Feb. 5, 1963 J. I. HOUSE ET AL 3,076,521

MUFFLER

Filed June 28, 1960 3 Sheets-Sheet 1

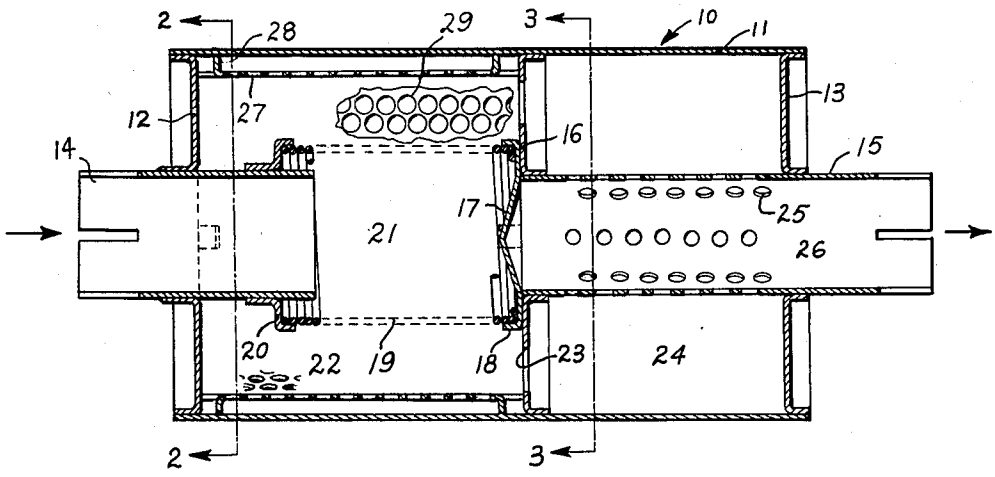


Fig. 1.

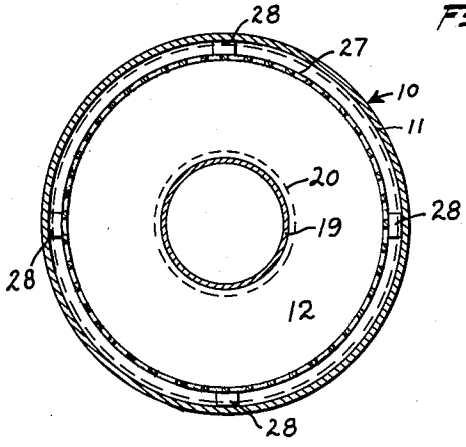


Fig. 2.

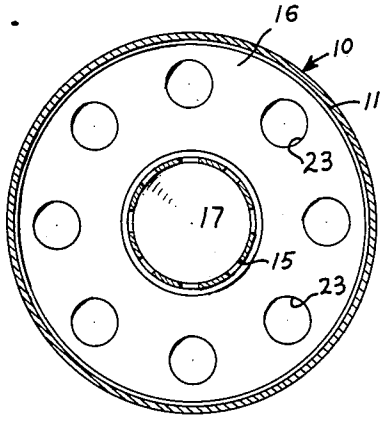


Fig. 3.

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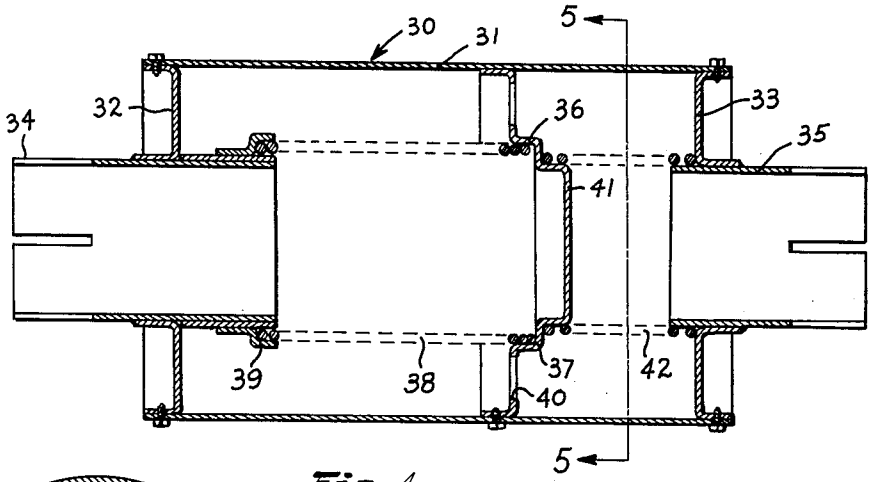


