 4 is branched off to be fed from the exhaust pipe 4 through the exhaust gas outlet port 4a and along the exhaust gas passageway means 21 to the inlet of the upstream part 8A of the catalytic converter 8. Accordingly, through the structure of the catalytic converter allowing gas flow only in sub-divided sections from the entry side to the outlet side of the catalytic converter 8 (substantially in parallel to the main flow through the exhaust pipe 4) but blocking any gas transfer in a direction rectangular thereto that portion of the lower half of the catalytic converter 8 covered and fluidly connected to the passageway means 21 to establish communication to the gas outlet port 4a defines the upstream part 8A of the catalytic converter 8 whereas the portion above said section defines the downstream part 8B of the catalytic converter 8.

In this embodiment also it is desirable to set the sectional area of the upstream part 8A of the catalytic con-

verter 8 smaller than two thirds of the whole cross section of the catalytic converter 8 and to set the quantity of exhaust gas passing through the exhaust gas passageway means 21 and the upstream part 8A of the catalytic converter 8 to be smaller than two thirds of the total quantity of exhaust gas flowing through the exhaust gas pipe 4.

With the structure as indicated above and shown in Figures 5 and 6 a part of the exhaust gas flowing through the exhaust pipe 4 is branched off and fed through the exhaust gas opening port 4a through the exhaust gas passageway defined by the upper and lower walls 21a, 21b to the upstream part 8A of the catalytic converter 8 to be cleaned therein and is then to be discharged into the centre expansion chamber C as indicated in small arrows in Figure 5.

In the centre expansion chamber C the partial flow of exhaust gas passing through the upstream part 8A of the catalytic converter 8 and cleaned therein and the main flow of exhaust gas passing through the exhaust pipe and the rear outlet 4c thereof to be reversed in the rearmost expansion chamber D to be fed from the rear into the centre expansion chamber C through the opening 11a of the baffle plate 11 join in the centre expansion chamber C to flow for substantial cleaning into the downstream part 8B of the catalytic converter 8.

Thus, also with a structure as shown in Figures 5 and 6 the exhaust gas is partly cleaned by the upstream part 8A of the catalytic converter 8 when a branched off partial flow of the exhaust gas is passed through the catalytic converter 8 to the centre expansion chamber C and, then, complete cleaning of the total flow of exhaust gas after said partial flow of pre-cleaned exhaust gas is recombined with the reaminder main flow of exhaust gas in the central expansion chamber C the catalytic converter 8, namely the downstream part 8B thereof takes place when the total flow of exhaust gas flows from the centre expansion chamber C through the downstream part 8B of the catalytic converter 8 to the front side expansion chamber A.

When a partial flow of exhaust gas is introduced into the upstream part of the catalytic converter 8 using the passageway means 21 as shown in Figures 5 and 6 it is easy to keep the temperature of the total flow of exhaust gas which flows through the downstream part 8B of the catalytic converter 8 relatively high as said partial flow of exhaust gas pre-cleaned in the upstream part 8A of the catalytic converter 8 flows into the centre expansion chamber C at a relatively high temperature and mixes therein with the main flow of exhaust gas coming from the rear expansion chamber D through the opening 11a into the centre expansion chamber C, said main flow of exhaust gas having a relatively low temperature.

Summarising the advantageous main effects of the embodiments of the present invention which are based on the basic flow regime, namely by branching off a partial flow from the total flow of exhaust gas and delivering same to an upstream part of the catalytic converter, precleaning said partial flow and recombining same with the rest of the exhaust gas for further cleaning treatment in the downstream part of the catalytic converter, same are as follows:

As the exhaust gas is introduced from the upstream side expansion chamber into the catalytic converter with oxygen left therein, the cleaning performance will not be deteriorated although a single catalytic converter is being used and cleaning of the exhaust gas is sub-divided in upstream and downstream parts through the catalytic converter. Aside from a sufficient cleaning effect and capacity of such a structure the muffler is prevented from becoming larger sized due to the specific design and flow conditions inside the muffler.

Morevoer, the temperature difference across the catalytic converter, specifically between its upstream part through which exhaust gas is allowed to flow at an upstream area and its downstream portion through which exhaust gas is allowed to flow after having partially passed through the upstream part of the catalytic converter is reduced as the exhaust gas is efficiently cleaned in both the upstream and downstream portions of the catalytic converter and, moreover, as the heat of the upstream part of the catalytic converter is effectively transmitted through heat conduction to the downstream part of the catalytic converter through which the exhaust gas at a downstream side is passed through. Therefore, thermal distortion of the catalytic converter does not occure and the catalytic converter is prevented from being broken of deformed. Said effect is promoted by a sufficient afterburning of unburnt hydrocarbons in the downstream part of the catalytic converter resulting from a sufficient amount of oxygen being present there so that a temperature difference between the upstream and downstream parts 8A, 8B of the catalytic converter 8 is reduced. This adds to avoid thermal distortion or break, deformation etc., of the catalytic converter.

Moreover, since the upstream part 8A of the catalytic converter 8 is disposed in the region of a relatively high temperature the exhaust gas rapid warming up of said part 8A of the catalytic converter takes place and the exhaust gas can be cleaned even in a very early stage after engine starting. Moreover, as the temperature of the exhaust gas forwarded to the downstream part 8B of the catalytic converter 8 is elevated due to the mixture with the pre-cleaned partial flow having a high temperature, the temperature drop of the exhaust gas is small, this also adds to an efficient cleaning of the exhaust gas in the downstream part 8B of the catalytic converter 8.

Finally, providing a reverse passageway in the muffler 5 utilising the catalytic converter 8 as a partition bridging one (downstream) expansion chamber contributes to keep the muffler 5 small sized even if said structure allows to increase the length of the exhaust pipe and dispite using two catalytic converters or converter sections to be installed.

