EXHAUST DEVICE WITH A FLAME RESONATOR

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ABSTRACT

The present invention relates to an exhaust device for internal-combustion-engine-driven small appliances. The exhaust device includes a housing which has at least one exhaust inlet opening and at least one exhaust outlet opening, and a flame resonator for suppressing flames emerging from the exhaust device. The flame resonator is arranged inside the housing and is configured as a channel-like resonator cavity into which the exhaust gas flows at least partly, whereby flames emerging from the housing can be avoided in the exhaust gas.
EXHAUST DEVICE WITH A FLAME RESONATOR

TECHNICAL FIELD

[0001] The present invention relates to an exhaust device, in particular for small appliances operated by internal combustion engines, comprising a housing which is formed at least from one rear shell and one front shell. The housing comprises at least one exhaust inlet opening and at least one exhaust outlet opening, wherein a catalyst is optionally arranged inside the housing and wherein the exhaust device further has a flame resonator for suppressing flames emerging from the exhaust device.

PRIOR ART

[0002] Such exhaust devices are used in particular in hand-operated small appliances with an internal combustion engine such as chain saws, hedge trimmers, angle grinders, lawn trimmers and the like.

[0003] Portable internal combustion engines for small appliances are usually designed as two-stroke engines and must adhere to increasingly stricter exhaust regulations in many countries important for sales. One possibility of adhering to these exhaust regulations is to use a catalyst. In this case, the catalyst is advantageously integrated in the exhaust. A problem however is the flame formation after the catalyst since emerging flames are unacceptable because of a possible fire hazard.

[0004] Known as a solution is a sufficiently long channel behind the catalyst. This gives the flame a sufficient residence time or path length inside the silencer for extinguishing purposes. However, this channel must be very long, however, to reliably avoid flames which under certain operating conditions of the appliance can be "blown" out from the channel. Thus, this channel is difficult to accommodate or cannot be accommodated in an advantageous manner in compact silencers.

[0005] Known from DE 20 2005 007 861 U1 is an exhaust system for an internal combustion engine comprising a housing in which at least one opening is provided for an exhaust inlet and a further opening for an exhaust outlet. Furthermore, the exhaust system comprises a catalyst for cleaning exhaust gases of the internal combustion engine which is provided in the housing of the exhaust system in such a manner that at least a substantial portion of the exhaust gases flow through the catalyst. The design of the exhaust system also includes a rear shell and a front shell, the catalyst being located between the two shells. However, the exhaust system is not provided with a flame resonator so that flames can escape from the housing of the exhaust device.

[0006] A device for extinguishing flames has already been proposed, which is located inside an exhaust system for an internal combustion engine behind a catalyst, and comprises a housing having a housing cross-sectional area and further comprising an incoming pipe for the flame extinguisher which has a first cross-sectional area through which the incoming exhaust gas is guided and comprising an outgoing pipe from the flame extinguisher which has a second cross-sectional area through which the outgoing exhaust gas is guided. At the same time, an expanding transition is provided from the first cross-sectional area to the housing cross-sectional area and a contracting transition from the housing cross-sectional area to the second cross-sectional area. In this variant, both the ingoing and the outgoing pipe are configured in a longitudinal axis.

[0007] In the known exhaust devices and in particular in the known devices for flame extinguishing, the problem arises that it is not possible to integrate a device for flame extinguishing inside an exhaust device according to the prior art designs as a result of the respective geometrical formations. Rather, the problem arises that in the known devices for flame extinguishing a considerable amount of space is required so that the ingoing and outgoing pipes to the flame extinguisher must be guided around the housing of the exhaust device which means considerable complexity of design and production technology and takes up additional space which in turn prevents or makes it difficult to achieve a compact and small design of the complete exhaust device.

[0008] Conventional exhaust devices have an exhaust outlet opening adjoining the device for flame extinguishing. However, the flame extinguisher itself is a single component so that this gives rise to the problem of executing the flame extinguisher jointly and uniformly with the exhaust device.