Fig. 4.

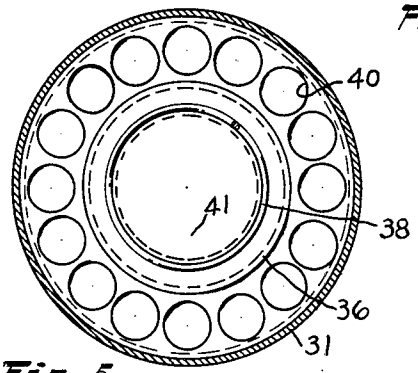


Fig. 5.

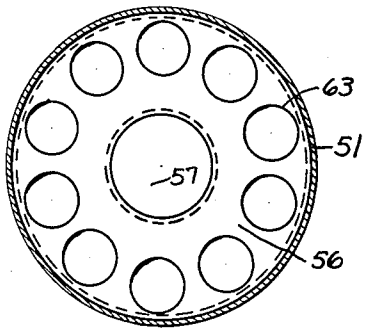


Fig. 7.

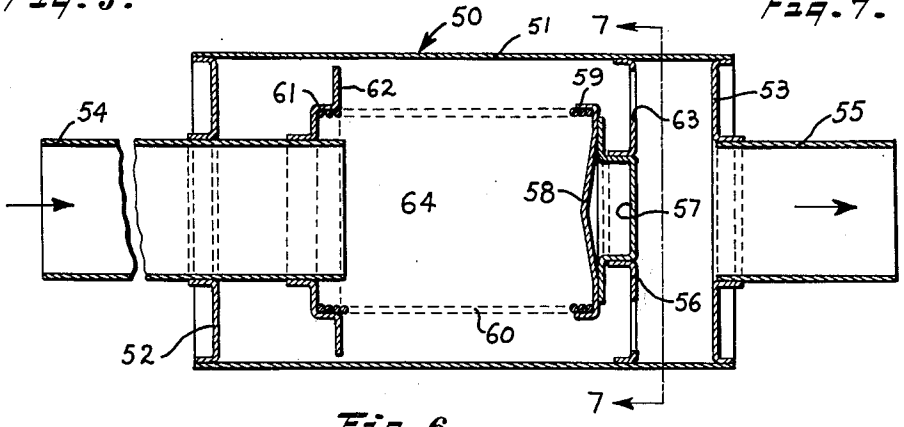


Fig. 6.

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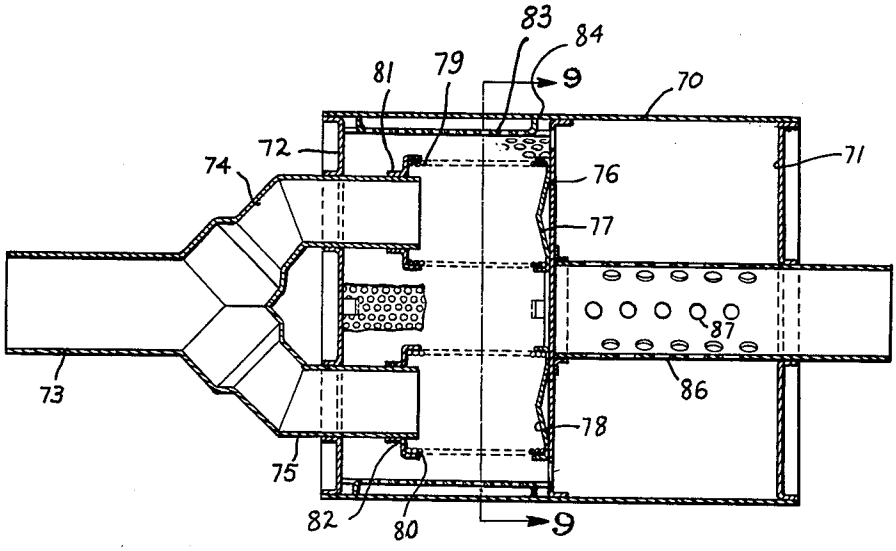


