April 22, 1941. A. S. CHIPLEY 2,239,549

SILENCING DEVICE FOR PULSATING GASES

Filed March 4, 1940 2 Sheets-Sheet 1

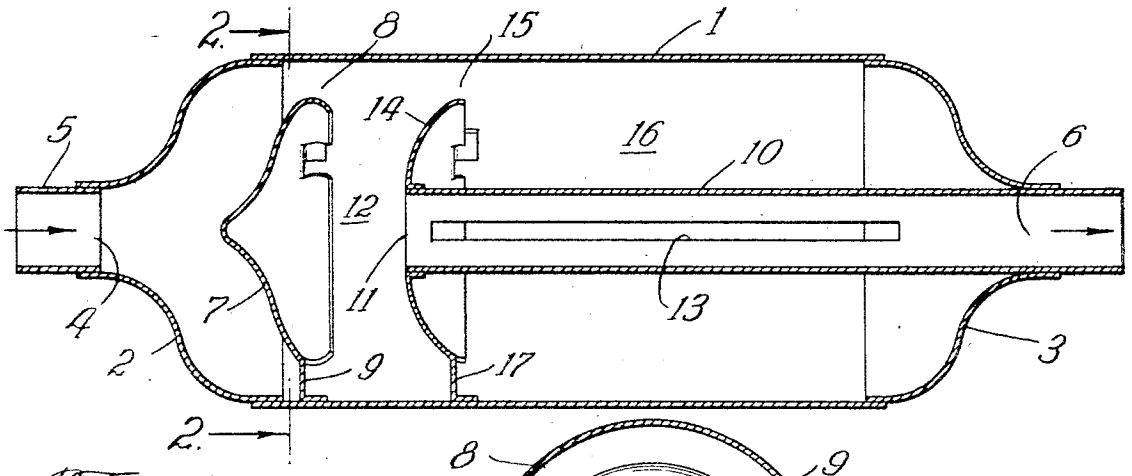


Fig. 1.

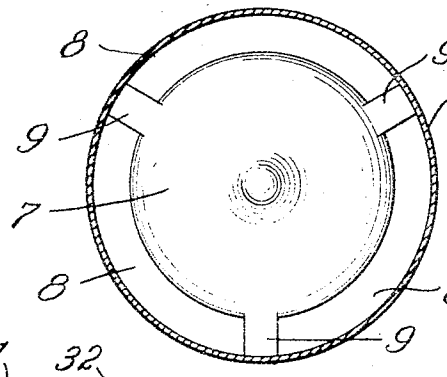


Fig. 2.

Fig. 3.

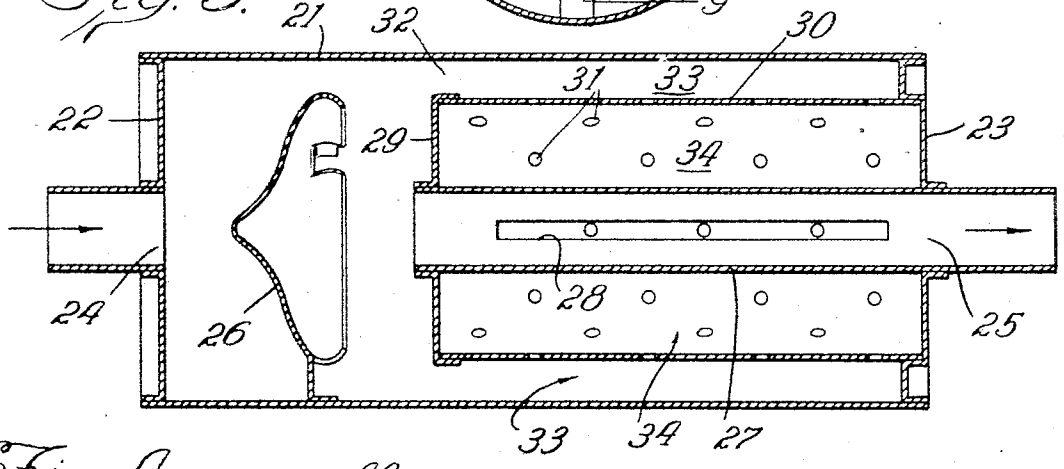
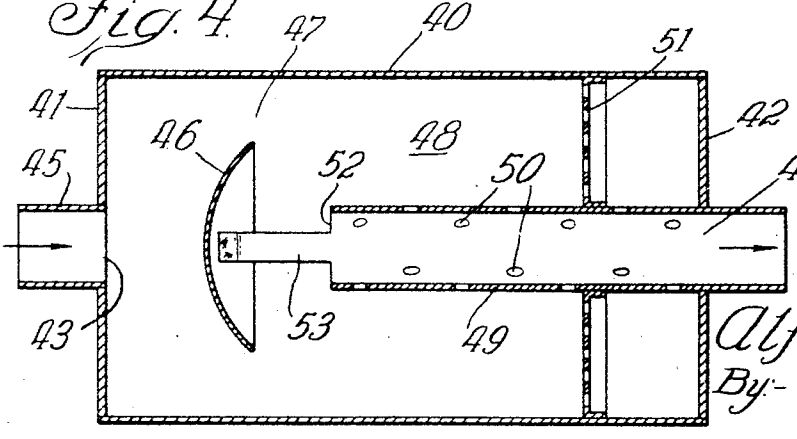


