May 3, 1955 C. JANEWAY 2,707,525

MUFFLER FOR INTERNAL COMBUSTION ENGINES

Filed March 9, 1954 3 Sheets-Sheet 1

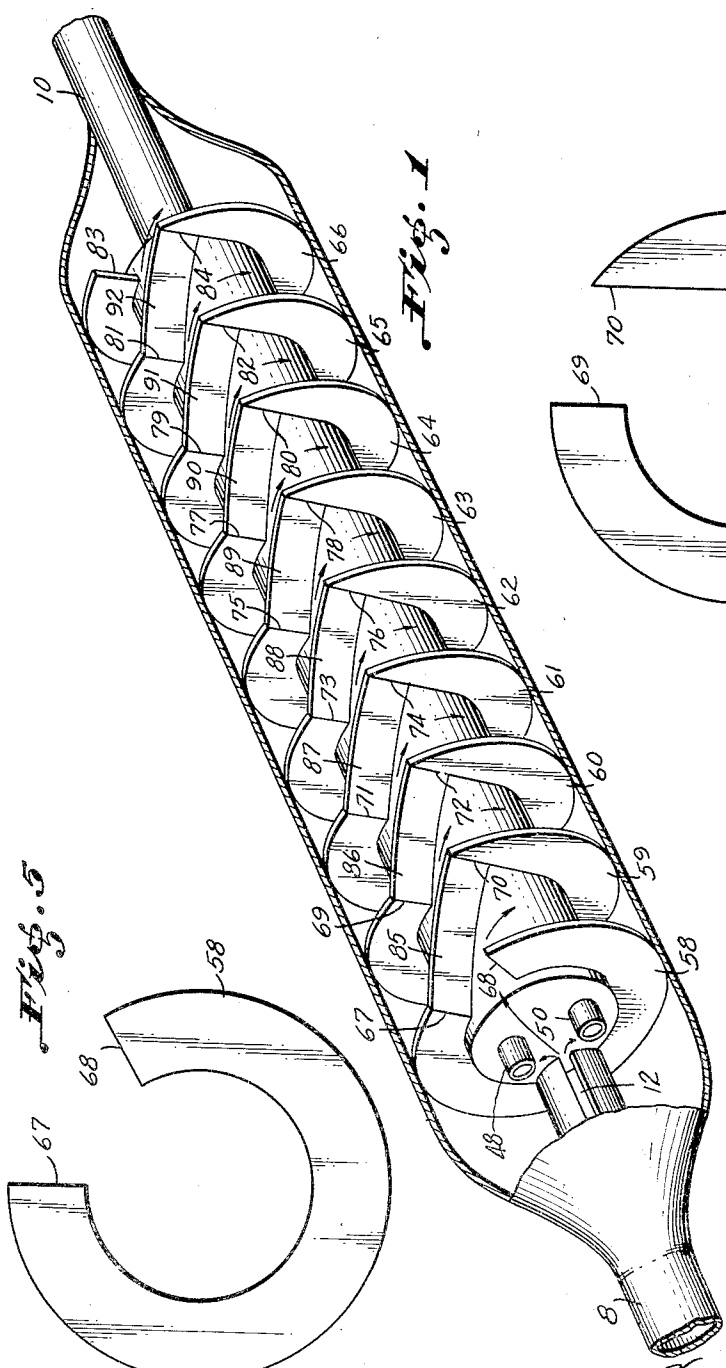

Fig. 1

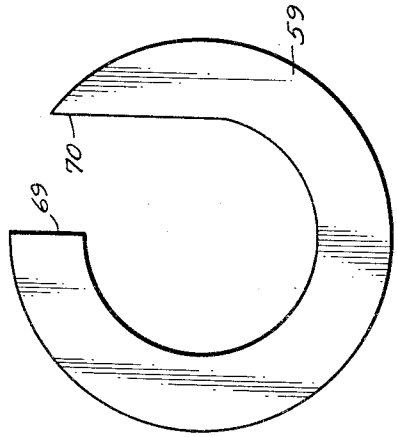

Fig. 6

Fig. 5

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MUFFLER FOR INTERNAL COMBUSTION ENGINES