[0009] Known from DE-PS 948 210 is a cyclone arrangement in a spark extinguisher whereby glowing particles in the exhaust gas are accelerated to the inside of the cyclone arrangement by the centrifugal force. However, this design also comprises a device for flame extinguishing having an elongated shape which is an impediment for a compact design of an exhaust device.

[0010] Furthermore, DE-PS 1 031 581 discloses a flame arrester for an exhaust pipe of internal combustion engines where a complex labyrinth system is used to achieve a good flame protection effect and at the same time to minimise the flowing resistance.

[0011] In such flame protection devices, on the one hand the geometric formation is a problem since these cannot be integrated in a compact design inside a housing of an exhaust device. On the other hand, individual devices are required for the flame arrester or the spark extinguisher which again requires a complex construction.

DESCRIPTION OF THE INVENTION

Object, Solution, Advantages

[0012] It is thus the object of the present invention to provide an exhaust device with a flame resonator which overcomes the disadvantages of the aforesaid prior art and has a simple construction and allows the flame resonator to be integrated in an exhaust device.

[0013] This object is achieved starting from an exhaust device according to the preamble of claim 1 in conjunction with its characterising features. Advantageous further developments of the invention are specified in the dependent claims.

[0014] The invention includes the teaching that the flame resonator is arranged inside the housing and is configured as a channel-like resonator cavity into which the exhaust gas flows at least partly, whereby flames emerging from the housing can be avoided in the exhaust gas. The invention starts from the idea that the device for flame extinguishing configured as a flame resonator is formed by an advantageous geometric configuration of the exhaust gas guidance inside the housing of the exhaust device.

[0015] The housing advantageously comprises at least one rear shell and a front shell, which are brought together such
that the insides of the shells lie opposite to one another to form the housing. At the same time, an intermediate shell is arranged between the rear shell and the front shell, wherein a first partial volume between the intermediate shell and the rear shell forms the channel-like resonator cavity and wherein this only has an opening in one direction. Consequently, the exhaust gas must flow in and out again through this opening in the resonator cavity.

[0016] As an alternative embodiment, it can be provided that the first partial volume between the intermediate shell and the front shell forms the channel-like resonator cavity. Furthermore, the exhaust device can comprise a catalyst which is arranged inside the housing, the catalyst being located either between the intermediate shell and the rear shell or between the intermediate shell and the front shell.

[0017] The first partial volume of the flame resonator differs from a second partial volume in that the exhaust gas flows through the catalyst into the volume between the rear shell and the intermediate shell and only reaches the exhaust outlet opening through the second volume. The exhaust gas initially passes through the catalyst into the U-shaped volume, where the two legs of the U-shaped volume form the first partial volume and the second partial volume. The catalyst from which the exhaust gas flows into the partial volume is located in the median line of the U-shaped space. In this case, the exhaust gas outlet opening only extends out from the second partial volume so that this is configured as channel-shaped and the channel only has an opening in one direction and is closed at the end. This first partial volume thus acts as a storage device for the exhaust gas coming from the catalyst, where the storage device can only be emptied via the channel of the second partial volume. At the same time, the storage device can build up a counter-pressure for a two-stroke engine. Accordingly, the size of the first partial volume should be dependent on the cylinder volume of the engine. Appropriately, the first partial volume can hold a multiple integer of the cylinder volume.

[0018] According to a further advantageous embodiment of the invention, it is provided that the exhaust device can be divided by a median line which runs geometrically centrally over the housing. The geometrical configuration of the first partial volume and the second partial volume is approximately symmetrical and an equally large first and second partial volume extends on each side of the median. The rear shell, the front shell and the intermediate shell can be produced as deep-drawn sheet-metal components so that the intermediate shell forms a wall for separating the two partial volumes from one another. The intermediate shell has a cup-shaped contour where the cup base is configured such that it is plane-parallel in the direction of the rear shell. However, the cup-shaped recess of the inner contour does not extend over the total width at the side of the median line so that the respective first and second partial volumes are formed from the respective side of the cup-shaped inner contour as far as the wall of the rear shell.