Fig. 8.

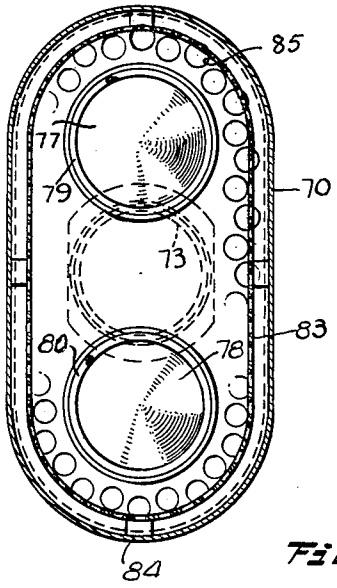


Fig. 9.

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MUFFLER

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Filed June 28, 1960, Ser. No. 39,313
18 Claims. (Cl. 181—65)

This invention relates to mufflers and particularly to mufflers for attenuating the exhaust of internal combustion engines in automotive vehicles.

Mufflers are conventionally used in conjunction with the internal combustion engines such as engines for automotive vehicles in order to suppress or attenuate the noise. In order to minimize the effect of the muffler on the engine operation, it is conventional to have the muffler produce a minimum of reduction in pressure of the exhaust gases. Thus, muffler design is usually a compromise between the suppression or attenuation of the noises and the reduction in the back pressure.

A major consideration in muffler design for automobile engines has been the size and space limitations. These limitations have become more critical with the advent of lower cars and more compact which have very little space in which a muffler can be positioned.

Another major consideration with regard to mufflers is that of corrosion that results from the gases themselves and from the chemicals such as salt which are used on the highways to melt snow and ice. Because of the great amount of material and large number of parts used in such mufflers, it has not been practical or economical to make such mufflers of the corrosion resistant material which is relatively expensive.

Another major problem with regard to mufflers is that of weight. Usually in order to obtain sufficient suppression or attenuation of the noises, the weight of the muffler becomes quite substantial adding to the overall weight of the automobile.

It is an object of this invention to provide a novel muffler construction which will attenuate the noise of the exhaust gases, which is simple and inexpensive in construction and incorporates a minimum number of parts so that it can be made of more expensive materials which are resistant to corrosion; and which requires a minimum amount of space, much less than that required by conventional mufflers.

In the drawings:

FIG. 1 is a longitudinal sectional view through a muffler embodying the invention.

FIG. 2 is a sectional view taken along the line 2—2 in FIG. 1.

FIG. 3 is a sectional view taken along the line 3—3 in FIG. 1.

FIG. 4 is a longitudinal sectional view through a modified form of muffler.

FIG. 5 is a sectional view taken along the line 5—5 in FIG. 4.

FIG. 6 is a longitudinal sectional view through a further modified form of muffler.

FIG. 7 is a sectional view taken along the line 7—7 in FIG. 6.

FIG. 8 is a longitudinal sectional view on an enlarged scale through a further modified form of muffler.

FIG. 9 is a sectional view taken along the line 9—9 in FIG. 8.