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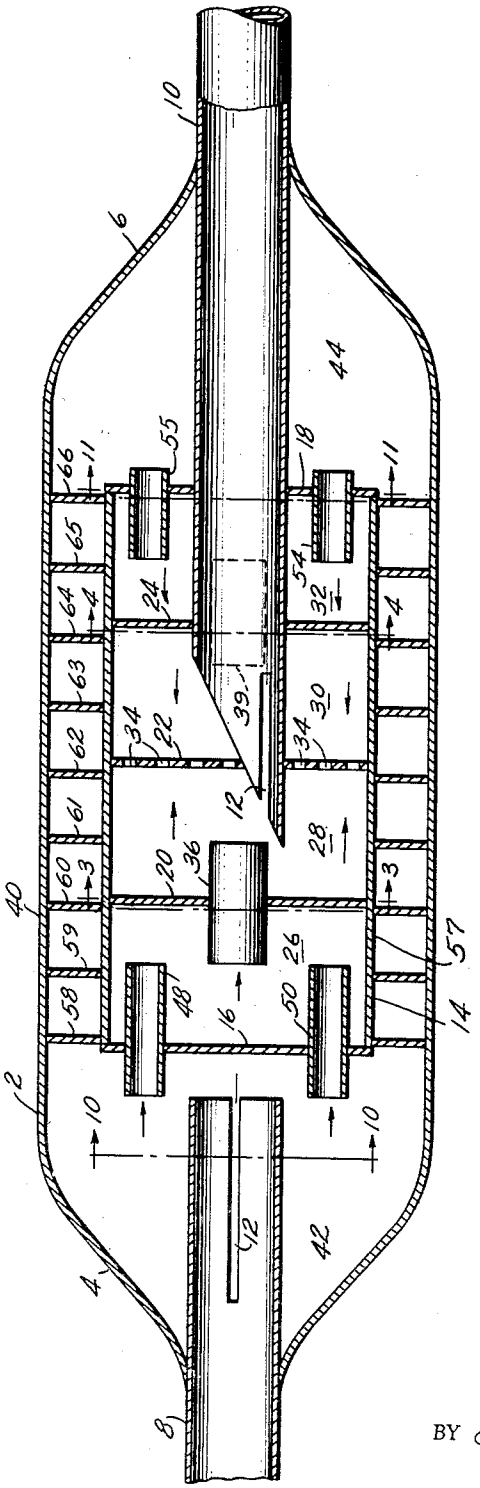

Fig. 2

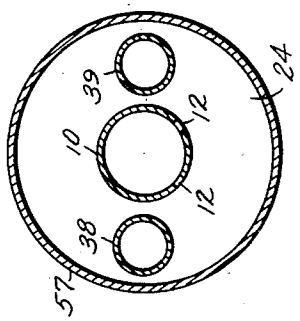

Fig. 4

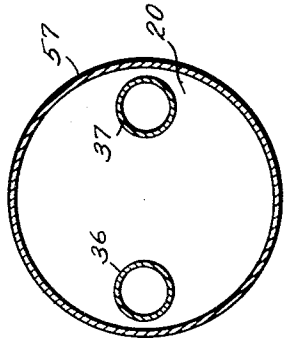

Fig. 3

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MUFFLER FOR INTERNAL COMBUSTION ENGINES