[0019] According to a further advantageous exemplary embodiment of the invention, the catalyst is cylindrical and is arranged centrally on the median line between the front shell and the intermediate shell. Alternatively, the catalyst can also be arranged between the rear shell and the intermediate shell. According to an additional exemplary embodiment, an insulating shell is provided between the rear shell and the intermediate shell which runs approximately at the same distance from the geometrical formation of the rear shell to form an insulating gap. The insulating gap is filled with an insulating compound for thermal and sound-emitting purposes, where the insulating compound can comprise a glass fibre insulation for example. Thus, the insulating shell forms the inner side of the rear shell or that of the front shell depending on whether the resonator cavity is formed between the intermediate shell and the rear shell or between the intermediate shell and the front shell.

[0020] Advantageously, the rear shell, the insulating shell and the intermediate shell have a respective opening which jointly form the exhaust inlet opening. Furthermore, the cup base of the intermediate shell is configured as plane-parallel to the insulating shell where the cup-shaped inner contour runs approximately centrally over the median line and is therefore arranged adjacent to the catalyst.

[0021] If the exhaust gas now enters through the exhaust inlet opening, through the rear shell, the insulating shell and the intermediate shell into the cup-shaped contour of the intermediate shell, this initially flows through a silencer element accommodated inside the cup-shaped inner contour of the intermediate shell. The intermediate shell initially isolates the space between the intermediate shell and the rear shell or the insulating shell which forms the first partial volume or the second partial volume. The exhaust gas thus flows into the space between the intermediate shell and the front shell so that after the exhaust gas has flowed through the silencer element, this is pressed into the catalyst. The catalyst forms the only fluidic connection between the space between the intermediate shell and front shell and the space between the intermediate shell and the insulating shell or the rear shell.

[0022] The exhaust gas now flows backwards, in the opposite direction to the exhaust gas flow through the exhaust inlet opening, through the cylindrical catalyst into the first and second partial volume. Since the first partial volume is configured as a channel which is open on one side, possible flames which can be formed after the catalyst flow into the first partial volume in which they are smothered. The exhaust gas then flows in the direction of the exhaust outlet opening through the second partial volume where turbulence forms between the first partial volume and the second partial volume which ultimately smothers the flames formed after the catalyst. Flame formation can thus be reliably suppressed so that the exhaust gas flows from the exhaust outlet opening free from flames and sparks and leaves the exhaust device.

[0023] According to a further advantageous exemplary embodiment of the invention, it is provided that a spacer sheet is arranged between the rear shell and the insulating shell in the area of the exhaust inlet opening, wherein the spacer sheet has a thickness according to the insulating gap. The spacer sheet forms a stiffening of the region of the respective openings within the rear shell, the front shell and the intermediate shell, the spacer sheet also comprising an opening so that this borders the openings in the respective shells. Thus, a stiffening is achieved so that the exhaust device can be screwed to the internal combustion engine in the area of the openings. In this case, the thickness of the spacer sheet corresponds to the thickness of the insulating gap so that when the respective shells are screwed tightly, the insulating gap and the insulating mass located therein are not pressed together. Furthermore, the spacer sheet can also be used for holding the exhaust device on the motor or cylinder.
The rear shell, the front shell, the intermediate shell and the insulating can be executed as deep-drawn sheet-steel components, where the steel sheet can comprise structural steel, optionally with coating or surface quenching and tempering such as galvanising, or as stainlees steel.

The rear shell, the insulating shell and the intermediate shell can be joined via a common dovetailed or caulked, pressed, soldered or welded edge since the respective shells must not usually be separated from one another in use. The front shell can also be joined positively to the remaining shells and it can further be provided that the front shell is likewise screwed to the internal combustion machine with the screw connection of the exhaust device and thus can be detachably arranged on the remaining shells.

Furthermore, the present invention is also directed to a hand-held work machine, in particular a chainsaw, hedge trimmer, rotary mower or the like, comprising an internal combustion engine and an exhaust device according to any one of the claims 1 to 19.