Referring to FIG. 1, muffler 10 comprises a cylindrical shell or casing 11 which has the ends thereof closed by end members 12, 13. An inlet tube 14 extends through end member 12 and has its inner end terminating adjacent the end member 12. An outlet tube 15 extends through end member 13 and has its inner end terminating substantially at the mid point of casing 11. The inner end of outlet tube 15 extends into an opening in a transverse baffle member 16 and the end of the outlet tube 15 is closed by a conical end plate 17. End plate 17 includes a peripheral axial flange 18. A tightly wound or closed helical spring 9 is fixed as by welding to flange 18 and extends axially toward the inlet tube 14 and in telescoping relation to the inner end thereof. The other end of spring 19 is fastened as by welding to a collar 20 that is telescoped and slidable on the exterior surface of the inner end of inlet tube 14. The spring 19 and collar 20 form an expansion chamber 21. When the exhaust gases enter chamber 21 through inlet tube 14, they strike conical end plate 17 and have their direction reversed by 180 degrees. As the pressure of the gases in chamber 21 builds up, the closed helical spring 19 is expanded axially toward the inlet tube 14 thereby opening up the convolutions and creating small passages between successive convolutions thereof through which the exhaust gases pass radially outwardly to the space 22 surrounding the helical spring 19 and inlet tube 14.

Baffle 16 is formed with a plurality of circumferentially spaced openings 23 through which the exhaust gases pass from space 22 into space 24 surrounding exhaust tube 15. Exhaust tube 15 is formed with a plurality of circumferentially and longitudinally spaced openings 25 through which the exhaust gases pass radially inwardly to the interior of outlet tube and from there axially to exhaust either directly or through a tailpipe (not shown).

In order to further suppress the noise without substantially affecting the back pressure, a cylindrical baffle 27 is provided in chamber 22 and is held in spaced relationship to the interior surface of casing 11 by integral tabs 28. Baffle 27 is formed with closed spaced openings 29 which operate to attenuate the noises produced by the exhaust gases.

The relative sizes of the various parts and openings are such that there is a minimum of back pressure produced by the muffler. Specifically, the cross sectional area of spring 19 is greater than the cross sectional area of inlet tube 14. Similarly, when the spring 19 is fully extended, the area between adjacent convolutions is greater than the cross sectional area of inlet tube 14. The sum of the cross sectional areas of the openings 23 in baffle 16 is also greater than the cross sectional area of the inlet tube 14 as is the sum of the cross sectional area of the openings 25 in the exhaust tube 15. Finally, the cross sectional area of the inlet tube 14 and exhaust tube 15 are substantially the same.

In use, the exhaust gases enter through inlet tube 14 and strike end plate 17. As the engine speed increases, or as the exhaust gases accumulate in chamber 21, pressure is created which acts on the collar 20 to move the collar 20 axially toward the inlet thereby extending the spring 19 to produce spaces between adjacent convolutions of the spring through which the exhaust gases can move radially in chamber 22. The exhaust gases then pass through openings 23 into chamber 24 and axially through opening 25 to the interior 26 of exhaust tube 15 and thereafter to the atmosphere or the tailpipe.

As the engine speed increases, the extension of spring 19 also increases correspondingly to permit exhaust. Tests have shown that the muffler operates to provide substantial attenuation of noise without adversely affecting back pressure at all engine speeds.

In addition to providing satisfactory muffling characteristics, the muffler design, utilizing a minimum number of parts, is such that it can be made at low cost and at the same time utilizing materials which are highly resistant to corrosion. Such materials are normally considered to be too expensive for use in mufflers and comprise stainless steel and aluminum.

In our opinion, the beneficial results of operation of the muffler in a minimum space are achieved due to the

following action: As the exhaust gases travel axially through the inlet tube 14 into the chamber 21, and impinge on the conical end plate 17 they have their direction turned 180 degrees and are directed into an annular space between the main stream of exhaust gases and the interior of the chamber 21 along the interior of spring 19. Because of the turbulence at the point where the exhaust gases change in direction and the opposing flow of the gases whose direction is changed, the main gas stream is made smaller in diameter. This necking down of the main stream reduces the cross sectional area of the main stream through inlet tube 14 so that it is smaller than the cross secetional area of the annular space surrounding the main stream. This, in turn, reduces the velocity of gases in the annular space so that the velocity of the pressure of the gases in the annular space is reduced and the static pressure is increased slightly. In addition, there is an impact load on the collar 20 due to the inertia of the gases. These two effects cause the collar 20 to slide axially on the inlet tube 14 toward the inlet. This movement causes the spring 19 to be extended producing the helical space between adjacent convolutions through which the exhausting gases may pass into the larger space 22.

