United States Patent [19]

Raudman, Jr. et al.

[54] EXHAUST SILENCER FOR INTERNAL COMBUSTION ENGINE

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Related U.S. Application Data

- [63] Continuation-in-part of Ser. No. 240,633, April 3, 1972, abandoned.
- [51] Int. Cl...... F01n 1/04 [58] Field of Search...... 181/36 C, 41, 42, 47 R,
- 181/49, 50, 57, 58, 60–62, 65, 71; 55/276

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[11] **3,863,733**

[45] Feb. 4, 1975

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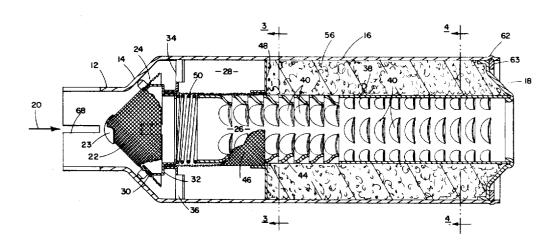
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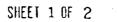
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[57] ABSTRACT

A tubular core member is mounted within a cylindrical housing, the housing being adapted to receive the exhaust stream of an internal combustion engine. The core member has a plurality of inwardly extending louvers formed along the longitudinal extent thereof and extending circumferentially thereabout. The louver openings face towards the direction of flow of the exhaust stream (i.e., towards the exhaust outlet of the silencer), the louvers having curved surfaces which are tapered in the direction from which the exhaust stream flows. A soft cushion pack of sound absorbing material is disposed in at least a part of the space between the core and the housing. The curved tapered surfaces of the louvers operate to shape the sound waves so as to cause attenuation of the sound energy.

8 Claims, 5 Drawing Figures





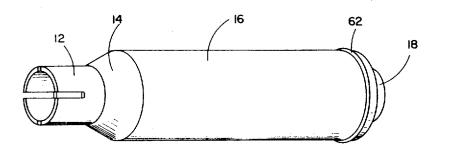
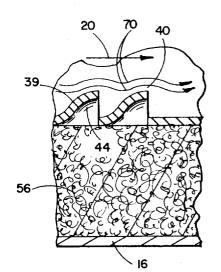


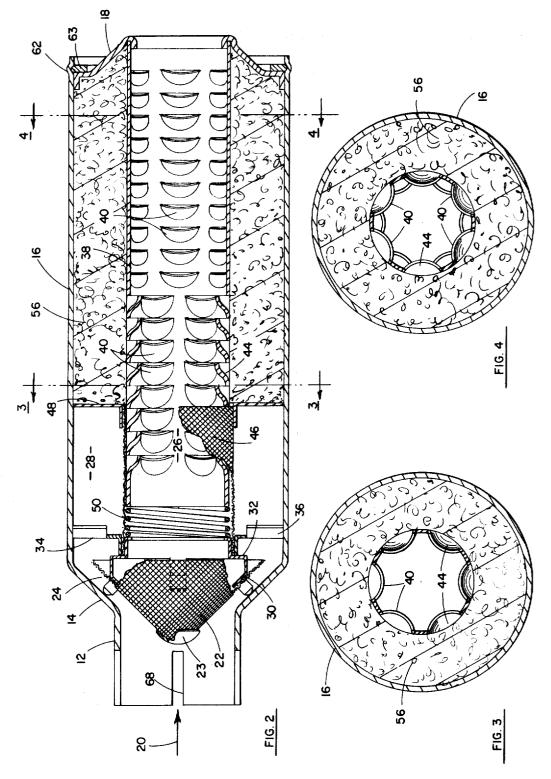
FIG. 1





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SHEET 2 OF 2



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EXHAUST SILENCER FOR INTERNAL COMBUSTION ENGINE

This application is a continuation in part of our Application Ser. No. 240,633, filed Apr. 3, 1972, and now abandoned.

There is presently a great need for engine exhaust silencers or mufflers (particularly for small engines of the type used on motorcycles, chain saws, snowmobiles, etc.), which have good silencing action but at the same time do not significantly decrease the efficiency 10 of engine operation. A further requirement for engines to be utilized in forest land and other fire hazard areas is that they effectively arrest sparks. Mufflers for utilization on small engines should also preferably be relatively small in size so that they can be readily mounted 15 in place without taking up undue space.