Fig. 4.



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SILENCING DEVICE FOR PULSATING GASES

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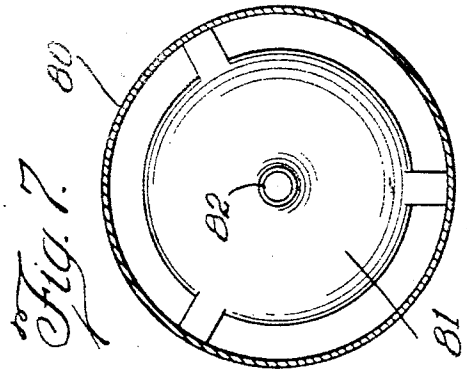


Fig. 7.

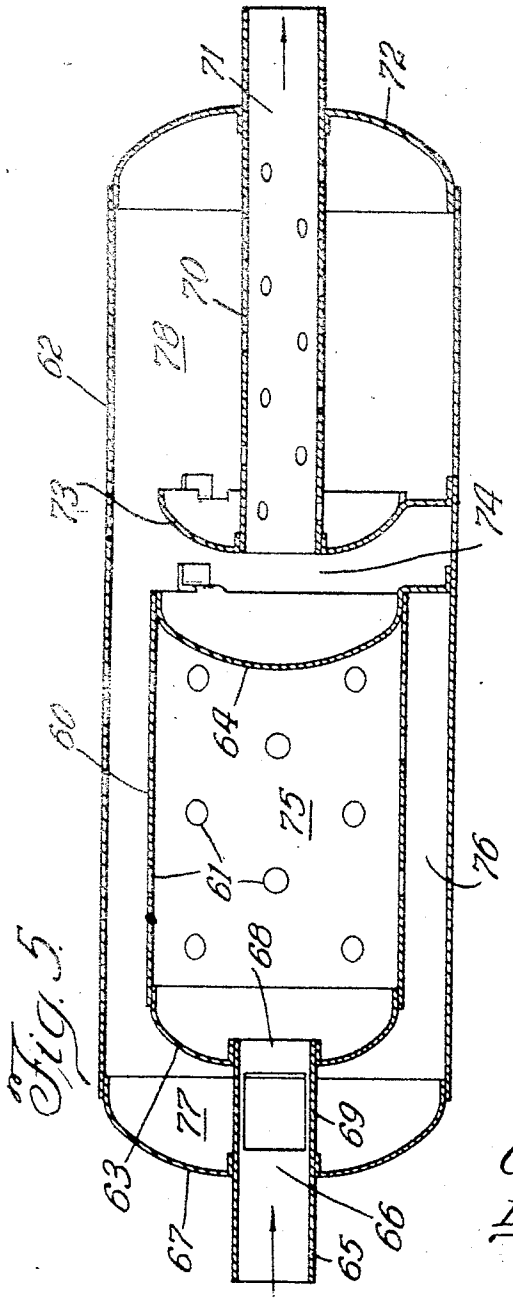


Fig. 5.