The spring expansion chamber 21 will assume due to extension of the spring 19 a position of balance for each condition of flow, that is, each loading and speed of the engine. Since the engine operation is never uniform, there is a continuous movement of the spring 19 preventing carbon or other foreign materials from building up on the spring 19.

Further, in accordance with our theory, the attenuation of the noise is accomplished because of three factors. First, the 180 degree change in direction of the exhaust gases; second, the impact of the gases on the collar 20; and third, the diffusion of the gases through the adjacent convolutions of the spring 19. The first two factors cause the sound waves to reflect and interfere reducing their amplitude. The third factor results in a reduction in amplitude. Further attenuation is achieved by the holes 29 in baffle 27, the openings 23 in the transfer baffle 16 and openings 25 in the outlet tube 15.

A modified form of muffler which operates in substantially the same fashion as the muffler shown in FIGS. 1 to 3 is shown in FIGS. 4 and 5 wherein the muffler 30 comprises an outer cylindrical shell or casing 31 the ends of which are closed by end members 32, 33. An inlet tube 34 extends through end member 32 and terminates adjacent the member 32 while an outlet tube 35 extends through end member 33 and terminates closely adjacent the inner surface thereof. A transverse baffle 36 extends transversely of the casing 31 at substantially ⅔ of the distance between members 32, 33 and closer to member 33. Baffle member 36 includes an integral stepped shoulder 37 on which the one end of a tightly wound helical spring 38 is fixed. The other end of the tightly wound spring 38 is fixed as by welding to a collar 39 that is telescoped over and slidable on the exterior of tube 34. Transverse baffle 36 also includes circumferentially spaced openings 40 surrounding the shoulder 37. At the inner edge of shoulder 37 the baffle 36 is formed with an axial imperforate protrusion or extension 41 and a loosely wound helical spring 42 extends over the projection 41 and the inner end of outlet tube 35.

The construction of the muffler shown in FIGS. 4 and 5 is thus substantially the same as the construction of the muffler shown in FIGS. 1 to 3 except that the baffle member 27 has been removed and the holes 25 in tube 15 have been replaced by a loosely wound helical spring 42.

A further modified form of muffler is shown in FIGS. 6 and 7 wherein muffler 50 comprises a cylindrical shell or casing 51 the ends of which are closed by end members 52, 53. An inlet tube 54 extends through end member 52 and an outlet tube 55 extends through end member 53. A transverse baffle 56 is positioned within the casing 51 and more near the end member 53 than the end member 52. A cup-shaped member 57 extends and is mounted in an opening in baffle member 56 and supports a conical plate 58. Plate 58 includes a flange 59 which extends axially toward inlet 45. One end of a tightly wound spring 60 is fixed to flange 59 and the other end of the spring 60 is fixed to a collar 61 telescoped over and slidable on the inlet tube 54. Collar 61 includes a radial flange 62. The baffle member 56 is formed with circumferentially spaced openings 63.

The operation of the muffler shown in FIGS. 6 and 7 is substantially the same as the other forms of muffler. The exhaust gases enter through inlet tube 54 on the interior 64 of spring 60. The direction of the gases is changed by impingement on end plate 58. As the pressure on the gases on the collar 61 increases the collar is moved axially toward the inlet providing a space between adjacent convolutions of spring 60 through which the gases move radially outwardly. The gases then pass axially through opening 63 and radially into tube 55 and thereafter to exhaust directly or through an exhaust pipe.

The relationships of the cross sectional areas of the inlet tube, outlet tube, openings in the transverse baffle and spaces between adjacent convolutions of the extended springs in the forms of the invention shown in FIGS. 3–4 and 5–6 are substantially the same as heretofore described with regard to the form of the invention shown in FIGS. 1–3.