The present invention relates to a method for cata-

lytically cleaning the exhaust gas of an internal combustion engine and an exhaust gas system wherein a multi-staged cleaning of exhaust gas takes place by means of that the total flow of exhaust gas is sub-divided into a plurality of partial flows of exhaust gas, at least in two flows of exhaust gas, fed through a catalytic converter means in successively varying amounts of volume through different parts of the catalytic converter means. In this was cleaning activity of the catalytic converter means can be improved and more even heat distribution across the catalytic converter means can be obtained and a small sized construction of a muffler of the exhaust gas system is possible.

Claims

1. Method for catalytically cleaning exhaust gas of an internal combustion engine (2) having a catalytic converter body (8) disposed in a muffler (5) of an exhaust gas system of the engine, **characterised in that**, a total flow of exhaust gas is subdivided into a plurality of partial flows of exhaust gas, a partial flow of exhaust gas is fed through a first branch (8A) of said catalytic converter body (8) and then the recombined total flow of exhaust gas is fed through a second branch (8B) of said catalytic converter body (8).

2. Method as claimed in claim 1, **characterised in that**, a pre-cleaning of a part of the total flow of exhaust gas is performed in the first branch of the catalytic converter body and that said pre-cleaned part of the exhaust gas is then recombined with the rest of the total flow of exhaust gas to be fed through the second branch of the catalytic converter body disposed in the muffler (5).

3. Method as claimed in at least one of the preceding claims 1 or 2, **characterised in that**, that part of the total flow of exhaust gas is fed through a portion of a single catalytic converter body (8), said portion projecting into an end portion (4b) of an exhaust pipe (4) extending into the muffler (5).

4. Method as claimed in at least one of the preceding claims 1 to 3, **characterised in that**, that a part of the total flow of exhaust gas is fed through a portion (8A) of a single catalytic converter body (8), said portion (8A) forming part of an exhaust gas side passageway branching off of an end portion (4b) of the exhaust pipe (4).

5. Method as claimed in at least one of the preceding claims 1 to 4, **characterised in that**, a main portion of the total flow of exhaust gas is fed without pre-cleaning to a rearmost end portion of the muffler (5), reversing said flow of exhaust gas to a centre expansion chamber (C) wherein recombination of said main flow of exhaust gas and said pre-cleaned part of the exhaust gas takes place feeding said recombined total flow of exhaust gas through that part (8B) of a single catalytic converter body (8) which was not subject to the flow of a part of said total flow of exhaust gas for conducting pre-cleaning of said part.

6. Method as claimed in at least one of the preceding claims 1 to 5, **characterised in that**, the flow of exhaust gas is reversed along a longitudinal axis of the muffler (5) therein from a rearmost expansion chamber (D) toward a front expansion chamber (A) to be treated through the catalytic converter body (8) and is then returned to the rear of the muffler (5) through a separating passageway means (13) and is discharged from the rear of the muffler (5).

7. Exhaust gas system of an internal combustion engine (2) comprising an exhaust pipe (4) extending into a muffler (5) which accommodates a catalytic converter body (8) and has a plurality of exhaust gas receiving expansion chambers (A-D), **characterised in that**, the catalytic converter body (8) comprises a first branch passageway (8A) through which a partial flow of an incoming total flow of exhaust gas is fed, and a second branch passageway (8B) through which the recombined total flow of exhaust gas is fed.

8. Exhaust gas system as claimed in claim 7, **characterised in that**, the catalytic converter means comprises a single catalytic converter body (8) disposed within said muffler.

9. Exhaust pipe system as claimed in claims 7 or 8, **characterised in that**, the catalytic converter body (8) is disposed to partially project into an end portion (4b) of the exhaust pipe (4).

10. Exhaust gas system as claimed in claims 7 or 8, **characterised in that**, the catalytic converter body (8) is disposed aside of the exhaust pipe (4) and that an exhaust gas passageway means (21) is provided branching off of the exhaust pipe (4) upstream of the catalytic converter body (8) and communicating to first branch passageway (8A) of the catalytic converter body (8) said first branch passageway (8A) establishing a downstream portion of said exhaust gas passageway means (21).

11. Exhaust gas system as claimed in at least one of the preceding claims 7 to 10, **characterised in that**, said muffler (5) comprises a plurality of expansion chambers (A to D) separated by recessed baffle plates (9,10,11) said expansion chambers (A to D) are disposed successively along a longitudinal axis

of the muffler (5).

12. Exhaust gas system as claimed in claim 11, **characterised in that**, the baffle plates (9,10,11) define cross-walls of the muffler (5).

13. Exhaust gas system as claimed in at least one of the preceding claims 7 to 12, **characterised in that**, the catalytic converter body (8) is disposed to connect an upstream expansion chamber (C) to a more downwardly disposed expansion chamber (A).

14. Exhaust gas system as claimed in claim 13, **characterised in that**, said catalytic converter body (8) is disposed to bridge a downstream expansion chamber (B) from which an exhaust gas discharge pipe (13) extends out of the muffler (5).

15. Exhaust gas system as claimed in at least one of the preceding claims 7 to 14, **characterised in that**, an outlet (4b) of the exhaust pipe (4) extends into the rearmost expansion chamber (D) from which a return flow of the exhaust gas forwardly is established through a centre expansion chamber (C), the catalytic converter body (8) and a front expansion chamber (A) to the downstream expansion chamber (B).

16. Exhaust gas system as claimed in claim 12, **characterised in that**, the catalytic converter body (8) is supported through the cross-walls (9,10) defining the downstream expansion chamber (B) to extend through a recess of the exhaust pipe (4) to project partially into the interior of said exhaust pipe (4) so as to allow the flow of a part of the exhaust gas through said projection part (8A) of the catalytic converter body (8) from an upstream entry side to a downstream discharge side thereof.

17. Exhaust gas system as claimed in at least one of the preceding claims 7 to 16, **characterised in that**, that part (8A) of the catalytic converter body (8) which defines a pre-cleaning first branch passageway of the catalytic converter body (8) comprises a sectional area which is equal or less than two thirds of the cross section of the whole catalytic converter body (8) and the part of the exhaust gas passing through said first branch passageway (8A) of the catalytic converter body (8) amounts maximally to two thirds of the quantity of the exhaust gas flowing through the exhaust pipe (4).