BRIEF DESCRIPTION OF THE DRAWINGS

Further measures which improve the invention are specified in the dependent claims or are presented in detail hereinafter jointly with the description of a preferred exemplary embodiment of the invention with reference to the figures. Shown purely schematically in the figures:

- FIG. 1 is an exploded view of the individual shells of an exhaust device according to the present invention;
- FIG. 2a is a cross-section of the exhaust device according to the present invention in mounted form;
- FIG. 2b is a plan view of the exhaust device from FIG. 2a;
- FIG. 2c is a cross-sectional side view of the exhaust device from FIG. 2a or FIG. 2b;
- FIG. 3a is a plan view of the exhaust device, where the front shell is removed; and
- FIGS. 3a, 3b, 3c, 3d are each perspective views of the exhaust device, where the front shell is removed in each case.

BEST MODE FOR CARRYING OUT THE INVENTION

The exemplary embodiment shown in FIGS. 1 to 3b shows an exhaust device 100 which has a channel-shaped resonator cavity formed between the intermediate shell 15 and the rear shell 10. However, it is expressly noted that the configuration of the channel-shaped resonator cavity can also be formed between the intermediate shell and the front shell.

FIG. 1 shows the exhaust device 100 according to the invention in an exploded view, where four shells, namely the rear shell 10, insulating shell 19, the intermediate shell 15 and the front shell 11 are shown successively from left to right in their respective joining positions in front of one another. The respective shells are configured as cup-shaped deep-drawn components and each comprise a steel sheet. The rear shell 10 and the front shell 11 form the outer contour of the exhaust device 100 and have a respective inner volume which jointly form the volume of the housing when the rear shell 10 and the front shell 11 are brought together.

Located between the rear shell 10 and the front shell 11 are the intermediate shell 15 and the insulating shell 19. The insulating shell 19 has approximately the same contour as the rear shell 10 so that both shells can be brought together with their respective walls plane-parallel to one another. An insulating gap is formed between the two shells 10, 19 which can be filled with an insulating compound.

The intermediate shell 15 is not configured as entirely shell-shaped but merely has a cup-shaped inner contour with a cup base 21 where the cup base 21 abuts plane-parallel against the insulating shell 19 in the joined state. The rear shell 10, the insulating shell 19 and the intermediate shell 15 show a respective opening 20, where the rear shell 10 embraces the opening 20a, the insulating shell 19 embraces the opening 20b and the intermediate shell 15 embraces the opening 20c. If the three shells 10, 15 and 19 are brought together, the openings 20a, 20b, 20c form the exhaust inlet opening 12. Adjacent to the exhaust inlet opening 12 are round hole-like openings through which connecting elements such as, for example, screws etc. can be passed. Furthermore, the front shell 11 likewise has two openings so that this can likewise be placed and fastened on the three remaining shells 10, 15 and 19 by means of the same screw connection.

The intermediate shell 15 comprises a catalyst 14 through which the exhaust gas can be passed completely. It is also feasible to additionally provide bypass holes so that the exhaust gas is not passed completely through the catalyst 14 but that a partial stream of the exhaust gas bypasses the catalyst. Provided between the rear shell 10 and the insulating shell 19 is a spacer sheet 22 which likewise comprises an opening 20, as well as the openings for passing through screw elements arranged next to the opening. The spacer sheet 22 has a thickness which corresponds to the thickness of the insulating gap so that this is maintained when the shells 10, 15 and 19 are tightly screwed.

In addition, the spacer sheet 22 provides an increase in strength or an improvement in the force application of the exhaust device 100 in the direction of the internal combustion engine which accommodates this. The exhaust gas leaves the exhaust device 100 through an exhaust outlet opening 13 which is provided both in the rear shell 10 and in the insulating shell 19. If the insulating shell 19 is joined equidistantly to the rear shell 10, the respective exhaust outlet opening 13 forms a common exhaust channel.

If the insulating shell 19 shown in the figures, which need not necessarily be provided, is used in the exhaust device 100 according to the invention, additional ventilation openings can be provided, for example, in the rear shell 10 through which fresh air passes for cooling the exhaust device 100. The fresh air cools the insulating shell 19 from its back side facing the rear shell 10. Optionally, any available engine cooling area can be used for cooling the rear shell 10 in which this is guided, for example, at least through the ventilation openings in the rear shell 10. The exhaust outlet opening 13 can likewise be provided with a venturi nozzle whereby fresh ambient air is sucked into the exhaust device 100 to bring about the mixing of the fresh air with the hot exhaust gases.