In the form of the invention shown in FIGS. 8 and 9, an elliptical or oval shaped housing 70 is provided with end plates 71, 72. The inlet tube 73 is divided into branches 74, 75 that project through the end wall 72. A central baffle plate 76 divides the chamber of housing 70 and a pair of conical baffle plates 77, 78 are provided on the baffle 76. Tightly wound springs 79, 80 have one end thereof fixed to the flanges of baffle 78 and the other end thereof fixed to collars 81, 82 telescoped on tubes 74, 75. A perforated cylindrical baffle 83 is provided within the area between the end wall 72 and baffle 76 and is held in spaced relationship thereto by circumferentially spaced and outwardly and radially extending tabs 84. The baffle 76 is formed with a plurality of circumferentially spaced staggered openings 85 (FIG. 9) through which the gases pass axially after having passed through the tightly wound springs 79, 80 as in the previous form of the invention. An outlet tube 86 having openings 87 projects from the baffle 76 through the end wall 71 to the atmosphere or to a tailpipe as the case may be.

The relationship of the cross sectional areas of the various elements of the muffler in the form of the invention shown in FIGS. 8 and 9 is substantially the same as in the previously described forms of the invention. Specifically, the cross sectional area of the springs 79, 80 is greater than the cross sectional area of the tubes 74, 75; when the springs are extended the area between adjacent convolutions is greater than the cross sectional area of the tubes 74, 75; the sum of the cross sectional areas of openings 85 is greater than the sum of the cross sectional areas of tubes 74, 75; the sum of the cross sectional areas of the openings 87 in outlet tube 86 is greater than the sum of the cross sectional areas of the tubes 74, 75; and the sum of the cross sectional areas of inlet tubes 74, 75 is substantially equal to the cross sectional area of the exhaust tube 86.

The terms "tightly wound" and "closed" when used herein to define the helical spring are intended to mean that the adjacent convolutions of the spring are in contact so that no space exists between adjacent convolutions.

We claim:

1. In a muffler, the combination comprising a casing, an inlet tube extending to the interior of said casting, a collar slidably mounted on said inlet tube in said casing,

a closed helical spring fixed at one end to said collar and axially aligned with said inlet tube, and closure means connected to and closing the other end of said spring, means fixing said closure means against axial movement relative to said inlet tube and said casing, said spring and closure means forming a chamber whereby when exhaust gases are passed inwardly through said inlet tube into said chamber the exhaust gases impinge on the closed end of said spring and as the static pressure of exhaust gases builds up in said chamber, the collar is caused to move axially on the inlet tube toward the inlet and thereby cause the spring to extend producing space between adjacent convolutions of the spring.

2. In a muffler, the combination comprising a casing, a transverse baffle member in said casing, an inlet tube extending from the exterior of said casing axially into said casing and terminating in spaced relationship to said baffle member, means for fixing said transverse baffle member against axial movement relative to said inlet tube and said casing, a collar slidably mounted on the inlet tube within said casing, a tightly wound helical spring axially aligned with said collar and having one end thereof fixed to said collar and the other end thereof fixed to said baffle member, said baffle member being imperforate in the area within the confines of said spring.

3. The combination set forth in claim 2 including a baffle member positioned in said casing in the area of said spring and comprising a wall in spaced relationship to the interior surface of said casing and having a plurality of openings therein.

4. In a muffler, the combination comprising a casing, an inlet tube extending into said casing, an outlet tube extending into said casing and being axially aligned with said inlet tube, a transverse member in said casing between the inner ends of said inlet tube and said outlet tube, means for fixing said transverse baffle member against axial movement relative to said inlet tube and said casing, a collar on the inner end of said inlet tube and slidably mounted relative thereto, a spring axially aligned with said inlet tube and having one end thereof fixed to said collar and the other end thereof fixed to said transverse baffle member, said spring comprising a plurality of tightly wound convolutions, said transverse baffle member being imperforate within the confines of said spring, said transverse baffle member having a plurality of axially extending openings surrounding said spring, and means providing a path of flow of the gases from the exterior of said outlet tube to the interior thereof within the confines of said casing.