18. Exhaust gas system as claimed in at least one of the preceding claims 7 to 17, **characterised in that**, the catalytic converter body (8) comprises a honeycomb catalyst structure having catalytic substances carried on its active surface.

19. Exhaust gas system as claimed in at least one of the preceding claims 7 to 18, **characterised in that**, the catalytic converter body (8) comprises a winding structure by winding a flat bent foil (8a) and a corrugated bent foil (8b) spirally lapping one above the other, said foils (8a,8b) being bonded by soldering to each other.

Patentansprüche

1. Verfahren zur katalytischen Reinigung eines Abgases einer Verbrennungskraftmaschine (2), die einen Katalysatorkörper (8), der in einem Abgastopf (5) eines Abgassystems der Maschine angeordnet ist, aufweist, **dadurch gekennzeichnet,** daß ein Gesamtstrom des Abgases in eine Vielzahl von Abgasteilströmen aufgeteilt wird, ein Abgasteilstrom durch einen ersten Zweig (8A) des Katalysatorkörpers (8) geführt wird und dann der wiederzusammengeführte Abgasgesamtstrom durch einen zweiten Zweig (8B) des Katalysatorkörpers (8) geführt wird.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet,** daß eine Vorreinigung eines Teils des Abgasgesamtstromes in den ersten Zweig des Katalysators durchgeführt wird, und daß der vorgereinigte Teil des Abgases dann wieder mit dem Rest des Abgasgesamtstromes zusammengeführt wird, um durch den zweiten Zweig des in dem Abgastopf (5) angeordneten Katalysatorkörpers geführt zu werden.

3. Verfahren nach zumindest einem der vorhergehenden Ansprüche 1 oder 2, **dadurch gekennzeichnet,** daß ein Teil des Abgasgesamtstromes durch einen Abschnitt eines einzigen Katalysatorkörpers (8) geführt wird, wobei sich der Abschnitt in einen Endabschnitt (4b) eines Abgasrohres (4), das sich in den Abgastopf (5) erstreckt, hineinragt.

4. Verfahren nach zumindest einem der vorhergehenden Ansprüche 1 bis 3, **dadurch gekennzeichnet,** daß ein Teil des Abgasgesamtstromes durch einen Abschnitt (8A) eines einzigen Katalysatorkörpers (8) geführt wird, wobei der Abschnitt (8A) einen Teil eines Abgasnebenpfades bildet, der von einem Endabschnitt (4b) des Abgasrohres (4) abzweigt.

5. Verfahren nach zumindest einem der vorhergehenden Ansprüche 1 bis 4, **dadurch gekennzeichnet,** daß der Hauptteil des Abgasgesamtstromes ohne Vorreinigung zu einem am weitesten hinten liegenden Endabschnitt des Abgastopfes (5) geführt wird, daß der Abgasstrom umgekehrt wird zu einer zentralen Expansionskammer (C), in der die Wiederzusammenführung des Hauptabgasstromes und des

vorgereinigten Teils des Abgases stattfindet und der zusammengeführte Gesamtabgasstrom durch den Teil (8B) des einzigen Katalysatorkörpers (8) geführt wird, der nicht der Durchströmung des Teils des Abgasgesamtstromes zur Durchführung der Vorreinigung dieses Teils ausgesetzt war.

6. Verfahren nach zumindest einem der vorhergehenden Ansprüche 1 bis 5, **dadurch gekennzeichnet,** daß die Abgasströmung innerhalb des Abgastopfes (5) entlang der Längsachse desselben umgekehrt wird von einer am weiteesten hinten liegenden Expansionskammer (D) zu einer vorderen Expansionskammer (A), um von dem Katalysatorkörper (8) behandelt zu werden, und dann zu dem Hinterseite des Abgastopfes (5) durch eine trennende Strömungsführungsvorrichtung (13) zurückgeführt und von der Hinterseite des Abgastopfes (5) abgeführt wird.

7. Abgassystem einer Verbrennungskraftmaschine (2) mit einem Abgasrohr (4), das sich in einen Abgastopf (5) erstreckt, der einen Katalysatorkörper (8) aufnimmt und eine Vielzahl von Abgasaufnahme-Expansionskammern (A bis D) aufweist, **dadurch gekennzeichnet,** daß der Katalysatorkörper (8) einen ersten Zweigdurchgang (8A) aufweist, durch den ein Teilstrom eines zugeführten Abgasgesamtstromes geführt wird, und einen zweiten Zweigdurchgang (88), durch den der wieder zusammengeführte Abgasgesamtstrom geführt wird.

8. Abgassystem nach Anspruch 7, **dadurch gekennzeichnet,** daß die Katalysatorvorrichtung einen einzigen, in dem Abgastopf angeordneten Katalysatorkörper (8) aufweist.

9. Abgassystem nach Anspruch 7 oder 8, **dadurch gekennzeichnet,** daß der Katalysatorkörper (8) teilweise in einen Endabschnitt (4b) des Abgasrohres (4) hineinragt.

10. Abgassystem nach einem der Ansprüche 7 oder 8, **dadurch gekennzeichnet,** daß der Katalysatorkörper (8) seitlich des Abgasrohres (4) angeordnet ist und daß eine Abgasführungsvorrichtung (21) vorgesehen ist, die von dem Abgasrohr (4) stromauf des Katalysatorkörpers (8) abzweigt und mit dem ersten Zweigdurchgang (8A) des Katalysatorkörpers (8) verbunden ist, wobei der erste Zweigdurchgang (8A) einen stromab angeordneten Abschnitt der Abgasführungsvorrichtung (21) bildet.

11. Abgassystem nach zumindest einem der vorhergehenden Ansprüche 7 bis 10, **dadurch gekennzeichnet,** daß der Abgastopf (5) eine Vielzahl von Expansionskammern (A bis D) aufweist, die durch Aussparungen aufweisende Prallplatten (9,10,11) getrennt sind, wobei die Expansionskammern (A bis D) entlang der Längsachse des Abgastopfes (5) aufeinanderfolgend angeordnet sind.