FIGS. 2a, 2b, 2c and 2d show the exhaust device 100, where the front shell 11 has been removed in the diagram in FIG. 2d in order to show the exhaust device 100 in plan view and to illustrate the geometrical formation of the intermediate shell 15. FIGS. 2a shows the exhaust device 100 in a cross-section so that the rear shell 10, the front shell
11, the exhaust inlet opening 12, the exhaust outlet opening 13, the intermediate shell 15 and the openings 20a, 20b, 20c can be identified. Shown between the intermediate shell 15 and the insulating shell 19 or the rear shell 10 on the left side of the plane of the diagram is the first partial volume 16 which forms the resonator cavity or storage device for the flame resonator. The second partial volume 17 which leads in the direction of the exhaust outlet opening 13, can be seen on the opposite side on the right in the plane of the diagram. The respective first and second partial volumes 16, 17 are formed by the special geometric configuration of the intermediate shell 15, where the boundary of the partial volumes 16, 17 is formed in particular by the cup-shaped inner contour of the intermediate shell 15. Also, it can be clearly seen that the intermediate shell 15 adjoins the insulating shell 19 in the area of the cup base 21.

[0042] FIG. 2b merely shows a plan view of the exhaust device 100 where the median line 18 as shown in FIG. 2a runs centrally through the exhaust device 100 and divides this into a left and a right partial region which are each formed approximately symmetrical with respect to one another. Merely the right partial region comprises the exhaust outlet opening 13.

[0043] FIG. 2c shows the exhaust device 100 in another cross-sectional plane which lies in the plane of the median line 18 according to FIGS. 2a and 2b as well as 2d. Thus, the catalyst 14 can be seen as well as the gap between the rear shell 10 and the insulating shell 19. It is clear that the exhaust gas entering through the exhaust outlet opening 12 passes directly into the cup-shaped recess of the intermediate shell 15 and only passes through the catalyst 14 before then entering into the space between the intermediate shell 15 and the insulating shell 19. Moreover, the openings 20a, 20b, 20c which jointly form the exhaust inlet opening 12 can also be seen from FIG. 2c.

[0044] It is clear in FIG. 2d that the first partial volume 16 is located on the left of the median line 16, the second partial volume 17 being provided on the right. If the exhaust gas now flows through the catalyst 14 into the U-shaped space below the intermediate shell 15, this can either flow directly in the direction of the second partial volume 17 and leave the exhaust device 100 through the exhaust outlet opening 13 whereas when the exhaust gas flows from the catalyst 14 in the direction of the first partial volume 16, the exhaust gas flows into the closed region. Possible flame formations are thereby reduced or made turbulent in such a manner that these cannot escape from the exhaust outlet opening 13.

[0045] It can furthermore be identified that all the radii offer production technology advantages so that the respective shells 10, 11, 15 and 19 can be configured as deep-drawn parts. The shells can either be joined positively holding to their respective edges or by a screw connection to the holes provided close to the exhaust inlet opening 12.

[0046] FIGS. 3a and 3b again show a diagram of the exhaust device 100 where this is in perspective view without showing the front shell 11. Thus, the inner side of the exhaust device 100 can be seen where the upper terminating shell forms the intermediate shell 15. The catalyst 14 is preferably detachably affixed to the intermediate shell 15 where in particular, the cup-shaped recess in the intermediate shell 15 can be identified in FIGS. 3a and 3b. The exhaust inlet opening 12 formed by the openings 20a, 20b and 20c can also be identified. As a result of its depth, the cup base 21 directly adjoins the insulating shell 19, a gap being formed between the cup base 21 and the insulating shell 19 as well as the rear shell 10, as can be seen in FIG. 3a and FIG. 3b.

[0047] The present invention is not restricted in its implementation to the previously specified preferred exemplary embodiment. Rather, a number of variants are feasible which also make use of the solution shown in fundamentally different types of designs.