5. The combination set forth in claim 4 wherein said latter means comprises openings in said outlet tube, said outlet tube terminating and being fixed to said transverse baffle member.

6. The combination set forth in claim 4 wherein said latter means comprises a loosely wound helical spring having one end thereof fixed to said transverse baffle member and the other end thereof fixed to said outlet tube in said casing.

7. In a muffler, the combination comprising a casing, a transverse baffle member in said casing, an inlet tube extending from the exterior of said casing axially into said casing and terminating in spaced relationship to said baffle member, means for fixing said transverse baffle member against axial movement relative to said inlet tube and said casing, a collar slidably mounted on the inlet tube within said casing, a tightly wound helical spring axially aligned with said collar and having one end thereof fixed to said collar and the other end thereof fixed to said baffle member, said baffle member being imperforate in the area within the confines of said spring, the cross sectional area of said spring being greater than the cross sectional area of said inlet tube.

8. In a muffler, the combination comprising a casing, a transverse baffle member in said casing, an inlet tube extending from the exterior of said casing axially into said casing and terminating in spaced relationship to said baffle member, means for fixing said transverse baffle member against axial movement relative to said inlet tube and said casing, a collar slidably mounted on the inlet tube within said casing, a tightly wound helical spring axially aligned with said collar and having one end thereof fixed to said collar and the other end thereof fixed to said baffle member, said baffle member being imperforate in the area within the confines of said spring, said baffle member having a plurality of openings therethrough in the area exterior of the confines of said spring.

9. The combination set forth in claim 8 wherein the sum of the cross sectional areas of the openings in said baffle member is greater than the cross sectional area of said inlet tube.

10. In a muffler, the combination comprising a casing, a transverse baffle member in said casing, an inlet tube extending from the exterior of said casing axially into said casing and terminating in spaced relationship to said baffle member, means for fixing said transverse baffle member against axial movement relative to said inlet tube and said casing, a collar slidably mounted on the inlet tube within said casing, a tightly wound helical spring axially aligned with said collar and having one end thereof fixed to said collar and the other end thereof fixed to said baffle member, said baffle member being imperforate in the area within the confines of said spring, the cross sectional area of said spring being greater than the cross sectional area of said inlet tube, said baffle member being provided with a plurality of openings therethrough in the area thereof exterior of the confines of said spring, the sum of the cross sectional areas of said openings in said baffle member being greater than the cross sectional area of said inlet tube.

11. In a muffler, the combination comprising a casing, an inlet tube extending into said casing, an outlet tube extending into said casing and being axially aligned with said inlet tube, a transverse member in said casing between the inner ends of said inlet tube and said outlet tube, means for fixing said transverse baffle member against axial movement relative to said inlet tube and said casing, a collar on the inner end of said inlet tube and slidably mounted relative thereto, a spring axially aligned with said inlet tube and having one end thereof fixed to said collar and the other end thereof fixed to said transverse baffle member, said spring comprising a plurality of tightly wound convolutions, said transverse baffle member being imperforate within the confines of said spring, said transverse baffle member having a plurality of axially extending openings surroundings said spring, and means providing a path of of flow of the gases from the exterior of said exhaust tube to the interior thereof within the confines of said casing, the cross sectional area of said spring being greater than the cross sectional area of said inlet tube.

12. In a muffler, the combination comprising a casing, an inlet tube extending into said casing, an outlet tube extending into said casing and being axially aligned with said inlet tube, a transverse baffle member in said casing between the inner ends of said inlet tube and said outlet tube, means for fixing said transverse baffle member against axial movement relative to said inlet tube and said casing, a collar on the inner end of said inlet tube and slidably mounted relative thereto, a spring axially aligned with said inlet tube and having one end thereof fixed to said collar and the other end thereof fixed to said transverse baffle member, said spring comprising a plurality of tightly wound convolutions, said transverse baffle member being imperforate within the confines of said spring, said transverse baffle member having a plurality of axially extending openings surrounding said spring, and means providing a path of flow of the gases from the exterior of said exhaust tube to the interior thereof within the confines of said casing, the sum of the cross sectional areas of said openings in said baffle member being greater than the cross sectional area of said inlet tube.