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Fig. 11

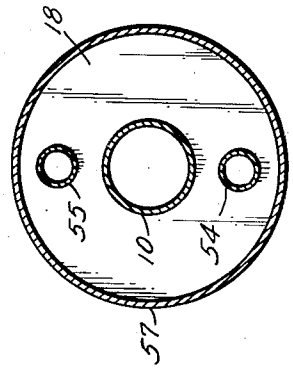


Fig. 7

Fig. 8

Fig. 10

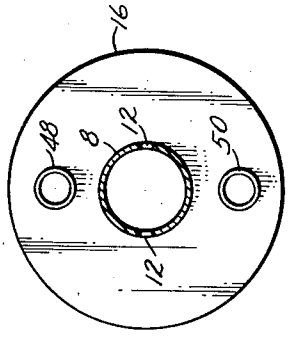


Fig. 9b

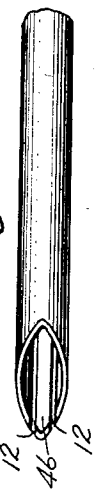


Fig. 9a

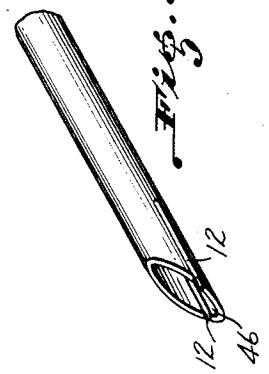


Fig. 12a

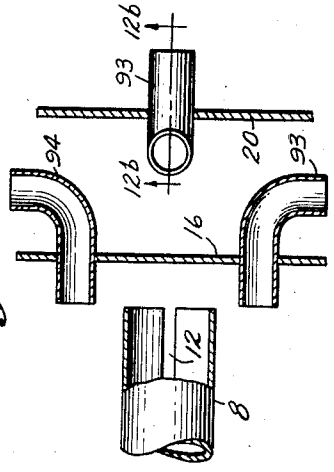
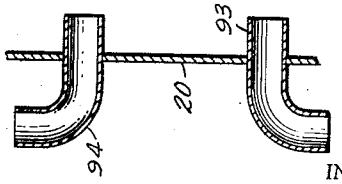


Fig. 12b



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MUFFLER FOR INTERNAL COMBUSTION ENGINES

Cornell Janeway, Silver Spring, Md.

Application March 9, 1954, Serial No. 414,941

7 Claims. (Cl. 181—56)

This invention relates to mufflers for internal combustion engines and the like.

Exhaust gases of an internal combustion engine leave said engine in a stream having successive concentrations of said gases at relatively high pressures and intermediate concentrations of said gases at relatively low pressures. The noise of the engine exhaust is due partially to the said gas impulses and partially to sound waves preceding the gas flow, said sound waves traveling through the exhaust gases as said gases pass through the muffler. The structure of the muffler, and of its embodiments, is based upon the simultaneous treatment of both the exhaust gases and the sound waves and may be effectively used for a single cylinder or a multicylinder engine.

The muffler of this invention incorporates a combination of structural components which allows the exhaust gases to expand, cancels the sound waves traveling through said exhaust gases by interference, and prevents back pressure restrictions. To diminish the sound waves, the exhaust gases having the sound waves traveling therethrough are divided into two streams which are directed through two separate paths, one path being longer than the other by one half the wave length, or a multiple thereof, of the sound waves. Each of said streams is so directed through the muffler that the respective streams approaching each other from opposite directions will meet at a portion of said muffler.

It is well known that the engine cycle used almost exclusively in automobile engines is the four stroke cycle which requires four piston strokes or two crankshaft revolutions per cycle. In a one cylinder engine, there is one exhaust for every two revolutions of the crankshaft or for every 720° of rotation of the crankshaft. In a 2 cylinder engine, there is one exhaust for every revolution of the crankshaft or for every 360° of rotation of the crankshaft. In a 4 cylinder engine, there is one exhaust for every one half revolution of the crankshaft or for every 180° of rotation of the crankshaft. In a six cylinder engine there is one exhaust for every one third revolution of the crankshaft or for every 120° of rotation of the crankshaft. In an 8 cylinder engine there is one exhaust for every one quarter revolution of the crankshaft or for every 90° of rotation of the crankshaft.

Because of the novel structure of the muffler, which includes, directly adjacent to the exhaust inlet pipe, a forward expansion chamber having a volume equal to at least approximately ten times the displacement volume of one cylinder, the muffler of this invention is capable of use both with a one cylinder engine or multicylinder engine to produce excellent silencing effects.

An object of this invention is to provide a muffler which can be effectively used for single cylinder and multicylinder internal combustion engines.

Another object of this invention is to provide a muffler which allows easy passage of the exhaust gases therethrough.

A further object of this invention is to provide a

muffler which allows for simultaneous expansion of the exhaust gases and attenuation of the sound by utilization of interference principle of sound waves.

A further object of this invention is to provide a muffler which can be effectively used for a multicylinder internal combustion engine in such a manner that the exhaust gases from each cylinder of the engine are treated successively and continuously.

Other objects and features will become apparent from the following detailed description.

Figure 1 is a view in perspective of the inner portion of a muffler of this invention.

Figure 2 is a longitudinal cross-sectional view of a muffler of this invention.

Figure 3 is a sectional view on line 3—3 of Figure 2.