REFERENCE LIST

[0048] 100 Exhaust device
[0049] 10 Rear shell
[0050] 11 Front shell
[0051] 12 Exhaust inlet opening
[0052] 13 Exhaust outlet opening
[0053] 14 Catalyst
[0054] 15 Intermediate shell
[0055] 16 First partial volume
[0056] 17 Second partial volume
[0057] 18 Median line
[0058] 19 Insulating shell
[0059] 20 Opening
[0060] 21 Cup base
[0061] 22 Spacer sheet

1. An exhaust device for internal-combustion-engine driven small appliances, comprising: a housing which has at least one exhaust inlet opening, at least one exhaust outlet opening, and a flame resonator for suppressing flames emerging from the exhaust device, characterised in that the flame resonator is arranged inside the housing and is configured as a channel-like resonator cavity into which the exhaust gas flows at least partly, whereby flames emerging from the housing can be avoided in the exhaust gas.

2. The exhaust device according to claim 1, characterised in that the housing comprises at least one rear shell and a front shell, which are brought together such that the insides of the shells lie opposite to one another to form the housing.

3. The exhaust device according to claim 2, characterised in that an intermediate shell is arranged between the rear shell and the front shell.

4. The exhaust device according to claim 3, characterised in that a first partial volume between the intermediate shell and the rear shell forms the channel-like resonator cavity, having an opening in one direction only.

5. The exhaust device according to claim 4, characterised in that a first partial volume between the intermediate shell and the front shell forms the channel-like resonator cavity.

6. The exhaust device according to claim 5, characterised in that the exhaust device comprises a catalyst which is arranged inside the housing.

7. The exhaust device according to claim 6, characterised in that the exhaust gas flows through the catalyst into the volume behind the rear shell and the intermediate shell.

8. The exhaust device according to claim 7, characterised in that after leaving the catalyst, the exhaust gas flows in a type of bifurcation either into the first partial volume forming the channel-like resonator cavity or into a second partial volume.

9. The exhaust device according to claim 8, characterised in that the exhaust gas reaches the exhaust outlet opening through the second partial volume.

10. The exhaust device according to claim 8, characterised in that the exhaust device can be divided by a median line which runs geometrically centrally over the housing.
wherein the geometrical configuration of the first partial volume and the second partial volume is approximately symmetrical and extends on each side of the median line.

11. The exhaust device according to claim 10, characterised in that the catalyst is cylindrical and is arranged centrally on the median line between the front shell and the intermediate shell or between the rear shell and the intermediate shell.

12. The exhaust device according to claim 10, characterised in that an insulating shell is provided between the rear shell and the intermediate shell which runs approximately at the same distance from a geometrical formation of the rear shell to form an insulating gap.

13. The exhaust device according to claim 11, characterised in that the insulating shell is arranged between the front shell and the intermediate shell, and runs approximately at the same distance from a geometrical formation of the front shell to form an insulating gap.

14. The exhaust device according to claim 12, characterised in that an insulating compound, in particular glass fibre insulation is incorporated in the insulating gap.

15. The exhaust device according to claim 12, characterised in that the rear shell, the insulating shell and the intermediate shell have a respective opening which jointly form the exhaust inlet opening.

16. The exhaust device according to claim 12, characterised in that the intermediate shell comprises a cup-shaped inner contour with a cup base and said cup base abuts in a plane-parallel manner against the insulating shell.

17. The exhaust device according to claim 16, characterised in that the separation of the first partial volume and the second partial volume is formed by the cup-shaped inner contour of the intermediate shell.

18. The exhaust device according to claim 13, characterised in that a spacer sheet is arranged between the rear shell and the insulating shell in the area of the exhaust inlet opening, wherein the spacer sheet has a thickness according to the insulating gap.

19. The exhaust device according to claim 17, characterised in that a silencer element can be accommodated in the cup-shaped inner contour.

20. A hand-held work machine, in particular chain saw, hedge trimmer, rotary mower or the like, comprising an internal combustion engine and an exhaust device (100) according to claim 1.

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