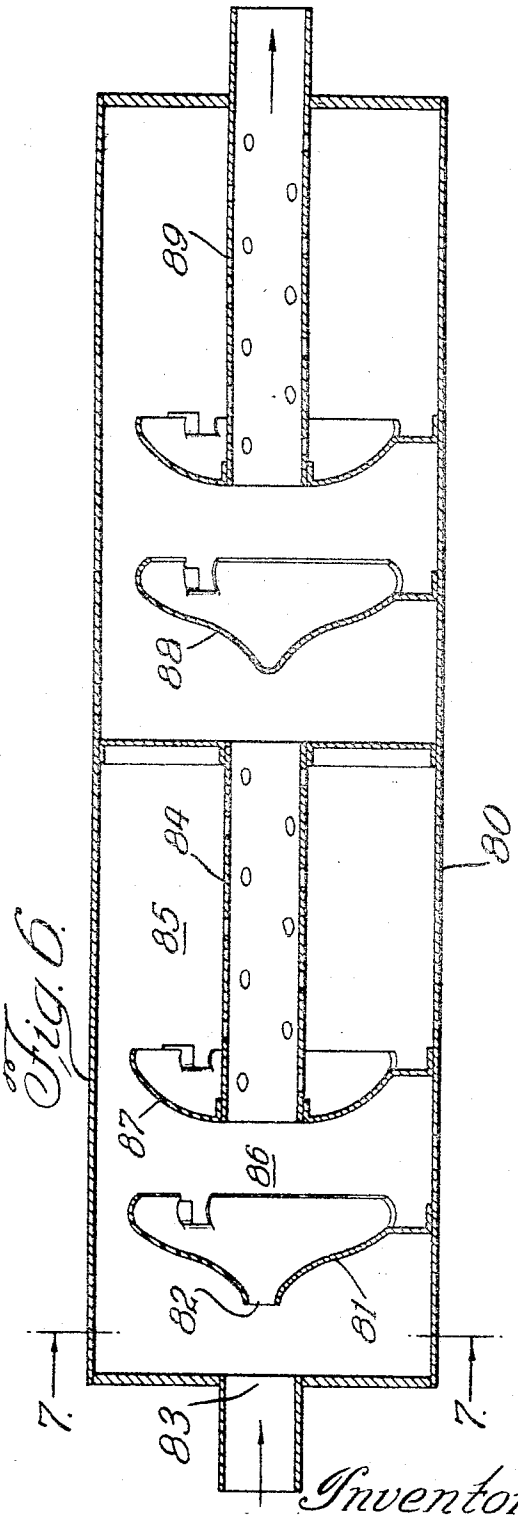


Fig. 6.

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Patented Apr. 22, 1941

2,239,549

UNITED STATES PATENT OFFICE

2,239,549

SILENCING DEVICE FOR PULSATING GASES

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Application March 4, 1940, Serial No. 322,085

11 Claims. (Cl. 181—57)

This invention relates to devices used for the prevention of noise caused by flowing, pulsating gases, such as the exhaust gases of internal combustion engines, or, as the terms are loosely used, to mufflers and silencers for such pulsating gas systems.

This application is a continuation in part of Alfred S. Chipley copending application Serial No. 271,031, filed May 1, 1939, now Patent 2,205,899, granted June 25, 1940.

Although the invention is useful for the prevention of noise caused by pulsating gases generally, including, for example, the intake and delivery of air compressors, the most severe conditions are met in the prevention of noise caused by the exhaust of internal combustion engines and for this reason the invention will be illustrated and described as applied to this particular problem.