Figure 4 is a sectional view on line 4—4 of Figure 2.

Figure 5 is a view in perspective of a partition used in a muffler of this invention.

Figure 6 is a view in perspective of another partition which can be used in a muffler of this invention.

Figures 7 and 8 are views in perspective of pipes which can be used in a muffler of this invention.

Figure 9*a* is a view in perspective of the portion of an exhaust outlet pipe, said portion being positioned within a muffler of this invention.

Figure 9*b* is a plan view of the pipe of Figure 9*a*.

Figure 10 is a sectional view on line 10—10 of Figure 2.

Figure 11 is a sectional view on line 11—11 of Figure 2.

Figure 12*a* is a partial longitudinal view of a second embodiment of a muffler of this invention wherein the pipes of Figures 7 and 8 are substituted for pipes as shown in Figure 1.

Figure 12*b* is a sectional view on line 12*b*—12*b* of Figure 12*a*.

More specifically, an outer cylindrically shaped casing 2 is provided with a forward end wall 4 and a rear end wall 6, said end wall 4 having positioned therein an exhaust inlet pipe 8 and said end wall 6 having positioned therein an exhaust outlet pipe 10. In said exhaust inlet pipe 8 are slots 12 which extend into pipe 8 for a portion of its length as shown in Figure 2.

Concentrically positioned within the outer casing 2 is a cylindrically shaped inner casing 14, which is provided with a forward end wall 16 and a rear end wall 18. Mounted within the casing 14 are transversely positioned partitions 20, 22, and 24, the distance between each being approximately equal, said partitions forming separate chambers 26, 28, 30, and 32, partition 22 being perforated as shown by the passageways or perforations 34 therethrough.

The chambers 26, 28, 30, and 32 are interconnected by open-ended pipes 36 and 37, passageways 34, and open-ended pipes 38 and 39, respectively.

The end walls 16 and 4 define with the outer casing wall 40 an expansion chamber 42, and end walls 6 and 18 define with the outer casing wall an expansion chamber 44. The exhaust gas inlet pipe 8 terminates in the chamber 42, and the exhaust gas outlet pipe 10 extends through chamber 44, partition 18, chamber 32, through partition 24, through chamber 30, through partition 22, having its opening 46 terminating both in chamber 30 and in chamber 28, as shown in Figure 2. Positioned in partition 16 are open-ended pipes 48 and 50, the respective ends of each terminating in chambers 42 and 26. The pipes 48 and 50 are preferably positioned directly above and directly below the pipe 8 and in such a manner that their respective longitudinal axes are on a horizontal plane to the horizontal plane of the longitudinal axis of the pipe 8 and their respective vertical axes are on a vertical plane coinciding with the vertical plane of the

vertical axis of pipe 8, as shown. It is preferable that the pipes 48 and 50 and the pipe 8 terminate on a plane parallel to the rear end wall 16, as shown in Figure 2.

The pipes 36 and 37 are positioned in partition 20 in such a manner that their respective longitudinal axes are on a horizontal plane coinciding with the horizontal plane of the longitudinal axis of the pipe 8 and their respective vertical axes are on a vertical plane parallel to the vertical plane of the vertical axis of pipe 8, the pipes 36 and 37 being spaced from the pipe 8 preferably as shown. The pipes 36 and 37 terminate in chambers 26 and 28, as shown, and preferably on a plane coinciding with the plane in chamber 26 on which the pipes 48 and 50 terminate, said plane being parallel to the wall 16.

The open-ended pipes 54 and 55 are positioned in wall 18 in a manner similar to pipes 48 and 50 in wall 16 and in the same relationship to pipe 10 as are pipes 48 and 50 to pipe 8, pipe 10 being so positioned that its longitudinal axis is on a plane coinciding with the longitudinal axis of pipe 8. The inner end of exhaust outlet pipe 10 is preferably cut diagonally, thus allowing the opening 46 to terminate both in chamber 28 and chamber 30.

