A muffler for a small engine includes a first expansion chamber 12 for exhaust gas having an exhaust gas inlet 11 being connected to an exhaust gas outlet of the engine, a second expansion chamber 15 being partitioned from the first expansion chamber 12 by a partition plate 14 and being communicated with the first expansion chamber 12 through a first communicating hole 13 on the partition plate 14, and a third expansion chamber 18 being partitioned from the second expansion chamber 15 by the partition plate 14 and being communicated with the second expansion chamber 15 through a second communicating hole 16 on the partition plate 14 and having an exhaust gas outlet 17. A first heat resistant mesh catalyst 19 is disposed on the exhaust gas inlet 11. A first exhaust gas purifier 20 composed of a heat resistant knit fabric 20a coated with a catalyst for purifying the exhaust gas is disposed on the communicating hole 13 on the partition plate 14.

Accordingly, the muffler for a small engine having a large muffling effect and a large purification effect on the exhaust gas can be provided. A manufacturing process of the exhaust gas purifier is simple and thereby a manufacturing cost of the muffler for a small engine is reduced.
FIG. 7

15 SECOND EXPANSION CHAMBER
15a' DOUBLE-WALL
15b DOUBLE-WALL
FIG. 14

23 HEAT RESISTANT MESH CATALYST
17 EXHAUST GAS OUTLET

THIRD EXPANSION CHAMBER
18

HEAT RESISTANT MESH CATALYST
19

EXHAUST GAS INLET
11

FIRST EXPANSION CHAMBER
12

EXHAUST GAS INLET
20d

EXHAUST GAS PURIFIER
20

SECOND COMMUNICATING HOLE
16

PARTITION BOARD
14

SECOND EXPANSION CHAMBER
15

EXHAUST GAS OUTLET
14c

CONVEX PART
14d

14a

20a 20b

20 FIRST EXHAUST GAS PURIFIER

15a
MUFFLER FOR SMALL ENGINE

TECHNICAL FIELD

[0001] The present invention relates to a muffler for a small engine suited for use in a brush cutter or a chain saw, for example.

BACKGROUND ART

[0002] A conventional muffler for a small engine comprises, as shown in FIG. 21, an exhaust gas first expansion chamber 2 having an exhaust gas inlet 1 connected to an exhaust gas outlet of the engine, and an exhaust gas second expansion chamber 4 having an exhaust gas outlet 3. Between the first expansion chamber 2 and the second expansion chamber 4, for example, an exhaust gas purifier 5 made of a honeycomb-like stainless steel support body having innumerable small holes along an axial direction and coated with a catalyst such as Rhodium, Palladium, etc., is disposed.

[0003] Further, a conventional muffler for a small engine comprises, as shown in FIG. 22, an exhaust gas first expansion chamber 2 having an exhaust gas inlet 1 connected to an exhaust gas outlet of the engine and an exhaust gas second expansion chamber 4 having an exhaust gas outlet 3. A concave exhaust gas receiver 6 having a plurality of communicating holes 6b on a concave surface 6a which is disposed in the first expansion chamber 2 so that the concave surface 6a faces to the exhaust gas inlet 1. Between the first expansion chamber and the second expansion chamber, an exhaust gas purifier 5 made of a honeycomb-like stainless steel support body having innumerable small holes in an axial direction and coated with the catalyst for purifying the exhaust gas. In FIG. 21 and FIG. 22, numerals '20', '40' and '7' indicate a wall which forms the first expansion chamber 2, a wall which forms the second expansion chamber 4 and a partition plate which partitions the first expansion chamber 2 and the second expansion chamber 4, respectively.

[0004] Conventionally, various kinds of mufflers for small engines have been developed. For example, a catalyst carrier for such a muffler is made by laminating thin metal sheets each having a number of openings with each surface of a cloth catalyst, and the catalyst carrier is formed into a waveform shape and the plate side is disposed in parallel with a flow direction of exhaust gas (Patent document 1).

[0005] A conventional exhaust gas muffler as described hereunder is known. The exhaust gas muffler accommodates a cylindrical shaped cloth catalyst having a coarsely woven and a cylindrical shaped cloth catalyst having a finely woven, therein. Each cylindrical shaped cloth catalyst is comparatively soft, is made by coating a catalyst onto a fabric and is formed into a cylindrical shape having an oval cross-section. The coarsely woven cylindrical shaped catalyst is disposed on an upper portion of the exhaust gas muffler so as to surround two reinforcing beams, and an exhaust gas outlet of an engine is communicated with an inside of the coarsely woven cylindrical shaped catalyst through an opening of the exhaust gas muffler. The finely woven cylindrical shaped catalyst is disposed at a lower portion of the exhaust gas muffler so as to surround two reinforcing beams, and so that a portion of an outer surface of the finely woven cylindrical shaped catalyst contact closely with an inner wall surface of the exhaust gas muffler. Accordingly, the inside of the exhaust gas muffler is partitioned to a chamber inside the coarsely woven cylindrical shaped catalyst, a chamber outside the coarsely woven cylindrical shaped catalyst, a chamber inside the finely woven cylindrical shaped catalyst and a chamber in a lowermost portion outside the finely woven cylindrical shaped catalyst. (Patent document 2)

[0006] Another conventional exhaust gas muffler as described hereunder is known. In the exhaust gas muffler, a plurality of catalyst carriers are connected in series in a flow passage of exhaust gas. Each catalyst carrier is stacked with a support plate having an opening and is covered with a wire mesh. One of the catalyst carrier stacked with a support plate is fixed to an upper housing of the exhaust gas muffler approximately horizontally. The other catalyst carrier stacked with a support plate is fixed to a lower housing of the exhaust gas muffler approximately horizontally. The exhaust gas muffler is partitioned to three chambers by the support plates. The wire mesh of the catalyst carrier being at an exhaust gas inlet side has a coarse opening and the wire mesh of the catalyst carrier being at an exhaust gas outlet side has a fine opening. (Patent document 3)

