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Mellin

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[54] **SWIRLING FLOW MUFFLER**

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[52] **U.S. Cl.** **181/58,** 181/42, 181/50, 181/59

[51] **Int. Cl.** **F01n 1/10**

[58] **Field of Search** 181/40, 42, 50, 55, 181/57–59

[56] **References Cited**

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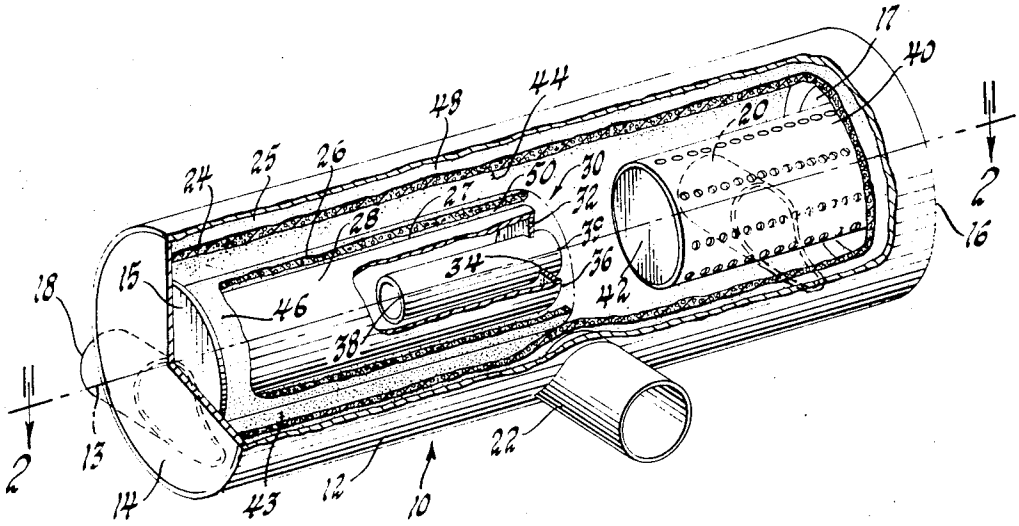
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Assistant Examiner—John F. Gonzales
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[57] **ABSTRACT**

In preferred form, a sound attenuating device receiving internal combustion engine exhaust gases including a closed cylindrical body having tangentially attached inlet and outlet ports providing unbaffled helical flow of the gases through the cylindrical body. A first layer of acoustical material is positioned within said closed cylindrical member in conformance to the interior surface thereof and can be spaced therefrom depending upon the particular material used. A second layer of acoustical material is concentrically disposed about a cylindrical resonator attached to one end of the closed cylindrical body. The second layer of acoustical material substantially conforms to the exterior surface of the resonator and can also be spaced therefrom depending upon the materials used. A perforated cylindrical member having a closed end is attached to the other end of the cylindrical body. The closed end of the perforated cylindrical member extends toward but is spaced from the end of the resonator which extends approximately half the axial length of the closed cylindrical body. Upon entrance into the inlet port, a substantial portion of the sound waves impinge against both layers of acoustical material so that both high frequency and medium frequency sound waves are absorbed by the material as the gases progress through the unbaffled helical flow path to the outlet port. The annulus itself is effective to cancel wavelengths associated with the circumferential distance. In addition, the muffler chamber exhibits lined expansion chamber noise reduction characteristics. This arrangement provides desirable sound attenuating results without creating a substantial pressure drop across the device.