In the annular space 56 formed by the inner peripheral surface of the wall 40 of casing 2 and the outer peripheral surface of the wall 57 of the casing 14 are positioned the equally spaced circular partitions 58, 59, 60, 61, 62, 63, 64, 65, and 66 extending laterally from the wall 57 to the wall 40. Each of said partitions has an opening extending from the wall 57 to the wall 40, the opening in partition 58 being defined by the edges 67 and 68 and the opening in partition 59 being defined by the edges 69 and 70. As shown in the drawings, the partitions 60–66, inclusive, are similar to partition 59 and the openings in said partitions are similar to the opening in partition 59. If desired, the partitions 59–66, inclusive, may have a configuration similar to partition 58, as shown in Figure 6. To obtain the best results it is necessary that the openings in each partition be confined within a 90° segment of the partition and preferably subtend no more than one-twelfth of the outer circumference of the partition. The circumferential distance along the perimeter of the respective partition between the topmost points on the respective edges of each opening will therefor be at least eleven-twelfths of the outer perimeter of said partition. The partitions are so arranged that the edges 67 and 70, 69 and 72, 71 and 74, and so on, are parallel, 69 and 70 being the edges of the opening in partition 59, 71 and 72 being the edges of the opening in partition 60, 73 and 74 being the edges of the opening in partition 61. If the partitions are all of the configuration of partition 58, one edge of the opening in each partition will be parallel to and adjacent to edge 67, and the outer edge of the opening will be parallel to and adjacent to edge 68, and so on. It is preferable that the cross-sectional area of each opening be approximately the same and that the partitions be so arranged that the respective openings be substantially directly adjacent one another, as shown in Figure 1. Edges 67, 69, 71, 73, 75, 77, 79, 81, and 83 are the top edges of the respective openings, and edges 68, 70, 72, 74, 76, 78, 80, 82, and 84 are the bottom edges of the respective openings. Edge 70 is the edge in the opening of partition 59 opposite to the edge 67 in partition 58, edge 72 is the edge in the opening of partition 60 opposite to the edge 69 in partition 59, and so on. In Figure 1, as shown, wherein partitions 60–66, inclusive, are of a configuration similar to partition 59, it is seen that the edges 67–84, inclusive, are all parallel to each other.

The partitions 58–66, inclusive, are preferably arranged that angular members or partitions 85–92, inclusive, will form an angle of approximately 30° with the respective partitions at the edges 67, 69, 71, 73, 75, 77, 79, 81, and 83 of the respective openings therein. The angular partition or member 85 is attached to partition 58 at edge 67 thereof and to partition 59 at edge 70 thereof, the angular partition or member 86 is attached to partition 59 at edge 69 thereof and to partition 60 at edge 72 thereof, and so on with angular members 87–92, inclusive. Each of the angular partitions or members 85–92, inclusive, is thus positioned between, and in contact with at all points on its respective upper and lower edges, the outer peripheral surface of the wall 57 of the inner casing 14 to the inner peripheral surface of the wall 40 of the outer casing 2.

Because of the aforesaid particular preferred arrangement and configuration of the partitions 58–66, inclusive, of the openings in their respective partitions, and of the angular members 85–92, inclusive, the exhaust gases and sound waves will be conducted into the annular space 56 through the opening defined by edges 67 and 68 in partition 58, along a substantially circular path in the space between the partitions 58 and 59, along a substantially angular path along the angular member 85 after being deflected by said member 85, and then into the space between partitions 59 and 60, and so on, and then through the opening defined by edges 83 and 84 in partition 66, in the direction of the arrows as shown in Figure 1. Because of said structural features, accumulation and storage of the expanded exhaust gases and unobstructed passage for said gases having the sound waves traveling therethrough will be prevented in the passage thereof from expansion chamber 42 to chamber 44.

For open-ended pipes 48, 50, 36, 37, 38, 39, 54, and 55, may be substituted the open-ended 90° elbow pipes 93 and 94, as shown in Figures 7 and 8, respectively. When such pipes are utilized, they are positioned as shown in Figure 12. The pipes substituted for 36 and 37 are positioned as shown in Figure 12*b*.