[0007] Another conventional exhaust gas muffler as described hereunder is known. An exhaust gas muffler of an internal-combustion engine includes a box-like exhaust gas muffler in which an inner exhaust gas muffler part and an outer exhaust gas muffler part are detachable with each other or integrated; a communicating hole which is disposed in the exhaust gas muffler and introduces exhaust gas being generated in the internal-combustion engine to the inside of the exhaust gas muffler; and a pipe member composed of a reticulated material having a proper elasticity being provided with a catalyst therein. The tube member is disposed in a space in the exhaust gas muffler so that a barrel of the tube is held in such a direction as being clipped between the exhaust gas muffler parts. According to the above mentioned exhaust gas muffler structure, only if the tube member is disposed in the space between the exhaust gas muffler parts which the inner and the outer exhaust gas muffler parts are integrated, the tube member is retained so as to fit with a surrounding configuration by barrel of the tube elastically deforming freely. (Patent document 4)

[0008] Another conventional exhaust gas muffler as described hereunder is known. A cylindrical spark arresting which is means for preventing sparks from splashing is composed of a cylindrical wire mesh member. The cylindrical spark arresting is retained in a state being fixed between an end of a tail pipe and an inner surface of an attaching body of the exhaust gas muffler. (Patent document 5)

[0009] Another conventional exhaust gas muffler as described hereunder is known. A partition plate is disposed along an axial direction of a cylinder of an engine in an exhaust gas muffler, and an inside of the exhaust gas muffler is partitioned into a first chamber near to an engine body and a second chamber distant from an engine body. A catalyst is kept in a lower portion of the partition plate. The catalyst having a function of re-burning unburned gas in exhaust gas through oxidation reaction, is constituted by coating the catalyst onto a surface of a passage in a honeycomb structure composed of a stainless steel. An inner catalyst cover which is disposed in a position in the first chamber and covers about one half inner side portion of the catalyst and an outer catalyst cover which is disposed on a position in the second chamber and covers about one half outer side portion of the catalyst, are attached to the partition plate. A space surrounded by the inner catalyst cover and the partition plate is a first catalyst chamber. An inlet side communicating hole which commu-
nicates the first catalyst chamber with the first chamber is formed on the inner catalyst cover. A space surrounded by the outer catalyst cover and the partition plate is a second catalyst chamber. An outlet side communicating hole which communicates the second catalyst chamber with the second chamber is formed on the outer catalyst cover. A catalyst installing box in which the catalyst is installed is configured by attaching the inner catalyst cover and the outer catalyst cover to the partition plate. (Patent document 6)  

[0010] Another conventional exhaust gas muffler as described hereunder is known. An exhaust gas muffler is provided with an expansion chamber into which exhaust gas being blown from an exhaust gas outlet of an internal combustion engine is introduced. A peripheral part of the expansion chamber comprises a double wall structure composed of an inner wall panel and an outer wall panel being isolated with a distance so as to form a space between the panels. An inlet of the exhaust gas which introduces the exhaust gas in the expansion chamber into the space is formed on the inner wall panel, an outlet of the exhaust gas which exhausts the exhaust gas from the space to an outside is formed on the outer wall panel, and a spark arrestor screen is disposed so as to cover the outlet of the exhaust gas. A cylindrical oxidation catalyst composed of a metal carrier is disposed as an exhaust gas purifier so as to protrude in each of the first expansion chamber and the second expansion chamber. (Patent document 7)  

[0011] Another conventional catalyst muffler as described hereunder is known. A catalyst muffler is divided into a body housing and a lid housing. Each of a ceramic cloth, a cloth catalyst and a wire mesh made of a stainless steel is formed so as to adjust closely to the three-dimensional configuration of each housing, and the ceramic cloth, the cloth catalyst and the wire mesh made of the stainless steel are stacked in turn and joined to the whole inner surface of each housing. (Patent document 8)  

[0012] A conventional muffler as described hereunder is known. A general-purpose muffler for an internal combustion engine is made by pinching and clamping a periphery of a separator along a joint surface of an upper housing and a lower housing being divided up and down. An inner space of the muffler is partitioned by the separator. An inlet opening and an outlet opening which communicates the first and the second chambers partitioned by the separator with an exhaust port of the internal combustion engine and to an outside air respectively are disposed in the muffler. A cylindrical member having a small hole or a clearance is attached to the inlet opening in the first chamber, and the cylindrical member is provided with an exhaust gas purifying catalyst. (Patent document 9)  


[0020] Patent document 8: Japanese Laid-Open Utility Model Application Publication No. 06-18617 (refer to claims, and FIG. 1 and FIG. 2)  
[0021] Patent document 9: Japanese Laid-Open Utility Model Application Publication No. 05-21114 (refer to claims, and FIG. 1 and FIG. 2)  

[0022] However, in a conventional muffler of an engine as shown in FIG. 21, for example, because the exhaust gas purifier is constituted by the honeycomb-like stainless steel support body coated with the catalyst for purifying exhaust gas, there is a problem that the manufacturing process is complicated and that a manufacturing cost is high.  

[0023] Further, though the exhaust gas receiver which is a component of a conventional improved muffler is formed to the concave shape and a plurality of communicating holes are bored on the concave surface as shown in FIG. 22, no function for purifying the exhaust gas is not provided therewith.  

[0024] The exhaust gas muffler of a 2-stroke engine as described in the patent document 1 includes the catalyst carrier. The catalyst carrier is made by laminating thin metal sheets each having numerous openings with each surface of the cloth catalyst. The catalyst carrier is formed into the wave form shape and the plate side is disposed in parallel with a flow direction of the exhaust gas. There is a problem that a manufacturing process is complicated and that the manufacturing cost is high.  

[0025] In the exhaust gas muffler of a 2-stroke engine as described in the patent document 2, because the exhaust gas inlet is not provided with the heat resistant mesh catalyst and the exhaust gas outlet is not provided with the heat resistant mesh catalyst, there is a possibility that sparks blow out from the exhaust gas outlet when the engine is under operation.  

[0026] In the exhaust gas muffler of a 2-stroke engine as described in the patent document 3, because the exhaust gas inlet is not provided with the heat resistant mesh catalyst and the exhaust gas outlet is not provided with the heat resistant mesh catalyst, there is a possibility that sparks blow out from the exhaust gas outlet while the engine is under operation.  

[0027] In the exhaust gas muffler as described in the patent document 4, the inside of the exhaust gas muffler is not partitioned to the first expansion chamber, the second expansion chamber and the third expansion chamber by the partition plate, a muffling effect is not as good as expected.  