One approach which has been used in certain prior art devices such as described in U.S. Pat. No. 3,522,863 to Ignoffo, and Swiss Pat. No. 274,724 to Lustenberger, is to use a centrally located core member having a plurality of inwardly extending projections which form scoops or louvers. In these prior art devices, the openings of the louvers face in the direction from which the exhaust gas is flowing, with the gas 25 flowing directly through these openings into the surrounding space between the housing and the core. Further, the surfaces of these louvers are generally shaped in a flat configuration.

The device of the present invention provides a substantial improvement in operation over the aforementioned prior art devices by providing louvers with openings which face in the direction of the exhaust gas flow (i.e., towards the exhaust outlet of the device) and back surfaces which have a curved taper in the direction from which the exhaust gas is flowing, such as to shape the sound wave in a manner whereby substantial attenuation of such waves is achieved.

It is therefore an object of this invention to provide an exhaust silencer utilizing a louvered core which ⁴⁰ shapes the sound waves of the exhaust in a manner such as to highly attenuate such waves.

It is a further object of this invention to provide an improved silencer of economic construction which can readily be disassembled for repair and cleaning. 45

Other objects of this invention will become apparent as the description proceeds in connection with the accompanying drawings, of which:

FIG. 1 is a perspective view illustrating one embodiment of the invention;

FIG. 2 is a cross-sectional view of the embodiment of FIG. 1;

FIG. 3 is a cross-sectional view taken along the plane indicated by 3-3 in FIG. 2;

FIG. 4 is a cross-sectional view taken along the plane ⁵⁵ indicated by 4-4 in FIG. 2; and

FIG. 5 is a cross-sectional view illustrating the operation of the louvers in the illustrative embodiment.

Briefly described, the device of the invention is as follows: A cylindrical housing is adapted to be connected to receive the exhaust stream from an internal combustion engine. Mounted in the housing in internal concentricity therewith is an open ended tubular core of solid heat resistant material, there being an open space formed between the outer wall of the core and the inner wall of the housing. Disposed in at least a portion of this space is a soft cushion pack of sound absorbing

material. A generally conically shaped screen is mounted on the end of the core facing towards the exhaust stream for deflecting particles in the stream which are greater than a predetermined size. These larger particles are passed into an annular chamber where they are rotated to cause breakdown thereof into smaller sizes and these broken down particles are then passed into the central portion of the core. The core has a plurality of inwardly extending louvers formed therein, these louvers extending along the longitudinal extent of the core and circumferentially thereabout. In the illustrative embodiment, the louvers are arranged in two sets, the louvers of each set being in rows with the rows of one set of louvers being circumferentially offset from the rows of the other set thereof. The openings of the louvers face towards the direction of the flow of the exhaust stream, with the back surfaces of such louvers being curved and tapered in the direction from which the exhaust stream flows into the unit; the curved tapered surfaces of the louvers operating to shape the sound waves so as to cause the attenuation of the sound energy.

Referring initially to FIG. 1, there is shown a muffler in accordance herewith which is generally embodied in a somewhat cylindrical housing defining an intake passage 12 adapted to be connected to receive an exhaust stream from an internal combustion engine. The passage 12 terminates at a truncated conical section 14, providing a transition to the major cylindrical portion 16 of the housing. At the opposed rear end (right) the cylindrical portion 16 of the housing receives an end cap member 18 affording a partial closure, and through which the exhaust stream passes. Generally, the structure as represented may be embodied in a relatively small size unit, e.g., under one cycle, and may also include a spark arrester.

Considering the unit hereof in somewhat greater detail, an exhaust stream as represented by an arrow 20 (FIG. 2) is received through the passage 12 to impinge upon a somewhat conical or concave-convex screen 22. The screen 22 may be of stainless steel, e.g., twenty mesh woven, and has a somewhat hemispherical cap 23 of solid metal affixed at the external peak as by welding.