The exhaust gases pass from the engine into the inlet pipe 8 and are caused to flow therefrom into the chamber 42 wherein said gases expand. The exhaust gases so expanded are caused to divide into two streams, each stream having sound waves therethrough; one stream or portion is caused to flow through the combined substantially circular and angular path defined by the partitions 58–66, inclusive, the openings therein and the angular members 85–92, inclusive, as hereinbefore described, into chamber 44 wherein a further expansion of said gases is brought about. In traveling through the path created by the structural components positioned in annular space 56, the gas is caused to flow through 360° between each partition before it is caused to flow into the said chamber 44, whereby said stream or portion of exhaust gas is conducted through pipes 54 and 55 into chamber 32 and then through pipes 38 and 39 into chamber 30, the positions of said pipes 54, 55, 38 and 39 in relation to each other causing said stream of gases to be conducted along a tortuous or zig-zag path within chamber 32 and along a substantially straight-line path in chamber 30. By conducting said stream or portion of exhaust gases through the aforedescribed combination of paths, the well known explosive-impulse noise factor caused by the pressure, in said exhaust gases, of the successive concentrations at relatively high pressures and intermediate concentrations at relatively low pressures is reduced as a result of the expansion of said gases and as a result of baffling action. Thus, the characteristic sound of the successive explosions is greatly attenuated.

The other stream or portion of exhaust gases is caused to flow through a tortuous or zig-zig path in the pipes 48 and 50, in the chamber 26, and through a substantially straight-line path in the chamber 28. Thus, the pressure impulses of that portion of the exhaust gases are caused to level out and the characteristic sound of the successive explosions are further attenuated.

The distance through which the first described stream of exhaust gases having the sound waves traveling therethrough, viz. that portion passing from chamber 42 through annular space 56, through chamber 44, through chamber 32, and through chamber 30, passes is one half wave length, or a multiple thereof, depending upon the

degree of attenuation desired, greater than the wave length of said sound waves, and thus the first described stream or portion of exhaust gases will lag behind the second described stream or portion of the gases by a distance approximately equal to one half wave length, or a multiple thereof, of said sound waves. The wave length may be easily calculated having available the engine speed, number of cylinders in said engine, and the velocity of sound in a hot gas.

Thus, the two streams or portions of the exhaust gases meet in the vicinity of the perforated partition, said two streams through which the sound waves are traveling, viz. said exhaust gases are a carrying medium for the the sound waves from the engine, being out of phase by one-half the wave length of said sound waves, and the sound waves approaching from opposite directions are canceled by interference. Because of the opening, which is cut diagonally, of pipe **10** being so positioned, as shown in Figure 2, a greater volume is provided wherein the exhaust gases upon meeting, after approaching from opposite directions, can be easily and quickly removed, thereby preventing accumulation and storage in that muffler portion.

The muffler is so constructed that the volume of chamber **42** is at least approximately ten times the displacement volume of one cylinder thus making it capable of use for both single cylinder and multicylinder engines, since thereby the exhaust gases from each cylinder are treated successively and continuously. This feature in combination with the other structure features herein described bring about excellent silencing effects.

From the drawings it may be seen that the cylindrical wall of exhaust pipe has therein two oppositely positioned slots **12** in the lower portion thereof leading from the inner portion of the outlet pipe to chambers **28** and **30**. Also, it is seen that said slots extend longitudinally from the opening of said outlet pipe and terminate in that portion of the pipe **10** which is in chamber **30**. To obtain the desired results, said slots must terminate in that portion of pipe **10** positioned in chamber **30**. By the inclusion of said slots in pipe **10**, there will be a diminishing of any residual noise before the so treated exhaust gas enters the atmopshere.

By utilizing the structural features shown in Figures 12*a* and 12*b* excellent silencing effects are also attained.

Further, sound absorbent lining may be used in either casing or in both casings.

The approximate dimensions of one muffler contemplated herein are as follows:

	Inches
Overall length	28.5
Diameter of outer casing	9
Diameter of inner casing	6
Length of inner casing	14

Many alterations and changes may be made without departing from the spirit and scope of this invention which is set forth in the appended claims which are to be construed as broadly as possible in view of the prior art.

I claim:

1. A muffler comprising an outer cylindrically shaped casing having end walls, a concentrically positioned cylindrically shaped inner casing within said outer casing, said inner casing having end walls spaced from the respective end walls of said outer casing, the outer peripheral surface of said inner casing being spaced from and defining an annular space with the inner peripheral surface of said outer casing, an exhaust gas inlet pipe at one end of said outer casing, an exhaust gas outlet pipe at the other end of said outer casing, means for conducting a first portion of the exhaust gases from the inlet pipe to the outlet pipe through a combined substantially circular and substantially angular path in said annular space, through a tortuous path in said inner casing, and then through a substantially straight-line path in said inner casing, and means for conducting the remaining portion of the exhaust gases from the inlet pipe to the outlet pipe through a tortuous path in said inner casing and then through a substantially straight-line path in said inner casing in a direction opposite to the direction of the first portion of the exhaust gases passing through the tortuous and then substantially straight-line path.

