EXHAUST SYSTEM IN AN IMPLEMENT DRIVEN BY INTERNAL COMBUSTION ENGINE

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ABSTRACT

An exhaust system for an implement, especially hedge clippers, trimmers, brush cutters, chain saws and the like, driven by an internal combustion engine, comprising an exhaust pipe for receiving exhaust gas from the engine, wherein the exhaust pipe has an outlet end opening out into the atmosphere, and a circumferentially extending condensate-guiding element disposed on the internal wall of the exhaust pipe, wherein the condensate-guiding element narrows the flow cross-section of the exhaust pipe.
EXHAUST SYSTEM IN AN IMPLEMENT DRIVEN BY INTERNAL COMBUSTION ENGINE

[0001] The instant application should be granted the priority date of Nov. 26, 2004, the filing date of the corresponding German patent application 10 2004 057 110.4-113.

BACKGROUND OF THE INVENTION

[0002] The invention relates to an exhaust system in a manually operated implement driven by an internal combustion engine.

[0003] Manually operated implements such as hedge trimmers, trimmers, brushcutters, chain saws and similar devices are driven by internal combustion engines which are equipped in standard designs with total-loss lubrication systems. In two-stroke engine designs, in particular, the fuel/air mixture introduced into the engine contains a low lubricating oil content which, after passing through the engine, is discharged into the environment as a fine mist together with the exhaust emissions also created. In addition to the aforementioned oil mist, combustion residues, atmospheric moisture and other similar products may also lead to mist formation, a phenomenon which can also be observed in four-stroke engines.

[0004] It has been shown that the aforementioned substances in the exhaust gas stream tend to form a film of condensate on the internal surfaces of the exhaust system. In certain designs the film of condensate can be observed being transported in the direction of the exhaust gas stream. Condensate is able to collect in the area of the outlet end of the exhaust pipe and then either drip from the outlet end or even run back along the outside of the exhaust pipe towards the engine. This leads to unpleasant fouling which requires the implement to be cleaned frequently.

[0005] The object of the invention is to improve an exhaust system of the aforementioned type in such a manner that the fouling effect is avoided.

[0006] In the proposed exhaust system for an implement driven by an internal combustion engine there is positioned on an internal wall of the exhaust pipe a circumferentially running condensate guide element which narrows the flow cross-section. The position of the circumferentially extending condensate guide element impedes the movement of the film of condensate in the direction of the exhaust gas stream. The condensate guide element extends radially inwardly from the internal wall of the exhaust pipe. Condensate which has collected or been deposited on the walls of the exhaust pipe builds up in this area and is directed radially inwardly. At the same time, because it extends radially inwardly, the circumferential condensate guide element reduces the free flow cross-section. As a result, the speed of the exhaust stream is increased locally. Due to the increased flow speed, condensate which has collected and been directed inwardly is carried along by the exhaust gas stream and discharged into the environment. The condensate is thus prevented from dripping out of the exhaust pipe.

[0007] In an advantageous development the exhaust pipe is connected downstream of a muffler with the condensate guide element being located in a section of the pipe outside the muffler. Hot exhaust emissions do not flow around this section of the exhaust pipe. The comparatively cool environment favors the formation of condensate. The position of the condensate guide element in this area causes the condensate substance to be reintroduced into the exhaust gas flow almost directly at the place of condensate formation.

[0008] The formation of large collections of condensate and the associated risk of droplet formation is reliably avoided.

[0009] The condensate guide element is advantageously positioned in the immediate vicinity and upstream of the outlet end. A renewed condensing and depositing of the condensate substance returned to the exhaust gas stream is eliminated.

[0010] In a preferred version the condensate guide element forms a separation point for the exhaust gas stream in its cross-section. The term “separation point” used here is not limited to an angular edged shape. It covers any aerodynamic shape which narrows the flow cross-section of the exhaust pipe and which, in contrast to a venturi-type design, generates flow separation from the surface with subsequent swirl formation. The flow separation caused by the condensate guide element and the subsequent swirl formation support the effect of the exhaust gas stream as it carries the film of condensate on the walls along with it.