[0028] In the muffler for an engine as described in the patent document 5, because the cylindrical spark arrestor made of the cylindrical wire mesh is retained in a state fixed between the end of the tail pipe and the inner surface of the attaching body of the exhaust gas muffler, it is difficult to replace the spark arrestor with a new one.  

[0029] In the exhaust gas muffler for a small engine as described in the patent document 6, because the catalyst which has a function of re-burning the unburned gas in the exhaust gas through the oxidation reaction, by coating the catalyst to the surface of the passage in the honeycomb structure composed of the stainless steel, a manufacturing process is complicated and a manufacturing cost is high.
[0030] In the exhaust gas muffler for a small engine as described in the patent document 7, while the cylindrical oxidation catalyst composed of the metal carrier is disposed as an exhaust gas purifier so as to protrude in the first expansion chamber and the second expansion chamber, there is a problem that a manufacturing cost of the cylindrical oxidation catalyst is high. Meanwhile, because between the inner wall panel and the outer wall panel which form the double wall part, the exhaust gas flows to the outlet opening disposed on the outer wall panel and the outer wall panel is heated thereby, there is a problem that the double wall part does not have an effect preventing the outer wall of the muffler from being heated.

[0031] In the catalyst muffler as described in the patent document 8, because the inside of the muffler is not partitioned to the first expansion chamber, the second expansion chamber and the third expansion chamber by the partition plate, a muffling effect is not good. Further, because the muffler is partitioned to two parts of the body housing and the lid housing, and the ceramic cloth, the cloth catalyst and the wire mesh made of the stainless steel are stacked in turn and joined to whole the inner surface of each housing, there is a problem that a structure of the catalyst in the muffler is complicated and a manufacturing cost is high.

[0032] In a silencer as described in the patent document 9, because a separator which divides the silencer to two parts is not provided with a catalyst for purifying exhaust gas, there is a problem that a purifying effect on the exhaust gas is insufficient.

DISCLOSURE OF THE INVENTION

[0033] A muffler for a small engine according to one embodiment of the present invention includes: a first expansion chamber (12) having an exhaust gas inlet (11) being connected to an exhaust gas outlet of an engine; a second expansion chamber (15) for exhaust gas being partitioned from the first expansion chamber (12) by a partition plate (14) and being communicated with the first expansion chamber (12) through a first communicating hole (13) on the partition plate (14); and a third expansion chamber (18) for the exhaust gas having an exhaust gas outlet (17), being partitioned from the second expansion chamber (15) by the partition plate (14) and being communicated with the second expansion chamber (15) through a second communicating hole (16) on the partition plate (14). A first heat resistant mesh catalyst (19) is disposed on the exhaust gas inlet (11). A first exhaust gas purifier (20) composed of a heat resistant knit fabric (20a) coated with a catalyst for purifying the exhaust gas is disposed on the first communicating hole (13) on the partition plate (14).

[0034] Further, in the muffler, the first exhaust gas purifier (20) can be composed of the heat resistant knit fabric (20a) coated with the catalyst for purifying the exhaust gas, supported with a heat resistant cover (20b) having at least one exhaust gas inlet (20d).

[0035] Further, in the muffler, the first exhaust gas purifier (20) is disposed on an exhaust gas inlet side of the communicating hole (13) on the partition plate (14), a second heat resistant mesh catalyst (22) and a heat resistant cover having a plurality of exhaust gas outlets (22a) are disposed on an exhaust gas outlet side thereof, and a third heat resistant mesh catalyst (23) can be disposed replaceably on the exhaust gas outlet (17).

[0036] Further, in the muffler, the first exhaust gas purifier (20) can be composed of the heat resistant knit fabric (20a) coated with the catalyst for purifying the exhaust gas, supported with a cover (20c) made of a heat resistant mesh.

[0037] Further, in the muffler, at least an outer wall of the second expansion chamber (15) which is not disposed on a side where the muffler is attached can be composed of a double wall structure of walls (15a, 15b).

[0038] Further, in the muffler, at least the outer wall of the second expansion chamber (15) which is not disposed on the side where the muffler is attached can be composed of the double wall structure of walls (15a, 15b) and an heat insulator 15c can be packed to the space between the double wall structure of walls (15a, 15b).

[0039] Further, in the muffler, an exhaust gas receiver (24) is disposed in the first expansion chamber (12) disposed opposite the exhaust gas inlet (11). The exhaust gas receiver (24) is connected to the exhaust gas inlet (11) and is provided with an exhaust gas outlet (24b) disposed opposite the exhaust gas inlet (11). A second exhaust gas purifier (25) which is composed of the heat resistant knit fabric coated with the catalyst for purifying the exhaust gas is installed on the exhaust gas outlet (24b) in the exhaust gas receiver (24). An inclined surface (24a) can be disposed on the exhaust gas outlet (24b) so that the exhaust gas flows in a direction toward the first exhaust gas purifier (20).

[0040] Further, in the muffler, the first heat resistant mesh catalyst (19) can be made of a SUS310S stainless steel mesh coated with the catalyst for purifying the exhaust gas.

[0041] Further, in the muffler, the second heat resistant mesh catalyst (21) can be made of the SUS310S stainless steel mesh coated with the catalyst for purifying the exhaust gas. The heat resistant cover (22) can be made of a SUS310S stainless steel sheet. The third heat resistant mesh catalyst (23) can be made of the SUS310S stainless steel mesh coated with the catalyst for purifying the exhaust gas.

[0042] Further, in the muffler, the exhaust gas receiver (24) can be made of the SUS310S stainless steel sheet.

[0043] Further, a muffler for a small engine according to another embodiment, includes: a first expansion chamber (12) for exhaust gas having an exhaust gas inlet (11) being connected to an exhaust gas outlet of the engine; a second expansion chamber (15) which is partitioned from the first expansion chamber (12) by a partition plate (14); and a third expansion chamber (18) for an exhaust gas outlet (17) being communicated with the second expansion chamber (15) through a second communicating hole (16) on the partition plate (14). A first heat resistant mesh catalyst (19) is disposed on the exhaust gas inlet (11). A convex part (14b) having at least one first communicating hole (14a) and protruding toward the first expansion chamber (12) is made in an integral molding manner. A first exhaust gas purifier (20) composed of the heat resistant knit fabric (20a) coated with a catalyst for purifying the exhaust gas is installed to a concave side of a convex part (14b) disposed opposite the second expansion chamber (15). A heat resistant cover (22) having the exhaust gas outlet (22a) is disposed for covering the first exhaust gas purifier (20) in a direction from a side of the second expansion chamber (15).