A considerable variety of silencer constructions have been used and are now in use in coping with the problem of preventing or reducing to a minimum the noise attendant upon the operation of internal combustion engines. These various forms of apparatus operate on divers principles and are grounded on as many different conceptions of the causes of noise. A particular silencer may, for example, be of the baffle, resonator, three-pass, two-pass, expansion chamber, or "pack" type, in simple or compound form, or it may embody a combination of two or more of these well-known types of apparatus. The object of combining the different forms of apparatus is to take advantage of the characteristics peculiar to each and thus obtain a device having the desired silencing characteristics. The resultant product of such a combination contains a plurality of classifiable "silencing sections." This expression will be used herein to denote a unit (which may be only a part of the complete silencer) of one of the forms of silencing apparatus, such as those enumerated above.

A new type of noise-preventing device, known as the "snubber," has recently been developed and commercially used. This device is fully described in Ralph L. Leadbetter Letters Patent Nos. 2,189,423 and 2,189,424, both dated February 6, 1940. As therein more fully disclosed, the snubber comprises a snubber tube into which the exhaust gases are projected at high velocity from the exhaust ports of the engine, an unconstricted shunt or by-pass passageway being provided around the snubber tube from the inlet to the outlet of the device. The snubber may be used as the silencer itself or a snubbing section may be employed in combination with other types of silencing sections in the building up of a composite device designed to accomplish a specified function with the desired degree of perfection. The snubber operates on a gas-inertia principle and, although it differs in operation from most of the other types of mufflers and silencers in that it operates to modify the gas "slug" pressure-velocity peaks and thus remove the primary cause of noise rather than to merely suppress the noise after it has been generated or minimize secondary reverberation in the exhaust system, it may be loosely referred to as a muffler or silencer.

The snubber tube of a snubber type of silencer is generally in the form of a perforated sheet metal member. It has been found that under certain circumstances, for example, when the device is used with a Diesel engine, especially one of the low speed, low pressure type, solid materials carried by the exhaust gases stick to the inside surface of the snubber tube and cause an accumulation of tarry deposits. This material may in time plug the perforations and deprive the silencer of its ability to effectively snub the exhaust slugs. Accordingly, one object of the invention disclosed in the copending application above referred to was to obviate the possibility of plugging of the snubber tube of a snubber type of silencer, or a snubber section thereof. A further object was to simplify this type of apparatus and to thereby reduce the cost of the device without at the same time sacrificing its high silencing efficiency or depriving it of other desirable characteristics. Means for achieving these ends are fully disclosed in said application.

An object of the present invention is to provide a silencing section of the snubber type in which the inlet and outlet of the section are concentric with respect to the outer shell of the device.

In the accompanying drawings

Fig. 1 is a longitudinal, sectional view of a simple embodiment of the invention;

Fig. 2 is a transverse, sectional view taken at the line 2—2 of Fig. 1;

Figs. 3, 4, 5, and 6 are longitudinal, sectional views of further embodiments of the invention; and

Fig. 7 is a transverse, sectional view taken at the line 7—7 of Fig. 6.

Referring specifically to Fig. 1, this unit is enclosed within a shell including side walls 1, preferably of circular cross section, and end closures 2 and 3. An inlet opening 4 is provided in inlet-end closure 2 and an inlet snout 5 may be mounted in the closure member at inlet opening

4 for convenience in mounting the silencer in the exhaust system of the engine. Opening 4 and snout 5 are disposed substantially concentrically in inlet-end closure 2 with respect to the shell walls 1. An outlet opening 6 is provided concentrically in outlet-end closure 3.

A transverse baffle 7 is disposed in alignment with the gaseous stream which enters the unit through inlet opening 4 as indicated by the arrow. This baffle is preferably generally conical in shape, as shown in the drawing, and is arranged with its apex pointing upstream. Plane, semispherical, or baffles having other shapes may be used. The baffles 7 does not span the entire cross section of the shell interior, an annular opening 8 being left between the baffle and shell walls 1 for the flow of gases. Three or four legs 9 may be formed in the manufacture of baffle 7 as a convenient means for mounting it within shell 1.