12. Abgassystem nach Anspruch 11, **dadurch gekennzeichnet,** daß die Prallpaltten (9,10,11) Querwände des Abgastopfes (5) bilden.

13. Abgassystem nach zumindest einem der vorhergehenden Ansprüche 7 bis 12, **dadurch gekennzeichnet,** daß der Katalysatorkörper (8) so angeordnet ist, um eine stromauf angeordnete Expansionskammer (C) mit einer weiter stromab angeordneten Expansionskammer (A) zu verbinden.

14. Abgassystem nach Anspruch 13, **dadurch gekennzeichnet,** daß der Katalysatorkörper (8) so angeordnet ist, um eine stromab angeordnete Expansionskammer (B) zu überbrücken, von der sich ein Abgasausstoßrohr (18) aus dem Abgastopf (5) heraus erstreckt.

15. Abgassystem nach zumindest einem der vorhergehenden Ansprüche 7 bis 14, **dadurch gekennzeichnet,** daß ein Auslaß (4b) des Abgasrohres (4) sich in die hinterste Expansionskammer (D) erstreckt, von der ein Zurückströmen des Abgases nach vorne bewirkt wird durch eine mittlere Expansionskammer (C), den Katalysatorkörper (8) und eine vordere Expansionskammer (A) zu der stromab angeordneten Expansionskammer (B).

16. Abgassystem nach Anspruch 12, **dadurch gekennzeichnet,** daß der Katalysatorkörper (8) durch die Querwände (9,10) gelagert ist, die die stromab angeordnete Expansionskammer (B) bilden, um sich durch eine Ausnehmung des Abgasrohres (4) zu erstrecken, um teilweise in das Innere dieses Abgasrohres (4) hineinzuragen zur Ermöglichung eines Abgasteilstromes durch den vorragenden Abschnitt (8A) des Katalysatorkörpers (8) von einer stromauf gelegenen Eingangsseite zu einer stromab gelegenen Ausgangsseite desselben.

17. Abgassystem nach zumindest einem der vorhergehenden Ansprüche 7 bis 16, **dadurch gekennzeichnet,** daß der Teil (8A) des Katalysatorkörpers (8), der einen vorreinigenden ersten Zweigdurchgang des Katalysatorkörpers (8) bildet, eine Teilfläche aufweist, die gleich oder kleiner als zwei Drittel des Querschnittes des gesamten Katalysatorkörpers (8) ist und der Teil des Abgases, der durch den ersten Zweigdurchgang (8A) ders Katalysatorkörpers (8) strömt, maximal zwei Drittel der Abgasgesamtmenge beträgt, die durch das Abgasrohr (4) strömt.

18. Abgassystem nach zumindest einem der vorherge-

henden Ansprüche 7 bis 17, **dadurch gekennzeichnet**, daß der Katalysatorkörper (8) einen wabenförmigen Grundkörper mit auf seiner aktiven Oberfläche abgelagerten katalytischen Substanzen aufweist.

19. Abgassystem nach zumindest einem der vorhergehenden Ansprüche 7 bis 18, **dadurch gekennzeichnet,** daß der Katalysatorkörpers (8) eine Wikkelstruktur besitzt, für die eine flach gekrümmte Folie (8a) und eine gewellte, gekrümmte Folie (8b) übereinanderliegend spiralartig aufgewickelt werden, wobei die Folien (8a,8b) miteinander durch Löten verbunden sind.

Revendications

1. Procédé de traitement catalytique des gaz d'échappement d'un moteur à combustion interne (2) ayant un corps de convertisseur catalytique (8) disposé dans un silencieux (5) d'un système de gaz d'échappement du moteur, caractérisé en ce qu'un écoulement total des gaz d'échappement est subdivisé en une pluralité d'écoulements partiels de gaz d'échappement, un écoulement partiel de gaz d'échappement est amené, via une première ramification (8A) dudit corps de convertisseur catalytique (8) et, ensuite, l'écoulement total recombiné de gaz d'échappement est amené, via une deuxième ramification (8B) du corps de convertisseur catalytique (8) .

2. Procédé selon la revendication 1, caractérisé en ce qu'un traitement préalable d'une partie de l'écoulement total des gaz d'échappement est exécuté dans la première ramification du corps de convertisseur catalytique et en ce que ladite partie, traitée au préalable, des gaz d'échappement est ensuite recombinée au restant de l'écoulement total des gaz d'échappement devant être amenés via la deuxième ramification du corps de convertisseur catalytique, disposé dans le silencieux (5).

3. Procédé selon au moins l'une des revendications 1 ou 2 précédentes, caractérisé en ce qu'une partie de l'écoulement total des gaz d'échappement est amenée via une partie d'un corps de convertisseur catalytique (8) unique, ladite partie faisant saillie dans une partie d'extrémité (4b) d'un tuyau d'échappement (4) s'étendant dans le silencieux (5).

4. Procédé selon au moins l'une des revendications 1 à 3 précédentes, caractérisé en ce qu'une partie de l'écoulement total des gaz d'échappement est amenée via une partie (8A) d'un corps de convertisseur catalytique (8) unique, ladite partie (8A) faisant partie d'un passage latéral de gaz d'échappement partant d'une partie d'extrémité (4b) du tuyau d'échappement (4) .

5. Procédé selon au moins l'une des revendications 1 à 4 précédentes, caractérisé en ce qu'une partie principale de l'écoulement total des gaz d'échappement est amenée sans traitement préalable à une partie d'extrémité se trouvant le plus à l'arrière du silencieux (5), inversant ledit écoulement des gaz d'échappement vers une chambre de détente (C) centrale, dans laquelle a lieu une recombinaison dudit écoulement principal des gaz d'échappement et de la partie traitée au préalable des gaz d'échappement, amenant ledit écoulement total recombiné des gaz d'échappement via la partie (8B) d'un corps de convertisseur catalytique (8) unique qui n'a pas été exposée à l'écoulement d'une partie dudit écoulement total des gaz d'échappement, afin d'effectuer un traitement préalable de ladite partie.