2. A muffler comprising an outer cylindrically shaped casing having end walls, a concentrically positioned cylindrically shaped inner casing within said outer casing, said inner casing having end walls spaced from the respective end walls of said outer casing, the outer peripheral surface of said inner casing being spaced from and defining an annular space with the inner peripheral surface of said outer casing, an exhaust gas inlet pipe at one end of said outer casing, an exhaust gas outlet pipe at the other end of said outer casing, means for conducting a first portion of the exhaust gases from the inlet pipe to the outlet pipe through a substantially circular path in said annular space, through a tortuous path in said inner casing, and then through a substantially straight-line path in said inner casing, and means for conducting the remaining portion of the exhaust gases from the inlet pipe to the outlet pipe through a tortuous path in said inner casing and then through a substantially straight-line path in said inner casing in a direction opposite to the direction of the first portion of the exhaust gases passing through the tortuous and then substantially straight-line path.

3. A muffler comprising an outer cylindrically shaped casing having end walls, a concentrically positioned cylindrically shaped inner casing within said outer casing, said inner casing having end walls spaced from the respective end walls of said outer casing, the outer peripheral surface of said inner casing being spaced from and defining an annular space with the inner peripheral surface of said outer casing, an exhaust gas inlet pipe at one end of said outer casing, an exhaust gas outlet pipe extending from within said inner casing to the other end of said outer casing, means for conducting a first portion of the exhaust gases from the inlet pipe through a combined substantially circular and substantially angular path in said space, through a tortuous path in said inner casing, and then through a substantially straight-line path in said inner casing to the exhaust gas outlet pipe within said inner casing, and means for conducting the remaining portion of the exhaust gases from the inlet pipe through a tortuous path in said inner casing and then through a substantially straight-line path in said inner casing to the exhaust gas outlet pipe within said inner casing in a direction opposite to the direction of the first portion of the exhaust gases passing through the tortuous and then substantially straight-line path.

4. A muffler comprising an outer cylindrically shaped casing having a forward end wall and a rear end wall, a concentrically positioned cylindrically shaped inner casing within said outer casing, said inner casing having a forward end wall and a rear end wall, said forward end wall of said inner casing and said forward end wall of said outer casing defining an expansion chamber, the outer peripheral surface of said inner casing being spaced from and defining an annular space with the inner peripheral surface of said outer casing, an exhaust gas inlet pipe terminating in said expansion chamber, an exhaust gas outlet pipe at the other end of said outer casing, means for conducting a first portion of the exhaust gases from the expansion chamber to the outlet pipe through a combined substantially circular and substantially angular path in said annular space, through a tortuous path in said inner casing, and then through a substantially straight-line path in said inner casing, and means for conducting the remaining portion of the exhaust gases from the expansion chamber to the outlet pipe through a tortuous path in said inner casing and then through a substantially straight-line path in said inner casing in a direction op-

posite to the direction of the first portion of the exhaust gases passing through the tortuous and then substantially straight-line path.

5. A muffler comprising an outer cylindrically shaped casing having a forward end wall and a rear end wall, a concentrically positioned cylindrically shaped inner casing within said outer casing, said inner casing having a forward end wall spaced from the forward end wall of said outer casing and a rear end wall spaced from the rear end wall of said outer casing, the outer peripheral surface of said inner casing being spaced from and defining an annular space with the inner peripheral surface of said outer casing, an exhaust gas inlet pipe at the forward end of said outer casing, an exhaust gas outlet pipe at the rear end of said outer casing, means for conducting a first portion of the exhaust gases from the inlet pipe to the outlet pipe through a combined substantially circular and substantially angular path in said annular space, through a tortuous path in said inner casing, and then through a substantially straight-line path in said inner casing, said means including a first expansion chamber defined by the forward end wall of said outer casing and the forward end wall of said inner casing and a second expansion chamber defined by the rear end wall of the outer casing and the rear end wall of the inner casing, and means for conducting the remaining portion of the exhaust gases from the inlet pipe to the outlet pipe through a tortuous path in said inner casing and then through a substantially straight-line path in said inner casing in a direction opposite to the direction of the first portion of the exhaust gases passing through the tortuous and then substantially straight-line path, said means including said first expansion chamber.