[0044] A muffler for a small engine according to another embodiment, includes: a first expansion chamber (12) for exhaust gas having an exhaust gas inlet (11) being connected to the exhaust gas outlet of the engine; a second expansion chamber (15) which is partitioned from the first
expansion chamber (12) by a partition plate (14); and a third expansion chamber (18) having an exhaust gas outlet (17) being communicated with the second expansion chamber (15) through a second communicating hole (16) on the partition plate (14). A first heat resistant mesh catalyst (19) is disposed on the exhaust gas inlet (11). A convex part (14d) having an exhaust gas outlet (14e) and protruding toward the second expansion chamber (15) is made in an integral molding manner. An exhaust gas purifier (20) composed of a heat resistant knitted fabric (20a) coated with a catalyst for purifying the exhaust gas is installed on an exhaust gas inlet side on the side of the first expansion chamber (12) of the convex part (14b). A heat resistant cover (20b) having at least one exhaust gas outlet (20b1) is disposed for covering the first exhaust gas purifier (20) from the first expansion chamber (12).

0045 The muffler for a small engine according to further another embodiment, includes: the first expansion chamber (12) for the exhaust gas having the exhaust gas inlet (11) being connected to the exhaust gas outlet of the engine; and the second expansion chamber (15) being partitioned from the first expansion chamber (12) by the partition plate (14) having the first communicating hole (13). The first heat resistant mesh catalyst (19) is disposed on the exhaust gas inlet (11). The first exhaust gas purifier (20) composed of the heat resistant knitted fabric (20a) coated with the catalyst for purifying the exhaust gas is disposed on the first communicating hole (13) on the partition plate (14). An outside air suction pipe (30) is disposed through the second expansion chamber (15). A portion of the outside air suction pipe facing to the first exhaust gas purifier (20) is composed of a double pipe. An end of the outside air suction pipe penetrates an outer wall and is communicated with an outside air. A plurality of suction holes (30b) are bored on the outer pipe of a double pipe (30a). The other end of the outside air suction pipe (30) is communicated with the exhaust gas outlet (17) through an exhaust gas guide (33).

0046 In further another embodiment of the muffler for a small engine according to the present invention, the exhaust gas guide (33) is provided with a pipe (34) being communicated with the first expansion chamber (12) of the exhaust gas and having a check valve (35).

0047 In further another embodiment of the muffler for a small engine according to the present invention, the muffler includes: the first expansion chamber (12) of the exhaust gas having the exhaust gas inlet (11) being connected to the exhaust gas outlet of the engine; and the second expansion chamber (15) partitioned from the first expansion chamber (12) by the partition plate (14) having the communicating hole (13). The first heat resistant mesh catalyst (19) is disposed on the exhaust gas inlet (11). The first exhaust gas purifier (20) composed of the heat resistant knitted fabric (20a) coated with the catalyst for purifying the exhaust gas is disposed on the first communicating hole (13) on the partition plate (14). The exhaust gas guide (33) which communicates the second expansion chamber (15) with the exhaust gas outlet (17), is provided with the pipe (34) being also communicated with the first expansion chamber (12) of the exhaust gas and having the check valve (35).

0048 According to further another embodiment of the muffler for a small engine of the present invention, in the muffler according to the one embodiment, another embodiment and further another embodiments of the present invention, a concave groove (31) being communicated with the third expansion chamber (18) at an end and the outside air at the other end is formed on an outer surface of the muffler, and a groove cover (32) covers the concave groove (31).

0049 According to further another embodiment of the muffler for a small engine of the present invention, in the muffler according to the one embodiment, another embodiment and further another embodiments of the present invention, an outside air suction pipe (30') being opened at each end is fixed along the outer wall of the muffler so as to communicate with the exhaust gas outlet (17) at an end and the outside air at the other end.

BRIEF DESCRIPTION OF THE DRAWINGS

0050 FIG. 1 is a cross-sectional view according to one embodiment of a muffler for a small engine of the present invention.

0051 FIG. 2 is an exploded perspective view according to one embodiment of the muffler for a small engine of the present invention.

0052 FIG. 3 is an assembling perspective view according to the one embodiment of the muffler for a small engine of the present invention.

0053 FIG. 4 is a cross-sectional view of the muffler in which the exhaust gas purifier according to the one embodiment of the muffler for a small engine of the present invention is modified to another embodiment.

0054 FIG. 5 is an exploded perspective view of the muffler in which the first exhaust gas purifier according to the one embodiment of the muffler for a small engine of the present invention is modified to another embodiment.

0055 FIG. 6 is an assembling perspective view of the muffler in which the first exhaust gas purifier according to the one embodiment of the muffler for a small engine of the present invention is modified to another embodiment.

0056 FIG. 7 is a cross-sectional view of a muffler having an outer wall composed of a double-wall structure, in a configuration according to the one embodiment of the muffler for a small engine of the present invention.

0057 FIG. 8 is a cross-sectional view of the muffler in which the heat insulator is packed in a space between the double walls of the outer wall, in the configuration as shown in FIG. 7.

0058 FIG. 9 is a cross-sectional view of the muffler in which the first exhaust gas purifier is modified to another embodiment, in the configuration as shown in FIG. 7.

0059 FIG. 10 is a cross-sectional view of the muffler in which a heat insulator is packed between the double walls of the outer wall, in the configuration as shown in FIG. 9.

0060 FIG. 11 is a cross-sectional view according to another embodiment of a muffler for a small engine of the present invention.

0061 FIG. 12 is a cross-sectional view of the muffler in which the first exhaust gas purifier is modified to another embodiment, in the configuration as shown in FIG. 11.

0062 FIG. 13 is a cross-sectional view according to further another embodiment of a muffler for a small engine of the present invention.

0063 FIG. 14 is a cross-sectional view according to further another embodiment of the muffler for a small engine of the present invention.