An outlet tube 10 extends through outlet opening 6 toward baffle 7. This tube terminates short of the baffle to provide a free passageway for gases passing through the annulus 8 into by-pass zone 12 and directly into the open end 11 of tube 10. The latter is slotted, as indicated at 13, or otherwise apertured to a limited extent. A plurality of short slots, perforations or openings of any other nature may be used in place of the slot shown. A partition 14 extends radially from outlet tube 10 at its open end 11. This partition is substantially coextensive with baffle 7, leaving an annular opening 15 between it and shell 1 in alignment with opening 8. It may be flat but is preferably somewhat dished and lipped at its edges, as shown, to prevent ringing of this member and to prevent "edge noise" due to the rush of gases past the partition through opening 15 into chamber 16. If support of partition 14 and outlet tube 10, other than that furnished by outlet-end closure 3, is desired, legs 17 may be formed integrally with partition 14 or separate mounting members may be used for this purpose.

In the operation of this device, the exhaust gases comprising pulsations or slugs traveling at high velocity followed by the slower moving tailings are projected toward baffle 7 within the unit. The stream is spread radially by the baffle and caused to flow through annular opening 8 toward openings 15. The slugs or portion of the gases having sufficient inertia to carry them over the distance between baffle 7 and partition 14 pass through opening 15 and into chamber 16. The energy of these rapidly traveling gases is transformed into static form by the building up of a pressure in chamber 16. This pressure condition is dissipated by leakage of the gases from chamber 16 into outlet tube 10 through slot 13. These gases are then exhausted from the unit through outlet opening 6.

The tailings passing through opening 8, lacking sufficient inertia to jump the gap between baffle 7 and partition 14, by-pass directly to outlet tube 10, entering this tube through open end 11. This path is the one of least resistance since it is not constricted as is the alternative passageway through chamber 16 in which the apertured walls of outlet tube 10 offer an impedance to the free flow of gases from chamber 16 into the tube. It is for this reason that the gases by-pass chamber 16 unless driven into this chamber by virtue of their own inertia. The recombined gases pass from the unit through outlet opening 6 and are exhausted to the atmosphere in a relatively smoothly flowing stream.

A device embodying a slightly modified form of the invention is shown in Fig. 3. This device is housed within a shell 21 having inlet- and outlet-end headers 22 and 23. Shell 21 is preferably cylindrical and inlet and outlet openings 24 and 25, respectively, are provided concentrically in headers 22 and 23, respectively. A baffle 26, outlet tube 27 having a slot or other aperture 28, and partition 29 are arranged within the shell in the manner described above. In addition, an apertured intermediate shell 30 extends between partition 29 and outlet-end header 23, being nested within the outer shell 21 in spaced relation to the latter. Perforations 31 or a plurality of slots may be employed in achieving a limited opening in intermediate shell 30.

It will be seen that an additional impedance is provided to the flow of gases following the restricted passageway through the unit. Gases projected through annular opening 32 into space 33 must pass through apertured shell 30 as well as the slotted walls of tube 27 in order to pass into the latter. An intermediate expansion of the gases is permitted in space 34. This device, although somewhat more costly to build than that of Fig. 1, is useful especially for heavy duty service.

A simplified form of the invention is illustrated in Fig. 4. It is intended particularly for very small size units, miniature silencers of which a plurality may be connected in series in the exhaust system. It comprises cylindrical shell 40 having end headers 41 and 42, the latter being provided with concentric inlet and outlet openings 43 and 44, respectively. Gases entering the unit through inlet snout 45 and inlet opening 43, as indicated by the arrow, impinge against baffle 46 and are spread to an annular stream passing through opening 47 between the periphery of the baffle and the lateral walls of shell 40. The high and low velocity constituents of the gases then separate, in the manner described above, into two streams. The stream of high velocity slugs project forwardly into space 48 and thence into outlet tube 49 via perforations 50 in the walls of the tube. Apertured partition 51 serves to support tube 49 and also to somewhat cushion the impact of the rapidly moving slugs. The more slowly moving gases enter outlet tube 49 at what may be considered to be an open end of the tube designated by the numeral 52. The straps 53 are employed to support baffle 46 and may be either separate elements fastened to the baffle and outlet tube 49 or may be unitary extensions of the outlet tube. In either case they are not of sufficient area to interfere with the free flow of gases into tube 49 at its open end 52 directly from opening 47.