6. Procédé selon au moins l'une des revendications 1 à 5 précédentes, caractérisé en ce que l'écoulement des gaz d'échappement est inversé le long d'un axe longitudinal du silencieux (5), depuis une chambre de détente (D) se trouvant le plus à l'arrière, vers une chambre de détente (A) avant, afin d'être traité via le corps de convertisseur catalytique (8) et est ensuite ramené à l'arrière du silencieux (5) via un moyen formant passage de séparation (13) et est évacué de l'arrière du silencieux (5).

7. Système de gaz d'échappement d'un moteur à combustion interne (2) comprenant un tuyau d'échappement (4) s'étendant dans un silencieux (5) qui loge un corps de convertisseur catalytique (8) et présente une pluralité de chambres de détente (A à D) recevant des gaz d'échappement, caractérisé en ce que le corps de convertisseur catalytique (8) comprend un premier passage de ramification (8A) dans lequel est amené un écoulement partiel d'un écoulement total entrant de gaz d'échappement, et un deuxième passage de ramification (8B) dans lequel est amené l'écoulement total recombiné de gaz d'échappement.

8. Système de gaz d'échappement selon la revendication 7, caractérisé en ce que le moyen à convertisseur catalytique comprend un corps de convertisseur catalytique (8) unique disposé dans ledit silencieux.

9. Système de tuyau d'échappement selon la revendication 7 ou 8, caractérisé en ce que le corps de convertisseur catalytique (8) est disposé de façon à faire partiellement saillie dans une partie d'extrémité (4b) du tuyau d'échappement (4).

10. Système de gaz d'échappement selon la revendi-

cation 7 ou 8, caractérisé en ce que le corps de convertisseur catalytique (8) est disposé à côté du tuyau d'échappement (4) et en ce qu'un moyen formant passage de gaz d'échappement (21) est prévu de façon à partir du tuyau d'échappement (4) en amont du corps de convertisseur catalytique (8) et à communiquer avec le premier passage de ramification (8A) du corps de convertisseur catalytique (8), ledit premier passage de ramification (8A) formant une partie aval dudit moyen formant passage de gaz d'échappement (21).

11. Système de gaz d'échappement selon au moins l'une des revendications 7 à 10 précédentes, caractérisé en ce que ledit silencieux (5) comprend une pluralité de chambres de détente (A à D) séparées par des plaques de déviation (9, 10, 11) creusées, lesdites chambres de détente (A à D) étant disposées successivement le long d'un axe longitudinal du silencieux (5).

12. Système de gaz d'échappement selon la revendication 11, caractérisé en ce que les plaques de déviation (9, 10, 11) forment des parois transversales du silencieux (5).

13. Système de gaz d'échappement selon au moins l'une des revendications 7 à 12 précédentes, caractérisé en ce que le corps de convertisseur catalytique (8) est disposé de façon à relier une chambre de détente (C) amont à une chambre de détente (A) disposée plus en aval.

14. Système de gaz d'échappement selon la revendication 13, caractérisé en ce que ledit corps de convertisseur catalytique (8) est disposé de façon à enjamber une chambre de détente (B) aval, à partir de laquelle un tuyau d'évacuation de gaz d'échappement (13) s'étend hors du silencieux (5).

15. Système de gaz d'échappement selon au moins l'une des revendications 7 à 14 précédentes, caractérisé en ce qu'une sortie (4b) du tuyau d'échappement (4) s'étend dans la chambre de détente (D) se trouvant le plus à l'arrière, à partir de laquelle un écoulement de retour des gaz d'échappement vers l'avant est établi via une chambre de détente (C) centrale, le corps de convertisseur catalytique (8) et une chambre de détente (A) avant, vers la chambre de détente (B) aval.

16. Système de gaz d'échappement selon la revendication 12, caractérisé en ce que le corps de convertisseur catalytique (8) est supporté via les parois transversales (9, 10) formant la chambre de détente (B) aval, afin de s'étendre à travers une cavité du tuyau d'échappement (4) de façon à faire partiellement saillie à l'intérieur dudit tuyau d'échappement (4), de manière à permettre l'écoulement d'une partie des gaz d'échappement via ladite partie de saillie (8A) du corps de convertisseur catalytique (8), depuis un côté d'entrée amont vers un côté d'évacuation aval de ce dernier.

17. Système de gaz d'échappement selon au moins l'une des revendications 7 à 16 précédentes, caractérisé en ce qu'une partie (8A) du corps de convertisseur catalytique (8) qui forme un premier passage de ramification à traitement préalable du corps de convertisseur catalytique (8) comprend une aire de section transversale qui est inférieure ou égale à deux tiers de la section transversale de l'ensemble du corps de convertisseur catalytique (8), et la partie des gaz d'échappement qui passe par ledit premier passage de ramification (8A) du corps de convertisseur catalytique (8) est égale au maximum aux deux tiers de la quantité de gaz d'échappement s'écoulant via le tuyau d'échappement (4).

18. Système de gaz d'échappement selon au moins l'une des revendications 7 à 17 précédentes, caractérisé en ce que le corps de convertisseur catalytique (8) comprend une structure catalytique alvéolaire ayant des substances catalytiques supportées par sa surface active.

19. Système de gaz d'échappement selon au moins l'une des revendications 7 à 18 précédentes, caractérisé en ce que le corps de convertisseur catalytique (8) comprend une structure d'enroulement, obtenue en enroulant une tôle métallique (8A) plane incurvée et une tôle métallique (8b) ondulée incurvée, se chevauchant hélicoïdalement l'une l'autre, lesdites tôles métalliques (8a, 8b) étant liées par brasage entre elles.