0064 FIG. 15 is a cross-sectional view according to further another embodiment of the muffler for a small engine of the present invention.
FIG. 16 is a cross-sectional view according to further another embodiment of the muffler for a small engine of the present invention.

FIG. 17 is a cross-sectional view according to further another embodiment of the muffler for a small engine of the present invention.

FIG. 18 is an exploded perspective view according to further another embodiment of the muffler for a small engine of the present invention.

FIG. 19 is an exploded perspective view according to further another embodiment of the muffler for a small engine of the present invention.

FIG. 20 is an exploded perspective view according to further another embodiment of the muffler for a small engine of the present invention.

FIG. 21 is a cross-sectional view of a conventional muffler for a small engine.

FIG. 22 is a cross-sectional view of another conventional muffler for a small engine.

BEST MODES FOR CARRYING OUT THE INVENTION

Hereunder, a detailed description is made referring to the drawings on the embodiments of the present invention.

FIG. 1 is a cross-sectional view according to one embodiment of a muffler for a small engine of the present invention. FIG. 2 is an exploded perspective view thereof and FIG. 3 is an assembling perspective view thereof.

The muffler for a small engine according to the one embodiment of the present invention includes: a first expansion chamber 12 having an exhaust gas inlet 11 being connected to an exhaust gas outlet of the engine; a second expansion chamber 15 for exhaust gas partitioned from the first expansion chamber 12 by a partition plate 14 and communicated with the first expansion chamber 12 through a first communicating hole 13 on the partition plate 14; and a third expansion chamber 18 for the exhaust gas having an exhaust gas outlet 17, partitioned from the second expansion chamber 15 by the partition plate 18 and communicated with the second expansion chamber 15 through a second communicating hole 16 on the partition plate 14. A first heat resistant mesh catalyst 19 is disposed on the exhaust gas inlet 11. A first exhaust gas purifier 20 composed of a heat resistant knit fabric 20a coated with a catalyst for purifying the exhaust gas is disposed on the first communicating hole 13 on the partition plate 14.

The first exhaust gas purifier 20 is composed of the heat resistant knit fabric 20a coated with the catalyst for purifying the exhaust gas, supported with a heat resistant cover 20b having at least one exhaust gas inlet 20d.

The first exhaust gas purifier 20 is disposed on an exhaust gas inlet side of the first communicating hole 13 on the partition plate 14, a second heat resistant mesh catalyst 21 and a heat resistant cover 22 having a plurality of exhaust gas outlets 22a are disposed on an exhaust gas outlet side thereof, and the third heat resistant mesh catalyst 23 can be disposed replaceably on the exhaust gas outlet 17.

The heat resistant cover 20b and the heat resistant cover 22 can be made by press forming a stainless steel sheet and are welded with the partition plate 14 around the first communicating hole 13.

An outer wall 12a of the first expansion chamber 12, an outer wall 15a of the second expansion chamber 15, the partition plate 14, and a partition plate 18a which is disposed between the partition plate 14 and the outer wall 12a of the first expansion chamber 12 by welding and constitutes the third expansion chamber 18, are made by forming a stainless steel sheet.

Among stainless steel materials, SUS310S stainless steel is preferred for making the outer wall 12a of the first expansion chamber 12, the outer wall 15a of the second expansion chamber 15, the partition plate 14, the partition plate 18a which constitutes the third expansion chamber 18, the heat resistant cover 20b and the heat resistant cover 22c. If SUS310S stainless steel is used for them, each life can be extended due to the excellent heat resistant and acid resistant properties.

Further, the first heat resistant mesh catalyst 19, the second heat resistant mesh catalyst 21 and the third heat resistant mesh catalyst 23 can be made of a stainless steel wire mesh or a stainless steel sheet having a number of fine holes bored, coated with a catalyst such as one or a combination of platinum, rhodium, palladium, etc., for purifying the exhaust gas. If the SUS310S stainless steel is used preferably as the stainless steel material, each life can be extended due to the excellent heat resistant and acid resistant properties.

Further, the heat resistant knit fabric 20a is made of a fabric being knit from a piece of wire or a few pieces of wires of a stainless steel and being folded to a pre-determined thickness, and coated with the catalyst for purifying the exhaust gas.

A manufacturing process of the heat resistant knit fabric 20a is simpler and a manufacturing cost grows less, as compared to the manufacturing process and the manufacturing cost of the conventional stainless steel honeycomb-like substrate.

As shown in FIG. 1, FIG. 2 and FIG. 3, because an inside of the muffler is partitioned into the first expansion chamber 12, the second expansion chamber 15 and the third expansion chamber 18, by the partition plate 14, its muffling effect improves. Further, because the first heat resistant mesh catalyst 19 is disposed on the exhaust gas inlet 11, sparks included in the exhaust gas of the engine do not enter the muffler (so-called, a spark arrestor effect). Further, because the first exhaust gas purifier 20 which is disposed on the first communicating hole 13 bored on the partition plate 14 so as to communicate the first expansion chamber 12 with the second expansion chamber 15, is composed of the heat resistant fabric 20a coated with the catalyst for purifying the exhaust gas, the manufacturing process is simpler and a manufacturing cost is reduced.

The second heat resistant mesh catalyst 21 is made of a stainless steel mesh coated with the catalyst for purifying the exhaust gas, and is welded to the partition plate 14. Further, the third heat resistant mesh catalyst 23 is made of the stainless steel mesh coated with the catalyst for purifying the exhaust gas. If the SUS310S stainless steel is used preferably as the stainless steel material, each life can be extended due to the excellent heat resistant and acid resistant properties.

FIG. 4 is a cross-sectional view of the muffler in which the first exhaust gas purifier 20 is modified to another embodiment. FIG. 5 is an exploded perspective view and FIG. 6 is an assembling perspective view. The first exhaust gas purifier 20 is composed of the heat resistant knit fabric 20a coated with the catalyst for purifying the exhaust gas, supported with the heat resistant cover 20c made of a heat resistant mesh. The heat resistant mesh can be made by coating a stainless steel mesh with the catalyst for purifying the exhaust gas.
gas, and the heat resistant cover 20c being made as such is welded to the partition plate 14. If the SUS310S stainless steel is used preferably as the stainless steel material, a life can be extended thereby due to the excellent heat resistant and acid resistant properties.