The screen 22 is spaced apart from, though matingly aligned with the conical section 14 of the housing to provide a somewhat conical, annular passage 24 therebetween. In general, the screen 22 functions to pass the major portion of the exhaust stream for flow through muffler section 26, while deflecting a fragment of the stream and those particles of greater size than the screen mesh, to cause such larger particles to flow radially through the passage 24, and ultimately into an annular space 28, in which the particles may be broken down to a safe size and passed to the muffler section 26 for release from the unit.

The screen 22 is supported by four turned-back radial arms 30 of a spider 32 affixed thereto. The spider is in turn affixed to a cylindrical screen 46 and an annular collector ring 34 which is a flat circular section with raised vanes 36, snugly fitted between the cylindrical portion 16 of the housing and the cylindrical screen 46.

The collector ring 34 defines the forward wall of the annular space 28, the rear wall of which is defined by an annular closed arrester plate 48. The collector ring 34 and the arrester plate 48 are concentrically mounted about the cylindrical screen 46 which in turn coaxially receives a coil spring 50 and the forward end of the core 38.

The core 38 is of cylindrical or tubular configuration and may comprise high-temperature resistant material, e.g., metal. Rows or louvers 40 are defined in the core 5 38, having curved surfaces 39 which are tapered in a direction opposite to the gas flow direction (arrow 20), and openings 44 facing towards the gas flow direction (i.e., towards the exhaust outlet). The louvers 40, as indicated, are arranged in rows, which are circumferen- 10 tially offset from each other. In the specific embodiment shown, the length of the core 38 is divided into two approximately half sections, with each half section defining six equally-spaced rows of louvers 40 about its circumference; with the rows in each half section offset 15 from the other half to provide a balanced overlap.

The core 38 is provided radial support within the housing by means of arrester plate 48, cap member 18 and cushion pack 56. Axial support is provided by the coil spring 50 fitted between the spider 30 and the core 20 38. Thus, the core is resiliently held against vibratory motion within a cushion pack 56 which is of annular configuration and may comprise glass wool, fibers or other sound-absorbing material.

The pack 56 essentially fills a portion of the annular 25 space between the core 38 and the internal wall of the cylindrical portion 16, while being held at its ends by the arrester plate 48 and end cap member 18. Each cap member 18 is open ended and is held in position by a retaining ring 63 that is flexed into an annular inside 30groove 62 defined at the termination of the cylindrical portion 16. The end cap member 18 concentrically receives the core 38 and provides an internal shoulder for mating engagement therewith.

In view of the above preliminary structural descrip- 35 cushion pack 56 may be replaced. tion of an embodiment of the invention, a complete understanding thereof may now best be achieved by the following explanation of its operation. The unit as depicted in the figures is connected to a duct to receive the exhaust stream from an internal combustion en- 40 gine, including gaseous products of combustion and hot particles (usually carbon). It is to be noted that the passage 12 has slots 68 formed therein to facilitate clamping engagement with the duct.

herein will usually be pulsating, as from a two-cycle engine. It is to be noted in such an application that, to some extent, flow exists in both directions and additionally that by appropriately matching the exhaust sys-50 tem to the engine, engine performance can be improved. Such opposed pressure patterns developed within an exhaust unit impede the free flow of exhaust gases, thereby reducing engine performance and additionally creating shock waves which account to a large 55 extent for noise from the exhaust system.

The pulsating exhaust stream which is received through the passage 12 initially impinges upon the convex forward surface of the screen 22 (FIG. 2). It is to be noted that the cap 23 receives the most directly im-60 pinging particles which are deflected into the passage 24. Consequently the screen life is prolonged considerably.

Generally, the gaseous products of combustion and small particles that pass through the screen 22 are re-65 ceived in the open chamber 26 of the core 38 and flow substantially unimpeded from the unit. Larger particles (along with a small portion of the stream) pass across

the surface of the screen 22 along the passages 24, then flow through the collector ring 34 (under the vanes 36) and thereby enter the annular space 28. The vanes 36 generally impart a rotary or circumferential flow pattern to the portion of the stream entering the space 28 with the result that particles therein are subjected to considerable turbulence. Generally, that turbulence tends to break down the particles to a smaller size so that they may flow through the cylindrical screen 46 to enter the core 38 through an adjacent louver opening 44.