3 Claims, 4 Drawing Figures



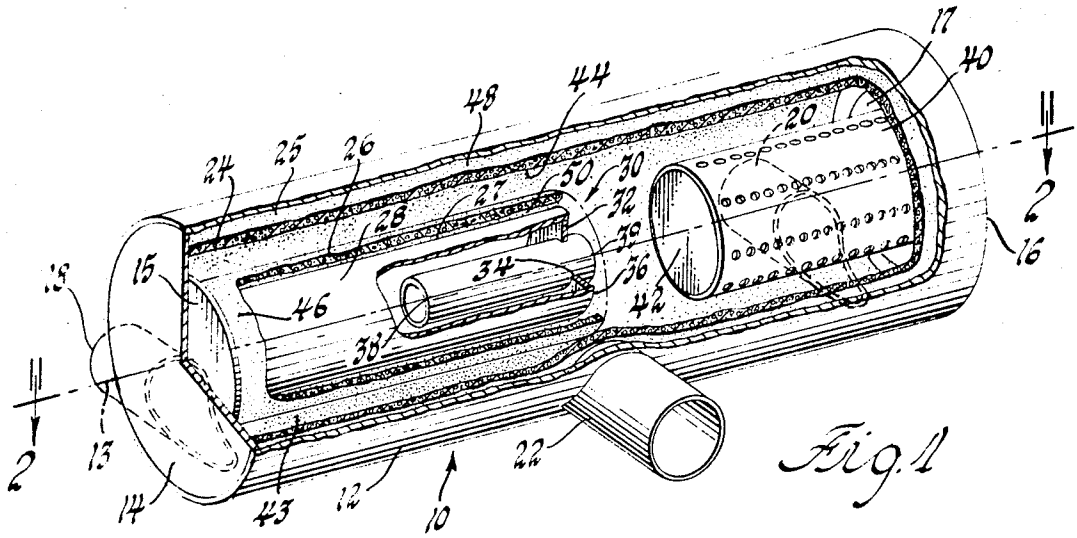


Fig. 1

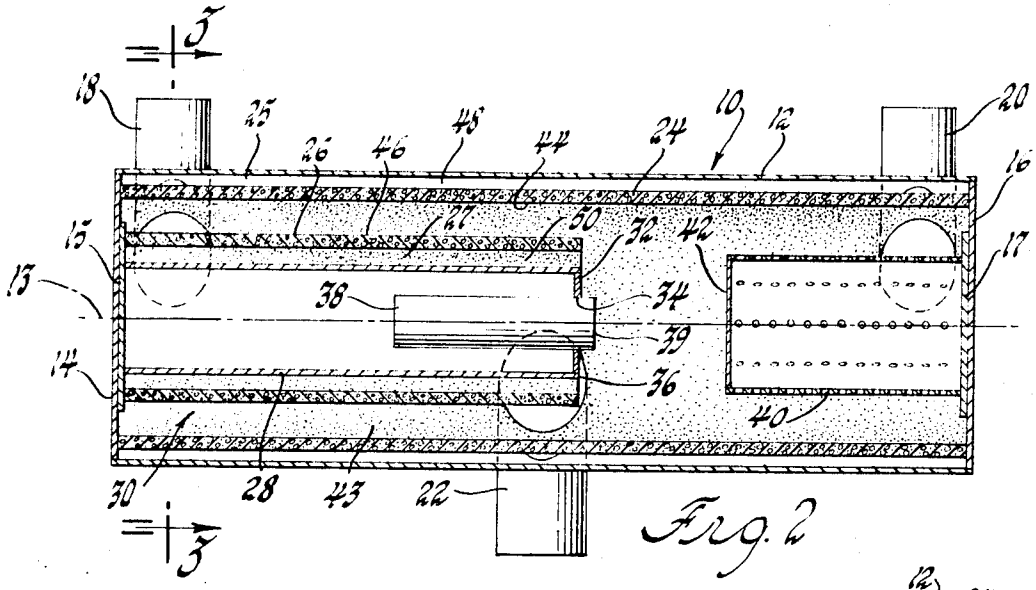


Fig. 2

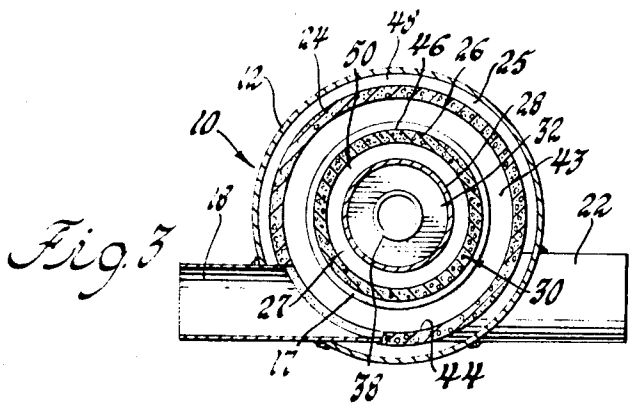


Fig. 3

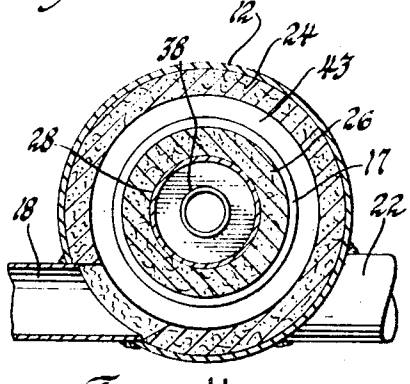


Fig. 4

SWIRLING FLOW MUFFLER

The present invention relates to a swirling flow muffler and more particularly to a swirling flow muffler including cylindrical bodies of acoustical material bounding a helical flow path therethrough and absorbing both high frequency and medium frequency sound energy in the exhaust gases received from an internal combustion engine.

Heretofore, it has been proposed to absorb acoustic energy by passing a fluid medium through a sound attenuating container containing flow obstructing baffles or other flow interfering structures utilized to create helical flow path therethrough. In an arrangement using baffles or other fixed members to produce a circuitous flow through the unit, sound energy is effectively dampened by virtue of the viscous dissipation in the circuitous flow path and cancellation in resonator components. Use of these dissipation members, however, necessarily obstructs flow through the muffling container consequently developing an undesirable exhaust gas back pressure. Therefore, it is a purpose of this invention to provide a sound attenuating device developing a swirling flow through a cylindrical muffler container without creating a significant pressure drop thereacross eliminating undesirable engine back pressure.