13. In a muffler, the combination comprising a casing, an inlet tube extending into said casing, an outlet tube extending into said casing and being axially aligned with said inlet tube, a transverse baffle member in said casing between the inner ends of said inlet tube and said outlet tube, means for fixing said transverse baffle member against axial movement relative to said inlet tube and said casing, a collar on the inner end of said inlet tube and slidably mounted relative thereto, a spring axially aligned with said inlet tube and having one end thereof fixed to said collar and the other end thereof fixed to said transverse baffle member, said spring comprising a plurality of tightly wound convolutions, said transverse baffle member being imperforate within the confines of said spring, said transverse baffle member having a plurality of axially extending openings surrounding said spring, and means providing a path of flow of the gases from the exterior of said exhaust tube to the interior thereof within the confines of said casing, the cross sectional area of said spring being greater than the cross sectional area of said inlet tube, the sum of the cross sectional areas of said openings in said baffle member being greater than the cross sectional area of said inlet tube.

14. In a muffler, the combination comprising a casing, a plurality of inlet tubes extending into the interior of said casing, a collar slidably mounted on each said inlet tube in said casing, a tightly wound helical spring fixed to each said collar and axially aligned with said inlet tube, and closure means connected to and closing the other end of each said spring, means fixing said closure means against axial movements relative to said inlet tubes and said casing whereby when exhaust gases are passed inwardly through said inlet tubes the exhaust gases impinge on the closed ends of said springs and as the pressure of exhaust gases builds up the collars are caused to move axially on the inlet tube toward the inlet and thereby cause the springs to extend producing spaces between adjacent convolutions of the springs.

15. In a muffler, the combination comprising a casing, a transverse baffle member in said casing, a plurality of inlet tubes extending from the exterior of said casing axially into said casing and terminating in spaced relationship to said baffle member, means for fixing said transverse baffle member against axial movement relative to said inlet tubes and said casing, a collar slidably mounted on each said inlet tube within said casing, a tightly wound helical spring axially aligned with each said collar and having one end thereof fixed to its respective collar and the other end thereof fixed to said baffle member, said baffle member being imperforate in the areas within the confines of said springs.

16. In a muffler, the combination comprising a casing, a plurality of inlet tubes extending into said casing, an outlet tube extending into said casing, a transverse member fixed in said casing between the inner ends of said inlet tubes and said outlet tube, means for fixing said transverse baffle member against axial movement relative to said inlet tubes and said casing, a collar on the inner end of each said inlet tube and slidably mounted relative thereto, a spring axially aligned with each said inlet tube and having one end thereof fixed to its respective collar and the other end thereof fixed to said transverse baffle member, each said spring comprising a plurality of tightly wound convolutions, said transverse baffle member being imperforate within the confines of said spring, said transverse baffle member having a plurality of axially extending openings surrounding said spring, and means providing a path of flow of the gases from the exterior of said exhaust tube to the interior thereof within the confines of said casing.

17. In a muffler, the combination comprising a tube into one end of which gases are adapted to be directed, a collar slidably mounted on the other end of said tube, a closed helical spring telescoped over said tube, said spring having one end thereof fixed to said collar and the other end thereof extending beyond said other end of said tube, closure means connected to and closing the other end of said spring, and means fixing said closure means against axial movement relative to said tube.

18. In a muffler, the combination comprising a tube into one end of which gases are adapted to be directed, a collar slidably mounted on the other end of said tube, said collar having a radial flange, a closed helical spring telescoped over said tube, said spring having one end thereof fixed to said radial flange of said collar and the other end thereof extending beyond the other end of said tube, closure means connected to and closing the other end of said spring, and means fixing said closure means against axial movement relative to said tube.

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