[0086] As described above, because the first exhaust gas purifier 20 is disposed on an inlet side of the exhaust gas of the first communicating hole 13 bored through the partition plate 14, and the second heat resistant mesh catalyst 21 and the heat resistant cover 22 having a plurality of the exhaust gas outlets 22a are disposed on an outlet side, the first exhaust gas purifier 20 is heated up fast and a temperature rises. Consequently, the exhaust gas is purified better. Further, because the third heat resistant mesh catalyst 23 is disposed replaceably on the exhaust gas outlet 17, the sparks can be prevented from blowing out, and the third heat resistant mesh 23 can be replaced easily.

[0087] As shown in FIG. 7 and FIG. 9, a wall of the second expansion chamber 15 which is not at least a wall of the engine side can be composed of a double wall structure of walls 15a, 15b.

[0088] Further, as shown in FIG. 8 and FIG. 10, the wall of the second expansion chamber 15 which is not at least a wall of the engine side can be composed of a double wall structure of walls 15a, 15b, and a heat insulator 15c can be packed to a space between the double walls.

[0089] By the configuration as described above, the outer wall of the muffler is prevented from being heated up. Further, because the heat insulator 15c is packed into the space between the double walls, an effect for preventing the outer wall of the muffler from being heated up is high.

[0090] According to another embodiment of the present invention, as shown in FIG. 11 and FIG. 12, an exhaust gas receiver 24 can be disposed in the first expansion chamber 12 disposed opposite the exhaust gas inlet 11 being connected to the exhaust gas outlet of the engine. The exhaust gas receiver 24 is connected to the exhaust gas inlet 11 and has an exhaust gas outlet 24b disposed opposite the exhaust gas inlet 11. In the vicinity of the exhaust gas outlet 24b inside the exhaust gas receiver 24, a second exhaust gas purifier 25 composed of the heat resistant knit fabric coated with the catalyst is disposed. An inclined surface 24a is attached to the exhaust gas outlet 24b and therefore the exhaust gas flows in a direction toward the first exhaust gas purifier 20.

[0091] After installing the second exhaust gas purifier 25 in the exhaust gas receiver 24, a center portion of the exhaust gas receiver 24 is deformed so as to protrude inward, and the second exhaust gas purifier 25 is fixed so as not to be detached.

[0092] By the configuration as described above, because a first exhaust gas exhaust gas is received by the exhaust gas receiver 24 and is received by the exhaust gas purifier 25 disposed therein, a purification effect on the exhaust gas is better.

[0093] Further, because the first heat resistant mesh catalyst 19 is made of the SUS310S stainless steel mesh coated with the catalyst for purifying the exhaust gas, a life of the first heat resistant mesh catalyst 19 can be extended due to the excellent heat resistant and acid resistant properties.

[0094] Further, because the second heat resistant mesh catalyst 21 is made of the SUS310S stainless steel mesh coated with the catalyst for purifying the exhaust gas, the heat resistant cover 22 is made of the SUS310S stainless steel sheet and the third heat resistant mesh catalyst 23 is made of the SUS310S stainless steel mesh coated with the catalyst for purifying the exhaust gas, each life of the second heat resistant mesh catalyst 21, the heat resistant cover 22 and the third heat resistant mesh catalyst 23 can be extended due to the excellent heat resistant and acid resistant properties.

[0095] Further, the exhaust gas receiver 24 is made of the SUS310S stainless steel sheet, and the second exhaust gas purifier 25 composed of the stainless steel knit fabric coated with the catalyst for purifying the exhaust gas is installed therein. Each life of the exhaust gas receiver 24 and the second exhaust gas purifier 25 is extended due to the excellent heat resistant and acid resistant properties.

[0096] According to another embodiment of the muffler for a small engine of the present invention, as shown in FIG. 13, a convex part 14b having at least one first communicating hole 14a and protruding toward first expansion chamber 12 is made on the partition plate 14 in an integral molding manner. The first exhaust gas purifier 20 composed of the stainless steel knit fabric coated with the catalyst for purifying the exhaust gas is installed to a concave part on the side of the second expansion chamber (15) of the convex part (14b), and the heat resistant cover 22 having the exhaust gas outlet 22a covers the first exhaust gas purifier 20 from the second expansion chamber 15. Consequently, the first exhaust gas purifier 20 can be manufactured at a lower cost due to a simpler configuration. The exhaust gas outlet 22a is disposed so that the exhaust gas does not flow in a direction toward the outer wall 15a of the second expansion chamber 15, but flows along the partition plate 14.

[0097] According to further another embodiment of the muffler for a small engine of the present invention, as shown in FIG. 14, a convex part 14a having the exhaust gas outlet 14a and protruding toward second expansion chamber 15 is made on the partition plate 14 in an integral molding manner. The first exhaust gas purifier 20 composed of the stainless steel knit fabric 20a coated with the catalyst for purifying the exhaust gas is installed in an inlet side of the concave part on the side of the first expansion chamber (12), and the heat resistant cover 20b having at least one exhaust gas inlet 20d covers the first exhaust gas purifier 20 from the first expansion chamber 12. Consequently, the first exhaust gas purifier 20 can be manufactured at a lower cost due to a simpler configuration. The exhaust gas outlet 14a is disposed so that the exhaust gas does not flow in a direction toward the outer wall 15a of the second expansion chamber 15, but flows along the partition plate 14.

[0098] In further another embodiment of the muffler for a small engine according to the present invention, as shown in FIG. 15, the first expansion chamber 12 for the exhaust gas having the exhaust gas inlet 11 is connected to the exhaust gas outlet of the engine and the second expansion chamber 15 is partitioned from the first expansion chamber 12 by the partition plate 14 having the communicating hole 13. The first heat resistant mesh catalyst 19 is disposed on the exhaust gas inlet 11. The first exhaust gas purifier 20 composed of the heat resistant knit fabric 20a coated with the catalyst for purifying the exhaust gas is disposed on the first communicating hole 13 on the partition plate 14. An outside air suction pipe 30 is disposed through the second expansion chamber 15. A portion of the outside air suction pipe 30 disposed opposite the first exhaust gas purifier 20 is composed of a double pipe. An end of the outside air suction pipe penetrates the outer wall and is communicated with the outside air. A plurality of suction holes 306 are bored on an outer pipe of the double...
pipe 30a. The other end of the outside air suction pipe 30 is communicated with the exhaust gas outlet 17 through an exhaust gas guide 33.