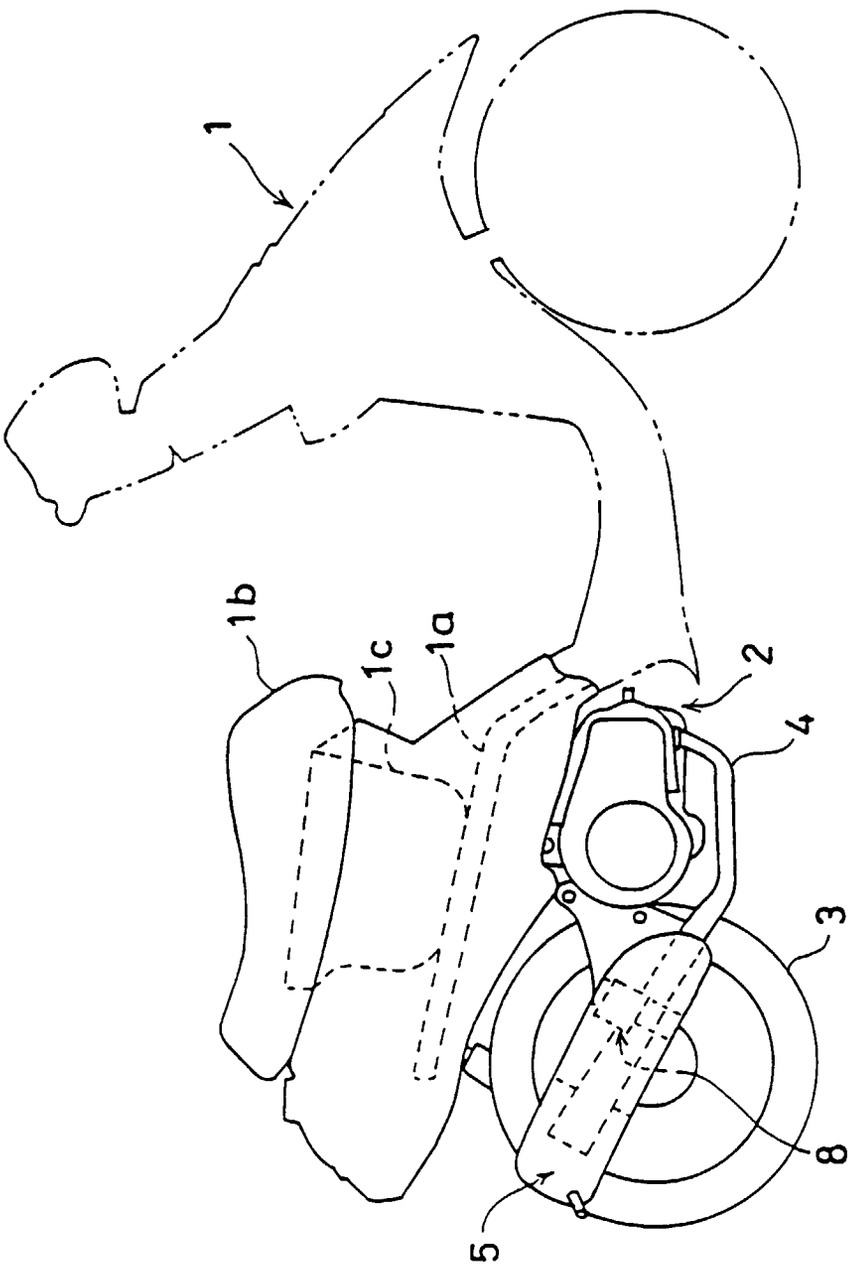

Fig. 1

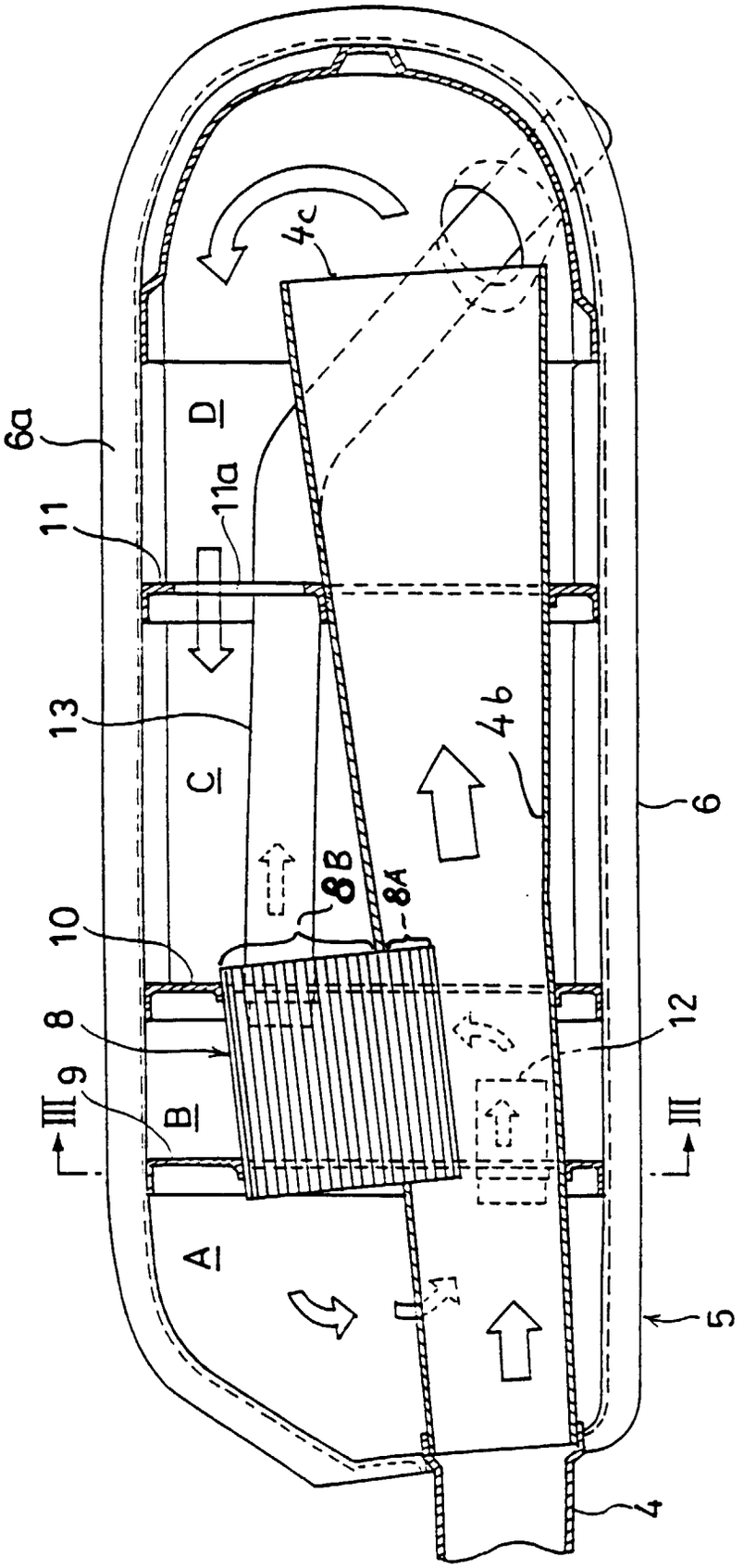

Fig. 2