Referring now to FIG. 5, the operation of the muffler section 26 is illustrated. It is first to be noted that the openings 44 of louvers 40 all face towards the direction of the gas flow (as indicated by arrow 20). It is further to be noted that the surfaces 39 of the louvers are curved and tapered in the direction from which the gas is flowing. The tapered curved louvers operate to create a generally sinusoidally shaped shock wave as indicated by arrows 70. The louvers thus effectively operate as venturis, creating a low pressure barrier which tends to attenuate the sound energy. Further, the offsetting of the louvers in the rear half of the unit from those in the front half tends to cause phase interference between the sound waves which tends to further attenuate the sound energy.

During the operation of the unit as described above, the force of the spring 50 serves to avoid vibrations which might otherwise occur within the unit. Additionally, the internal components of the unit are readily removable simply by removing the ring 63 and withdrawing the internal components. In that manner, the core 38 may be removed and cleaned and on occasion, the

In the construction of the unit, the housing incorporating the passage 12, the section 14 and the cylindrical portion 16 may be formed of aluminum, utilizing impact extrusion techniques, to provide a lightweight rugged housing. As indicated, the screens 22 and 46 may be formed of stainless steel and in that regard, any of a variety of forming techniques may be used to achieve the cylindrical and conical shapes.

The core 38, as indicated above, may be formed from The exhaust stream applied to the unit as disclosed ⁴⁵ a tube. Specifically for example, the louvers **40** may be punch cut, as well known in the art, to provide the specific desired pattern. The pack 56 may simply take the form of a single loop of glass fiber material.

> The assembly of the unit may be performed by first inserting the modular unit 51 into the cylindrical portion 16 in mating concentric relationship therewith. Thereafter, the spring 50 may be dropped in place along with the core 38 and the pack 56. Finally, closure member 18 is set in place by means of ring 63. Assembly is thus complete and the unit may be placed in use by mounting it to receive an exhaust stream.

> While the device of the invention has been described and illustrated in detail, it is to be clearly understood that this is intended by way of illustration and exmaple only and is not to be taken by way of limitation, the spirit and scope of the invention being limited only by the terms of the following claims.

We claim:

1. An exhaust silencer for receiving an exhaust stream from a combustion engine comprising:

a housing adapted to be connected to receive said exhaust stream:

- an open ended core mounted in said housing with an open space formed between the outer wall of the core and the inner wall of the housing, said space including first and second portions, said second space portion having a substantially greater longi-5 tudinal extent than said first portion, said core having a plurality of inwardly extending louvers formed along the longitudinal extent of said core and circumferentially thereabout, the openings of all of said louvers facing towards the direction of 10 flow of said exhaust stream, said louvers having curved surfaces tapered in the direction from which said exhaust stream flows; and
- sound absorbing material substantially filling only said second space portion, thereby impeding the 15 flow of gas through the louvers to said second portion:
- the curved tapered surfaces of said louvers operating to shape the sound waves so as to create a low pressure barrier which tends to attenuate the sound en- 20 ergy

2. The silencer of claim 1 wherein said louvers are arranged in two sets, each set encompassing substantially one half of the surface of said core, the louvers of each set thereof being arranged in rows spaced substantially 25 ing the broken down particles into said core comprises equally around the circumference of the core and running substantially parallel to the longitudinal axis of said core, the rows of one set being circumferentially

offset from the rows of the other set. 3. The silencer of claim 1 wherein said housing is cylindrical and said core is tubular.

4. The silencer of claim 1 and further including a generally conically shaped screen mounted on the end of said core facing towards said exhaust stream for deflecting particles in the stream greater than a predetermined size, means for breaking said particles to a lesser size and means for passing the broken down particles into said core.

5. The silencer of claim 5 wherein said means for breaking said particles comprises an annular chamber formed between said core and said housing, said particles being passed from said screen to said chamber and rotated therein to cause breakdown of the particles.

6. The silencer of claim 5 and further comprising a cap of solid metal affixed to the apex of said conical screen, said cap operating to attenuate the sound energy in the exhaust stream.

7. The silencer of claim 1 and further comprising spring means for resiliently retaining said core in said housing.

8. The silencer of claim 4 wherein the means for passa cylindrical screen mounted on said core on the portions thereof facing said annular chamber.

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