Meanwhile, in the embodiment as shown in FIG. 15, while the exhaust gas purifier 20 is composed of the heat resistant knit fabric 20a, supported with the heat resistant cover 20c made of the heat resistant mesh, the exhaust gas purifier 20 can be constituted, as shown in FIG. 1, by the heat resistant knit fabric 20a supported with the heat resistant cover 20b having at least one exhaust gas inlet 20d.

Because such an outside air suction pipe 30 is disposed, the exhaust gas passing through the first exhaust gas purifier 20 enters the outer pipe 30a through the suction holes 30b bored on the outer pipe 30a of the double pipe portion of the outside air suction pipe 30, and flows in a direction toward the exhaust gas outlet 17. Consequently, because the exhaust gas in the outside air suction pipe 30 is suctioned, the outside air enters the outside air suction pipe 30 from an outside air suction inlet 30c at the other end thereof and a temperature of the exhaust gas being exhausted from the exhaust gas outlet 17 lowers.

In further another embodiment of the muffler for a small engine according to the present invention, as shown in FIG. 16, a pipe 34 is connected to the exhaust gas guide 33 so that it communicates with the exhaust gas first expansion chamber 12, and a check valve 35 is attached to the pipe 34.

The check valve 35 can be a butterfly valve as shown in FIG. 16 (b), and a top end portion of the pipe 34 can be formed to a smaller size as shown in FIG. 16 (c).

Accordingly, because the outside air (oxygen) flows into the first expansion chamber 12 through the check valve 35 attached to the pipe 34, a burning efficiency of the exhaust gas while the exhaust gas in the first expansion chamber 12 being burned in the first exhaust gas purifier 20 is high, and further, because part of the exhaust gas re-circulates into the first expansion chamber 12 and is re-burned in the first exhaust gas purifier 20, a purifying effect on the exhaust gas is good.

In further another embodiment of the muffler for a small engine according to the present invention, as shown in FIG. 17, the first expansion chamber 12 of the exhaust gas having the exhaust gas inlet 11 is connected to the exhaust gas outlet of the engine and the second expansion chamber 15 is partitioned from the first expansion chamber 12 through the partition plate 14 having the communicating hole 13. The first heat resistant mesh catalyst 19 is disposed on the exhaust gas inlet 11. The first exhaust gas purifier 20 composed of the heat resistant knit fabric 20a coated with the catalyst for purifying the exhaust gas is disposed on the first communicating hole 13 on the partition plate 14. The exhaust gas guide 33 which communicates the second expansion chamber 15 with the exhaust gas outlet 17, is provided with the pipe 34 which is also communicated with the first expansion chamber 12 of the exhaust gas and has the check valve 35.

Accordingly, because part of the exhaust gas in the second expansion chamber 15 re-enters the first expansion chamber 12 through the pipe 34 and the check valve 35, and is re-burned in the first expansion chamber 20, a purification effect on the exhaust gas is good.

In further another embodiment of the muffler for a small engine according to the present invention, as shown in FIG. 18, a concave groove being communicated with the third expansion chamber 18 (refer to FIG. 1) at an end and with the outside air at the other end is formed on an outer surface of the muffler, and a groove cover 32 covers the concave groove 31. The exhaust gas is exhausted from the third expansion chamber 18 through an exhaust gas outlet 17. The outside air enters the third expansion chamber 18 through the concave groove 31 formed on the outer wall of the muffler following the exhaust gas being exhausted. Therefore, temperature of the exhaust gas being exhausted from the exhaust gas outlet 17 lowers. Here, as shown in FIG. 19, the groove cover which covers the concave groove 31 can be made in one member including a lattice member 28 which covers the exhaust gas outlet 17 of the third expansion chamber 18 and a groove cover 32 which covers the concave groove 31.

In further another embodiment of the muffler for a small engine according to the present invention, as shown in FIG. 20, an outside air suction pipe 30' being opened at each end is fixed along the outer wall of the muffler so as to communicate with the exhaust gas outlet 17 at an end and the outside air at the other end. Because the outside air enters the third expansion chamber 18 through the other end of the outside air suction pipe 30' following the exhaust gas which is exhausted from the third expansion chamber 18 (refer to FIG. 1) through the exhaust gas outlet 17, temperature of the exhaust gas being exhausted from the exhaust gas outlet 17 lowers. The outside air suction pipe 30' can be fixed along the outer wall of the muffler by means such as welding, etc. Further, as shown in FIG. 1, FIG. 3, FIG. 4, FIG. 6 and FIG. 11 to FIG. 17, each end portion of the outer walls 12a, 15a, and the partition plate 14 is fixed by clamping.

Meanwhile, as shown in FIG. 7 to FIG. 10, each end portion of the double-walls 12a, 12b, the partition plate 15 and the double-walls 15a', 15b' forming the second expansion chamber 15 is fixed by clamping.

The numeral '26' is, as indicated in FIG. 1 to FIG. 6 and FIG. 11 to FIG. 20, a pipe member which is disposed on a position between the outer wall 12a forming the first expansion chamber 12 and the outer wall 15a forming the second expansion chamber 15, and in which a bolt 27 for fixing the muffler to the engine is inserted. The numeral '28', as indicated in FIG. 1 to FIG. 6 and FIG. 11 to FIG. 20, is a lattice member which is attached replaceably to the outer wall 12a of the muffler using an attaching screw. The third heat resistant mesh catalyst 23 can be replaced by detaching the lattice member 28.

1. A muffler for a small engine, comprising:
   a first expansion chamber of exhaust gas having an exhaust gas inlet being connected to an exhaust gas outlet of the engine;
   a second expansion chamber of the exhaust gas being partitioned from the first expansion chamber by a partition plate and being communicated with the first expansion chamber through a first communicating hole through the partition plate;
   a third expansion chamber of the exhaust gas having an exhaust gas outlet and being partitioned from the second expansion chamber by the partition plate and being communicated with the second expansion chamber through a second communicating hole through the partition plate,
   a first heat resistant mesh catalyst disposed at the exhaust gas inlet; and
   a first exhaust gas purifier composed of a knit fabric coated with a catalyst for purifying the exhaust gas and disposed at the first communicating hole.
2. The muffler for a small engine according to claim 1, further comprising:
   a heat resistant cover having at least one exhaust gas inlet for supporting the knit fabric.