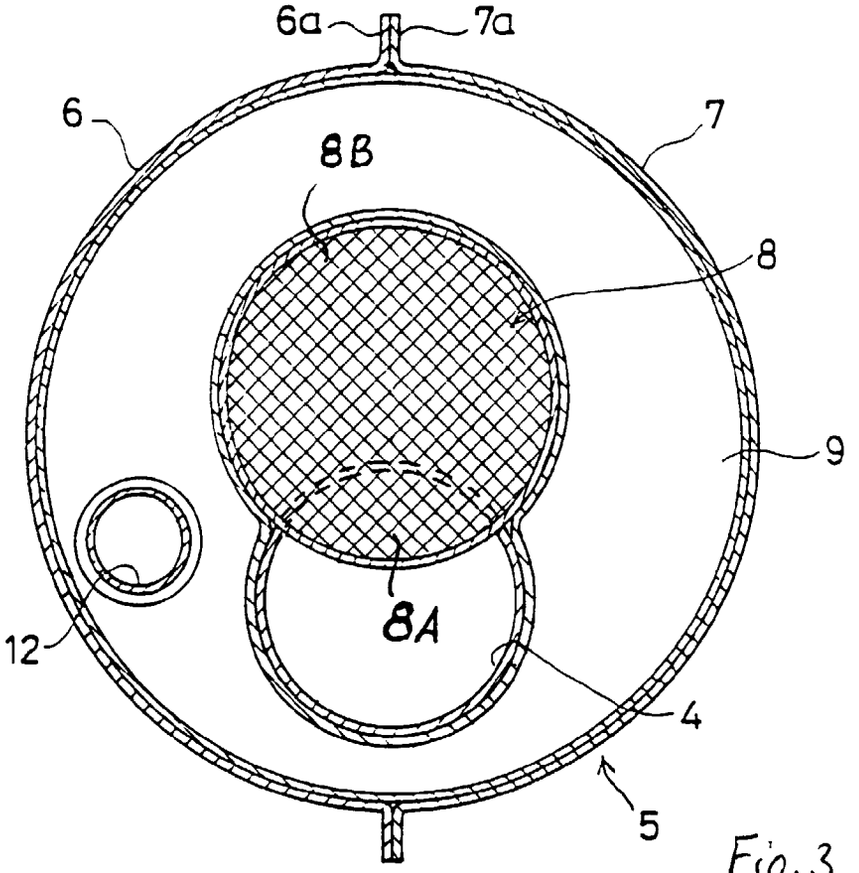

Fig. 3

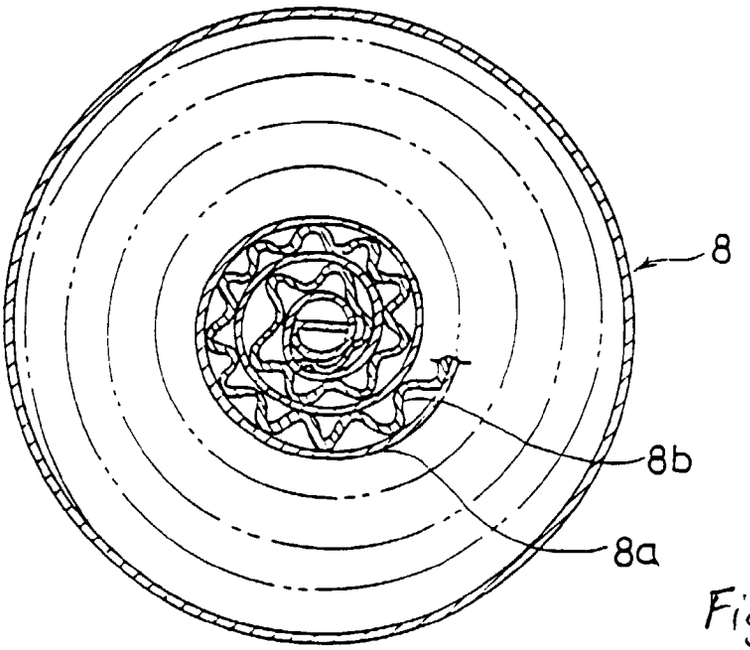

Fig. 4