[0011] Swirled droplets of condensate are pushed into the inner area of the exhaust gas stream near the center line which makes it harder for further deposits to occur on the succeeding pipe walls.

[0012] In a useful development the condensate guide element runs in a spiral shape along the internal wall of the exhaust pipe. The spiral shape which extends axially permits a restricted degree of axial movement of the film of condensate deposited on the walls and thus its distribution over the axial length of the condensate guide element. Distributed over its length, the condensate guide element is able to return the deposited condensate to the exhaust gas stream with greater efficiency. Somewhere in the region of two to six spirals inclusive, and in particular a design featuring some four spirals, have proved useful in creating a sufficient flow direction effect at small volumes.

[0013] In an advantageous design the downstream end of the condensate guide element is located in the area of a center line of the exhaust pipe. Residual condensate which has not been returned the length of the condensate guide element into the exhaust gas stream, runs in the direction of flow of the exhaust gas along the condensate guide element to its downstream end. Here it is located in the area of the center line where it can be better removed from the exhaust gas stream and discharged. The formation of condensate residues is avoided.

[0014] In a useful version the condensate guide element is designed as a spiral-shaped wire spring. The circular shape of the wire cross-section has proved effective both in collecting the stream of deposited condensate and in directing the flow of the exhaust gas stream and forming swirls. These advantageous effects are matched by a simple and cost-effective design.

[0015] The upstream end of the wire spring is preferably bent radially inwardly. The inwardly bent wire end can easily be used as an assembly aid. At the same time, the end of the wire which projects into the flow cross-section helps to form swirls and thus to improve the reabsorption of the condensate.
In an advantageous design the wire spring is held pre-tensioned radially in the exhaust pipe. In addition to reliable positioning, this radial pre-tensioning also ensures the application of a radial force pushing the spring and the internal wall together. A sealing effect can be observed in this area. The film of condensate is unable to creep between the wire spring and the pipe wall. In fact, it is diverted radially inwardly around the wire cross-section of the wire spring where optimum conditions for reintroduction into the exhaust gas stream prevail.

Embodiments of the invention are explained in greater detail below with reference to the schematic drawings, in which:

FIG. 1 shows an overview of a manually operated implement based on the example of hedge clippers with an exhaust system illustrated in the form of a block diagram;

FIG. 2 shows a perspective, transparent view of the exhaust pipe of the arrangement illustrated in FIG. 1 with details of the condensate guide element positioned therein;

FIG. 3 shows a section through an enlarged schematic view of the flow conditions in the area of the wire cross-section of the condensate guide element in the arrangement illustrated in FIG. 2;

FIG. 4 shows a perspective, detailed view of the condensate guide element as illustrated in FIG. 2 in the form of a wire spring; and

FIG. 5 shows a variant of the wire spring illustrated in FIG. 4 with one end drawn into the area of the center line.

FIG. 1 shows a perspective view of a manually operated implement based on the example of hedge clippers which is driven by an internal combustion engine (1). Instead of hedge clippers, the implement in question might also be a brush cutter, a parting-off grinder or a chain saw, for example.

The internal combustion engine (1), which is not illustrated in greater detail, is held in a housing (17) and is almost completely covered by the housing (17). All that can be seen of the internal combustion engine (1) in the view shown here is a spark plug connector (20) and a crank handle (19) for starting the internal combustion engine (1).

A front handle (15) and a rear handle (16) are provided for guiding the hedge clippers by means of which a shearing blade (18) driven by the internal combustion engine (1) can be guided along the foliage to be cut.

In the embodiment shown, the internal combustion engine (1) is a two-stroke internal combustion engine with total-loss lubrication in which a portion of lubricating oil is mixed with the fuel for operation. It is also possible to provide separate lubrication with a separate lubricant reservoir and an at least approximately loss-free lubrication system, in a four-stroke engine, for example.