The device of Fig. 5 is a compound unit composed of two sections. The first section is a snubbing section of the type more fully described in the Chipley copending application above referred to. The second section is similar to that shown in Fig. 1. In the illustrated unit, an inner shell 60 having distributed perforations 61 is nested within outer shell 62 and between baffle 63 and partition 64. An inlet snout 65 passes through inlet opening 66 provided concentrically in inlet-end closure 67. An opening 68 is provided in baffle 63 in alignment with inlet opening 66. The inlet snout 65 terminates, in effect, short of baffle 63, extension strips 69 being used only for the purpose of supporting baffle 63.

The second section of the unit contains an ap-

ertured outlet tube 70 extending through outlet opening 71 provided in outlet-end closure 72, the tube terminating at partition 73 and opening into space 74.

In this device, the pulsating gases are operated upon in succession in the two sections of the unit. The high velocity slugs project into snubber chamber 75, the tailings by-passing directly to annular channel 76 directly from inlet snout 65 through by-pass chamber 77. The gases entering the snubber chamber pass therefrom through apertures 61 to join the by-passed gases in annular channel 76. These recombined gases then pass on into the second muffling section and divided to follow alternative paths through chamber 78 or by-pass chamber 74 in the manner fully described above.

Another compound unit is illustrated in Figs. 6 and 7. This device is essentially a combination of two sections similar to that of Fig. 1 arranged in series within a housing 80. The baffle 81 of the first section, however, is provided with a relatively small opening 82 in alignment with inlet opening 83 The purpose of this opening is to permit a portion of the gases entering the section through inlet opening 83 to pass directly to apertured tube 84 and thence to the second muffling section of the series. The balance of the gases entering the first section are spread by baffle 81 and pass either into chamber 85 or by-pass chamber 86 between partition 87 and baffle 81. The gases following all three of the alternative paths are conducted to the second section of the unit through conduit 84 where they are again spread by baffle 88 and eventually are exhausted from the unit through apertured outlet conduit 89.

The energy of impact of the incoming exhaust gases against baffle 81 is somewhat modified by means of the opening 82 and the direct passage through the first section of the unit thereby provided. Noises due to this impact are considerably reduced in this way.

It is not feasible to illustrate the large number of possible modified forms that the invention may take. The principal alternative constructions have been shown and described. It will be understood that the various elements shown in connection with a particular embodiment of the invention may be used for a corresponding purpose in one of the other illustrated units.

The dimensions and relative proportions of the several units herein described are generally as indicated in the drawings. These dimensions, on the whole, are not critical, although the space between the end of the apertured outlet conduit and the contiguous baffle should, in each case, be sufficient to provide a passageway of area equal to or greater than the area of the outlet conduit. The walls of the outlet conduits, shell 30 in Fig. 3, and shell 60 in Fig. 5 should be sufficiently apertured to provide an open area approximately equal to from 30 to 100 per cent of the area of the outlet conduit of the unit.

I claim:

1. In a device of the character described including a cylindrical shell, a silencing section having an inlet and an outlet both disposed approximately at the axis of said shell, a transverse baffle member spaced downstream from said inlet and incompletely spanning the cross section of said shell to provide a substantially annular opening between said baffle member and said shell, and an open ended apertured tube extending from said outlet toward said baffle member and terminating short thereof, the area of said annular opening being not substantially less than the cross-sectional area of said tube, the construction and arrangement being such that all gases entering said silencing section at said inlet may travel therethrough in a generally forwardly direction without reversal.

2. A device in accordance with claim 1 in which the end of the apertured tube contiguous the baffle member is spaced therefrom a distance sufficient to provide a passageway for gases into the end of said tube having a minimum cross-sectional area not substantially less than the cross-sectional area of said tube.