6. A muffler comprising an outer cylindrically shaped casing having end walls, a concentrically positioned cylindrically shaped inner casing within said outer casing, said inner casing having end walls spaced from the respective end walls of said outer casing, the outer peripheral surface of said inner casing being spaced from and defining an annular space with the inner peripheral surface of said outer casing, an exhaust gas inlet pipe at one end of said outer casing, an exhaust gas outlet pipe at the other end of said outer casing, means for conducting a first portion of the exhaust gases from the inlet pipe to the outlet pipe through a combined substantially circular and substantially angular path in said annular space, through a tortuous path in said inner casing, and then through a substantially straight-line path in said inner casing, said means including in said annular space a plurality of substantially equidistant transversely positioned partitions, each of said partitions extending from the outer peripheral surface of said inner casing, at all points thereof, to the inner peripheral surface of said outer casing, at all points thereof, each of said partitions having an opening extending from the outer peripheral surface of said inner casing to the inner peripheral surface of said outer casing, said openings being in like portions of said partitions, a plurality of angularly positioned walls, each of said walls extending from one edge of an opening at all points thereof to the opposite edge of the opening in the adjacent partition at all points thereof, and means for conducting the remaining portion of the exhaust gases from the inlet pipe to the outlet pipe through a tortuous path in said inner casing and then through a substantially straight-line path in said inner casing in a direction opposite to the direction of the first portion of the exhaust gases passing through the tortuous and then substantially straight-line path.

7. A muffler comprising an outer cylindrically shaped casing, said casing having a dome shaped forward end wall and a dome shaped rear end wall, a concentrically positioned inner cylindrically shaped casing having forward and rear end walls, said forward end wall of said outer casing and said forward end wall of said inner casing defining a first expansion chamber, said rear end wall of said outer casing and said rear end wall of said inner casing defining a second expansion chamber, the outer peripheral surface of said inner casing being spaced from and defining an annular space with the inner peripheral surface of said outer casing, a plurality of substantially equidistant transversely positioned partitions in said annular space, each of said partitions extending from the outer peripheral surface of said inner casing at all points thereof to the inner peripheral surface of said outer casing at all points thereof, each of said partitions having an opening extending from the outer peripheral surface of said inner casing to the inner peripheral surface of said outer casing, each of said partitions having an opening extending from the outer peripheral surface of said inner casing to the inner peripheral surface of said outer casing, said openings being in like portions of said partitions, a plurality of angularly positioned walls, each of said walls extending from one edge of an opening at all points thereof to the opposite edge of the opening in the adjacent partition at all points thereof, an exhaust gas inlet pipe terminating in said first expansion chamber, a transversely positioned partition in said inner casing spaced from and defining an inner first chamber with said forward end wall of said inner casing, a plurality of open-ended pipes positioned in said forward end wall of said inner casing in offset relationship with said exhaust gas inlet pipe, each of said pipes having one end terminating in said first expansion chamber and the other end terminating in said first chamber, a perforated transversely positioned partition in said inner casing spaced from and defining with said latter partition an inner second chamber, a plurality of open-ended pipes positioned in said latter partition, each being positioned in offset relationship with each of said latter plurality of pipes and having one end terminating in said inner first chamber and the other end terminating in said second chamber, a transversely positioned partition in said inner casing spaced from said perforated partition and said rear end wall of said inner casing and defining an inner third chamber with said perforated partition and an inner fourth chamber with said rear end wall, an exhaust gas outlet pipe extending through said second expansion chamber and having one end terminating in both said inner second and third chambers, a plurality of open-ended pipes in said rear end wall of said inner casing, each of said pipes having one end terminating in said second expansion chamber and the other end terminating in said inner fourth chamber, a plurality of open-ended pipes positioned in said partition spaced from said perforated partition and said rear end wall of said inner casing, each being positioned in offset relationship with each of said latter plurality of pipes and having one end terminating in said inner fourth chamber and the other end terminating in said third chamber.

No references cited.