The exhaust emissions created when the internal combustion engine is in operation are discharged into the environment by an exhaust system which is covered by the housing (17) and indicated in the illustrated by means of a block diagram. For this purpose, the exhaust system comprises a muffler (7) downstream of which is connected an exhaust pipe (2). A stream of exhaust gas indicated by means of an arrow (3) passes through first the muffler (7) and then the exhaust pipe (2) until it discharges into the environment at the free outlet end (4) of the exhaust pipe (2). In order to create the flow-conducting connection, an inner pipe section (9) of the exhaust pipe (2) projects into the muffler (7). A pipe section (8) of the exhaust pipe (2) positioned downstream of this runs outside the housing of the muffler (7). Positioned in the outer pipe section (8) in the immediately vicinity and upstream of the outlet end (4) is a condensate guide or condensate-guiding element (6) which is described in greater detail below.

The exhaust pipe (2) shown in FIG. 1 is illustrated in an enlarged and transparent form in FIG. 2. The exhaust pipe (2) has a circular cross-section and runs along a center line (12). Positioned at the outlet end (4) is the condensate guide element (6) which is designed as a spiral shaped or helical wire spring (14) in the embodiment shown. The spiral-shaped wire spring (14) or coil spring is inserted radially pre-tensioned to the free end of the exhaust pipe (2) near the outlet end (4). Due to the radial pre-tensioning force, the wire spring is fixed in position in both a frictional and positive fit and conforms to the internal wall (5) of the exhaust pipe (2) on the inside. The exhaust pipe (2) is also provided with an axial retainer (21) at the outlet end (4) to fix the position of the wire spring (14) axially.

Upstream of the condensate guide element (6), the exhaust pipe (2) provides the exhaust gas stream (3) with an undisturbed, circular flow cross-section. This flow cross-section is narrowed several times circumferentially and radially inwardly by the wire spring (14) which rises up from the internal wall (5).

The flow conditions at the condensate guide element are shown in an enlarged, schematic view in FIG. 3. The circular cross-section of a wire (22) of the wire spring (14) (FIG. 2) is pressed against the internal wall (5) of the exhaust pipe (2). The course of the exhaust gas stream (3) is shown by means of flow lines. In the interests of clarity only two (27) of these flow lines, located near the wall, are shown in the drawing. A film of condensate (23) has formed on the internal wall (5) upstream of the wire (22). Due to the interaction with the exhaust gas stream (3) and in some cases under the effect of gravity, the film of condensate (23) endeavors to migrate in the direction of the exhaust stream (3) towards the outlet end (4) (FIG. 2). The view shown in FIG. 3 illustrates how as a result the film of condensate (23) builds up upstream of the wire (22) and is directed away from the internal wall (5) towards the center line (12) by the condensate guide element (6) (FIG. 2).

The aerodynamic shape selected for the circular cross-section of the wire (22) causes a break in the laminar flow of the exhaust gas stream (3). Downstream of the maximum distance to the internal wall (5), a separation point (26) is formed after which the flow separates off from the surface of the condensate guide element (6) and the subsequent section of the internal wall (5). Thus the swirls (25) indicated are formed. Once a significant portion at least of the exhaust gas stream (3) close to the wall downstream of the condensate guide element (6) has formed swirls, the separation point (26) formed in relation to the cross-section of the wire (22) manifests itself as a separation line along the length of the wire material. Instead of the circular cross-section of the wire (22) shown, other, for example angular,
cross-sectional shapes may be useful for the formation of an aerodynamic separation point (26).

[0032] The narrowing of the free flow cross-section due to the condensate guide element (6) causes a local acceleration of the exhaust gas stream (3) which is shown in the illustration by means of the decreasing distance between the flow lines (27) and which reaches its maximum value somewhere in the area of the maximum radial lifting or elevation of the condensate guide element (6) from the internal wall (5). The exhaust gas flow (3) and/or the weight direct the film of condensate (23) around the cross-section of the wire (22) into the aforementioned area. Here the high flow speed in conjunction with the separated swirls (25) lead to the break-up of the film of condensate (23) into individual drops (24) which are carried along by the exhaust gas flow (3) before they have a chance to precipitate out on the internal wall (5) again. The separation point (26) and the drops (24) are positioned a certain radial distance from the internal wall (5) which helps to avoid renewed deposit formation.