3. A device in accordance with claim 1 and having a partition substantially coextensive with said baffle member and extending radially from said apertured tube at the end thereof.

4. A device in accordance with claim 1 and including an apertured partition extending transversely from the apertured tube to the shell at a point intermediate the length of said tube.

5. In a device of the character described including a cylindrical shell, a silencing section having an inlet and an outlet both disposed approximately at the axis of said shell, an imperforate transverse baffle spaced from said inlet and disposed in the gas stream from said inlet, at least portions of the periphery of said baffle being spaced from said shell to permit free passage of gases between said baffle and said shell, a transverse partition spaced downstream from said baffle, at least portions of the periphery of said partition being spaced from said shell to permit free passage of gases between said partition and said shell, and an apertured conduit connecting the space between said baffle and said partition with said outlet of said muffling section, the construction and arrangement being such that all gases entering said silencing section at said inlet may travel therethrough in a generally forwardly direction without reversal.

6. The device of claim 5 in which the baffle is generally conical shaped and is arranged with its apex in upstream position.

7. In a device of the character described including an outer cylindrical shell, a silencing section having an inlet and an outlet both disposed approximately at the axis of said shell, an imperforate transverse baffle spaced from said inlet and disposed in the gas stream from said inlet, at least portions of the periphery of said baffle being spaced from said shell to permit free passage of gases between said baffle and said shell, a transverse partition spaced downstream from said baffle and having openings at its peripheral portions in alignment with the openings between said baffle and said shell, an apertured conduit connecting the space between said baffle and said partition with said outlet of said silencing section, and an apertured intermediate cylindrical shell nested within said outer shell and extending from said partition inside of the peripheral openings therein to the downstream boundary of said section to enclose a space between said intermediate shell and said apertured conduit.

8. A device of the character described comprising a cylindrical housing, end closures for said housing having an inlet and an outlet opening respectively, a substantially imperforate transverse baffle spaced from said inlet, the periphery of said baffle being spaced from said housing, an apertured outlet tube extending from said outlet toward said baffle and terminating short thereof,

and means extending between said outlet tube and said baffle to support the latter, the construction and arrangement being such that all gases entering said device at said inlet opening may pass by said baffle and into said outlet tube without reversal of their generally forwardly movement.

9. A device of the character described comprising an elongated cylindrical housing having an inlet opening disposed concentrically in the inlet end and an outlet opening disposed concentrically in the outlet end thereof, first and second transverse partitions spaced apart and spaced from the inlet end of said housing, said first partition having an opening therein in alignment with said inlet opening, an apertured shell nested within said housing in spaced relation thereto and extending between said partitions, an apertured outlet conduit extending from said outlet opening toward but terminating short of said second partition, and a third partition extending radially from the end of said outlet conduit, the peripheries of all three of said partitions being spaced from said housing to permit free flow of gases between said partitions and said housing.

10. A device of the character described comprising a cylindrical housing having an inlet opening and an outlet opening concentrically of the respective ends thereof, a first transverse partition having an opening at its center and dividing said housing into two silencing sections, said first section comprising: a transverse baffle spaced from said inlet opening, at least a portion of the periphery of said baffle being spaced from said housing to permit free flow of gases between said baffle and said housing, an apertured tube extending from said first partition at said opening therein toward but terminating short of said first baffle, and a second partition substantially coextensive with said first baffle extending radially from said apertured tube at the end thereof; said second section comprising: a second transverse baffle spaced from said first partition, at least a portion of the periphery of said second baffle being spaced from said housing to permit the free flow of gases between said second baffle and said housing, a second apertured tube extending from said outlet opening of said housing toward but terminating short of said second baffle, and a third partition substantially coextensive with said second baffle and extending radially from said apertured tube at the end thereof, the construction and arrangement being such that all gases entering said device at said inlet opening may travel therethrough in a generally forwardly direction without reversal.

11. The device of claim 10 in which said first mentioned transverse baffle is provided with an opening of small size as compared with said inlet opening in alignment with said inlet opening.

ALFRED S. CHIPLEY.