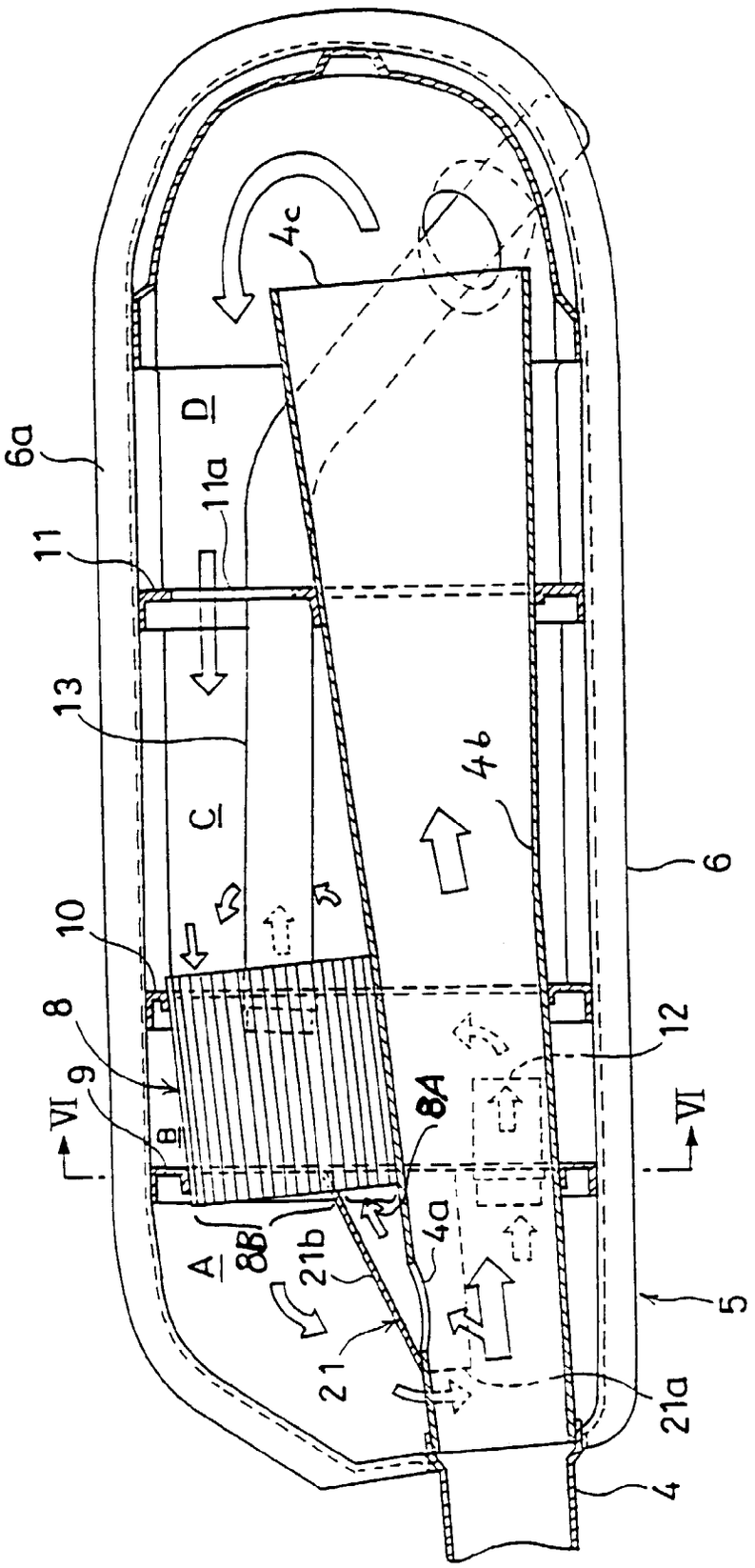

Fig. 5

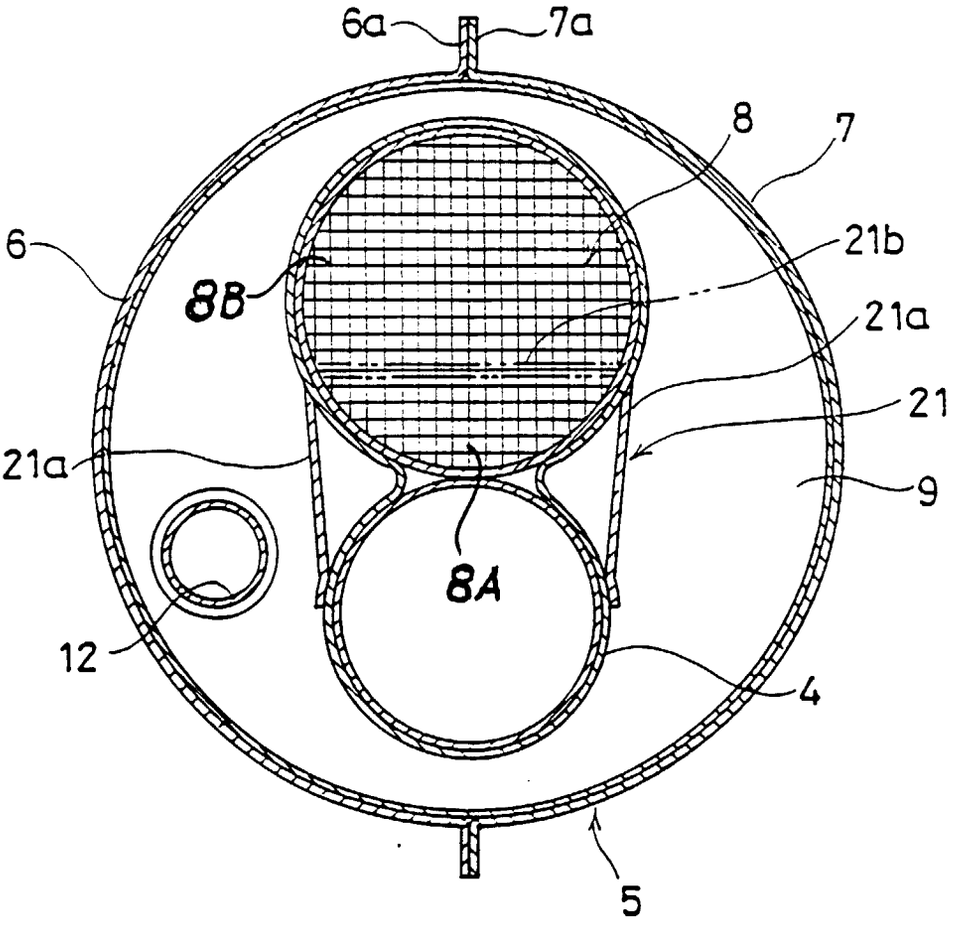

Fig. 6