[0033] FIG. 4 shows an individual, perspective view of the wire spring (14) illustrated in FIG. 2. The wire spring (14) usefully comprises some two to six screw-like spirals (10). The embodiment shown illustrates a spiral (14) with slightly more than four turns. The wire spring (14) is also curved radially inwardly at its upstream end (13) as a result of which the end (13) projects inwardly into the flow cross-section of the exhaust gas flow (3) (FIG. 2).

[0034] A variant of the wire spring (14) shown in FIG. 4 is illustrated in FIG. 5. Its downstream end (11), seen in the direction of flow of the exhaust gas stream (3) (FIG. 3), runs from the section of the spiral (10) at the circumference radially inwardly as far as a longitudinal axis (28) of the wire spring (14). There the downstream end (11) is bent in the direction of the longitudinal axis (28). When installed, the spirals (10) run in a spiral against the internal wall (5) of the exhaust pipe (2), as is also the case in the embodiment illustrated in FIGS. 2 and 4. Here the longitudinal axis (28) coincides with the center line (12) of the exhaust pipe (2) (FIG. 2). The downstream end (11) of the wire spring (14) thus lies at least approximately on the center line (12) of the exhaust pipe (2) or in the center of the flow cross-section of the exhaust gas stream (3). The embodiment illustrated in FIG. 5 corresponds to that shown in FIG. 4 in so far as all the other features and reference numerals are concerned.

[0035] In the embodiments illustrated here the condensate guide element (6) is designed as a spiral-shaped wire spring (14). A metal strip, a contoured exhaust pipe (2) wall or comparable other designs may also be advantageous. Instead of a spiral-shaped course, an annular aperture-like design may also be useful, it also being possible to positioned several circular disks one after another in a cascade.


[0037] The present invention is, of course, in no way restricted to the specific disclosure of the specification and drawings, but also encompasses any modifications within the scope of the appended claims.

We claim:

1. An exhaust system for an implement driven by an internal combustion engine, comprising:
   - an exhaust pipe adapted to receive exhaust gas from said internal combustion engine, wherein said exhaust pipe has an outlet end that is adapted to open out into the atmosphere; and
   - a circumferentially extending condensate-guiding element disposed on an internal wall of said exhaust pipe, wherein said condensate-guiding element is adapted to narrow a flow cross-section of said exhaust pipe.

2. An exhaust system according to claim 1, wherein said exhaust pipe is disposed downstream of, and in communication with, a muffler, and wherein said condensate-guiding element is disposed in a pipe section of said exhaust pipe that is disposed externally of said muffler.

3. An exhaust system according to claim 1, wherein said condensate-guiding element is disposed in the immediate vicinity of, and upstream of, said outlet end.

4. An exhaust system according to claim 1, wherein a cross-section of said condensate-guiding element forms a separation point for said exhaust gas.

5. An exhaust system according to claim 1, wherein said condensate-guiding element extends helically along said internal wall of said exhaust pipe.

6. An exhaust system according to claim 5, wherein said condensate-guiding element has about two to six spirals.

7. An exhaust system according to claim 6, wherein said condensate-guiding element has about four spirals.

8. An exhaust system according to claim 5, wherein a downstream end of said condensate-guiding element is guided in the vicinity of a center line of said exhaust pipe.

9. An exhaust system according to claim 5, wherein said condensate-guiding element is a helical wire spring.

10. An exhaust system according to claim 9, wherein an upstream end of said wire spring is bent radially inwardly.

An exhaust system according to claim 9, wherein said wire spring is held in said exhaust pipe in a radially pre-tensioned manner.

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