3. The muffler for a small engine according to claim 1, further comprising:
   a second heat resistant mesh catalyst and a heat resistant cover having a plurality of exhaust gas outlets disposed on an outlet side of the exhaust gas; and
   a third heat resistant mesh catalyst disposed replaceably on the exhaust gas outlet wherein the first exhaust gas purifier is disposed on an exhaust gas inlet side of the first communicating hole through the partition plate.

4. The muffler for a small engine according to claim 1, further comprising:
   a heat resistant cover made of a heat resistant mesh for supporting the knit fabric.

5. The muffler for a small engine according to claim 1, wherein at least an outer wall of the second expansion chamber which is not disposed on a side where the muffler is attached is constituted by a double-wall structure of walls.

6. The muffler for a small engine according to claim 1, wherein the outer wall of the second expansion chamber which is not at least the wall of the engine side is constituted by the double-wall structure of walls and a heat insulator is packed into a space between the double walls.

7. The muffler for a small engine according to claim 1, further comprising:
   an exhaust gas receiver disposed inside the first expansion chamber disposed opposite the exhaust gas inlet, being connected to the exhaust gas inlet and having an exhaust gas outlet opposite the exhaust gas inlet; and
   a second exhaust gas purifier composed of the heat resistant knit fabric coated with the catalyst for purifying the exhaust gas, being installed in a vicinity of the exhaust gas outlet inside the exhaust gas receiver; and
   an inclined surface formed on the exhaust gas outlet so as to flow the exhaust gas in a direction toward the first exhaust gas purifier.

8. The muffler for a small engine according to claim 1, wherein the first heat resistant mesh catalyst is made of a SUS310S stainless steel mesh coated with the catalyst.

9. The muffler for a small engine according to claim 3, wherein the second heat resistant mesh catalyst is made of the SUS310S stainless steel mesh coated with the catalyst for purifying the exhaust gas, the heat resistant cover is made of a SUS310S stainless steel sheet, and
   the third heat resistant mesh catalyst is made of the SUS310S stainless steel mesh coated with the catalyst for purifying the exhaust gas.

10. The muffler for a small engine according to claim 7, wherein the exhaust gas receiver is made of the SUS310S stainless steel sheet.

11. A muffler for a small engine, comprising:
    a first expansion chamber of the exhaust gas having an exhaust gas inlet being connected to an exhaust gas outlet of the engine;
    a second expansion chamber being partitioned from the first expansion chamber by a partition plate;
    a third expansion chamber having an exhaust gas outlet being communicated with the second expansion chamber through a second communicating hole on the partition plate,
    a first heat resistant mesh catalyst disposed at the exhaust gas inlet;
    a convex part having at least one first communicating hole and protruding toward the first expansion chamber, the convex part made in an integrally molding manner with the partition plate;
    a first exhaust gas purifier composed of a heat resistant knit fabric coated with the catalyst for purifying the exhaust gas installed on a concave part on the side of the second expansion chamber of the convex part; and
    a heat resistant cover having an exhaust gas outlet disposed for covering the first exhaust gas purifier in a direction from the second expansion chamber.

12. A muffler for a small engine, comprising:
    a first expansion chamber of the exhaust gas having an exhaust gas inlet being connected to an exhaust gas outlet of the engine;
    a second expansion chamber which is partitioned from the first expansion chamber by a partition plate;
    a third expansion chamber having an exhaust gas outlet being communicated with the second expansion chamber through a second communicating hole on the partition plate;
    a first heat resistant mesh catalyst disposed on the exhaust gas inlet;
    a convex part having an exhaust gas outlet and protruding toward the second expansion chamber, the convex part made in an integrally molding manner with the partition plate;
    a heat resistant knit fabric coated with a catalyst for purifying the exhaust gas installed on an exhaust gas inlet side on the side of the first expansion chamber of the convex part; and
    a heat resistant cover having an exhaust gas outlet disposed for covering the first exhaust gas purifier the first expansion chamber.

13. A muffler for a small engine, comprising:
    a first expansion chamber for the exhaust gas having an exhaust gas inlet being connected to an exhaust gas outlet of the engine;
    a second expansion chamber being partitioned from the first expansion chamber by a partition plate having a communicating hole;
    a first heat resistant mesh catalyst disposed on the exhaust gas inlet;
    a first exhaust gas purifier composed of a heat resistant knit fabric coated with a catalyst for purifying the exhaust gas is disposed on the first communicating hole on the partition plate; and
    an outside air suction pipe disposed through the second expansion chamber, a portion of the outside air suction pipe disposed opposite the first exhaust gas purifier and composed of a double pipe, an end of the outside air suction pipe bored through the outer wall and communicating with an outside air;
    wherein a plurality of suction holes are bored through an outer pipe of the double pipe and the other end of the outside air suction pipe communicates with an exhaust gas outlet through an exhaust gas guide.
14. The muffler for a small engine according to claim 13, wherein the exhaust gas pipe is provided with a pipe having a check valve and being communicated with the first expansion chamber of the exhaust gas.

15. A muffler for a small engine, comprising:
a first expansion chamber of exhaust gas having an exhaust gas inlet being connected to an exhaust gas outlet of the engine;
a second expansion chamber partitioned from the first expansion chamber by a partition plate having a communicating hole;
a first heat resistant mesh catalyst disposed on the exhaust gas inlet;
a first exhaust gas purifier composed of a heat resistant knit fabric coated with a catalyst for purifying the exhaust gas disposed on a first communicating hole on the partition plate; and

an exhaust gas pipe communicating the second expansion chamber with an exhaust gas outlet provided with a pipe being communicated with the first expansion chamber of the exhaust gas and having a check valve.

16. The muffler for a small engine according to claim 1, wherein a concave groove which is communicated with the third expansion chamber at an end and with the outside air at the other end is formed on an outer surface of the muffler, and a groove cover covers the concave groove.

17. The muffler for a small engine according to claim 1, wherein an outside air suction pipe being opened at each end is fixed along the outer wall of the muffler so as to communicate with the exhaust gas outlet at an end and with the outside air at the other end.

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