A further purpose of this invention is to provide a sound attenuating device incorporating cylindrical bodies of acoustical material to dampen both high and medium frequency sound energies as the gases transverse a helical flow path. These features are accomplished by providing a closed cylindrical muffler container having spaced outlet and inlet ports tangentially attached to the container requiring the gases to impinge against surfaces of the cylindrical bodies creating a helical flow path. A first cylindrical body of acoustical material is placed adjacent the inside surface of the cylindrical muffler container while a second cylindrical body of acoustical material having a reduced diameter is positioned coaxially within the first body so that the flow path is defined between the inner surface of the first body and the outer surface of the second body. In this manner a portion of the sound waves are required to be exposed to the inside surface of the first body which dampens both high frequency and medium frequency sound energy while a substantial portion of the sound waves are also exposed to the outer surface of the second acoustical body which likewise dampens both high and medium frequency sound energy. In addition, the device is effective to also attenuate a portion of the sound energy by virtue of the wavelengths associated therewith cancelling through wave interference on the annular circumference of the acoustical bodies. Further reduction in sound energy is obtained by the entire unit acting as a lined expansion chamber. The two cylindrical bodies of sound absorbing material and the helical flow path combine to substantially eliminate high and medium frequency sound energy normally existing in vehicle exhaust gases.

A general object of the present invention is to provide an improved acoustical absorbing swirling flow muffler providing an unbaffled helical flow path therethrough without generating a substantial back pressure.

Another object of the subject invention is to provide an improved muffler having a swirling helical flow path that is created by attaching inlet and outlet conduits to the muffler at tangential positions and including spaced

cylindrical bodies of acoustical material with the muffler defining the flow path substantially dampening both high and medium frequency sound energies of the gases flowing therethrough.

A further object of the subject invention is the provision of an improved sound attenuating swirling flow internal combustion engine exhaust gas muffler including a closed cylindrical container having tangentially connected inlet and outlet conduits creating a helical flow path for the gases received in the container, a first cylindrical body of sound absorbing material coaxial with the container with its outer surface spaced therefrom, a second cylindrical body of sound absorbing material coaxial with the first body and spaced therefrom the space between the inner surface of the first body and the outer surface of the second body defining the flow path so that a substantial portion of the sound waves contact these surfaces, and a resonator tube coaxially within the second body so that a substantial portion of the sound energy in the exhaust gases is cancelled or absorbed by the absorbing material, the annular dimensions of the bodies and the resonator.

A further object of the subject invention is to provide an improved sound attenuating swirling flow muffler for use with internal combustion engines providing an unbaffled flow path therethrough and incorporating sound absorbing material resulting in sound absorption quality achieved by presently used mufflers in a more economical fashion without creating a substantial pressure drop thereacross.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation may be best understood by reference to the following description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a perspective view with portions broken away of a specific embodiment of the subject invention.

FIG. 2 is a cross-sectional view taken on line 2—2 of FIG. 1.

FIG. 3 is a cross-sectional view taken on line 3—3 of FIG. 2.

FIG. 4 is a cross-sectional view of a modified form of the subject invention.

For purposes of illustration reference is made to FIG. 1 wherein a swirling flow muffler assembly **10**, constructed in accordance with this invention, is illustrated as including a cylindrical container **12** having a longitudinal axis **13** and including closed ends **14** and **16**. Inlet conduits **18** and **20** are tangentially connected to the closed cylinder **12** adjacent the closed ends **14** and **16**, respectively. An outlet conduit **22** is tangentially connected to the cylindrical container **12** near its midportion as shown. A first cylindrical body **24** of sound absorbing or acoustical material is positioned within the closed cylinder **12** but spaced therefrom as indicated at **25**. The body **24** can be positioned in engagement with the inner surface of the cylinder **12** if desired. A second cylindrical body **26** of sound absorbing or acoustical material coaxially extends approximately half the axial length of the closed cylinder **12** and is connected to end **14** at an attached stiffening plate **15**. It also is concentrically disposed about a first cylindrical sleeve **28** of a resonator assembly **30** while being spaced therefrom as indicated at **27**. The body **26** can also be placed in engagement with the outer surface of

sleeve 28 if desired. The sleeve 28 is also connected to the plate 15 on end 14 of the closed cylinder 12 and has a cylindrical plate 32 containing an aperture 34 secured to its free end 36. The plate 32 receives a relatively smaller tubular sleeve 38 which is retained in the aperture 34 of plate 32. The smaller sleeve 38 extends approximately half the axial length of sleeve 28 and has a portion 39 protruding from the sleeve 28 as shown in FIG. 1. The muffler assembly 10 also includes perforated cylindrical member 40 attached to a stiffening plate 17 secured to end 16 of cylinder 12 and extends inwardly toward end 36 of the sleeve 28. The perforated cylinder 40 includes a closed end 42 so that gases entering inlet 20 will encounter the perforations in the sleeve but cannot pass through the end thereof.

The inlet conduits 18 and 20, as previously mentioned, are tangentially connected to the cylindrical container 12 and extend into space 43, of the embodiment of the invention shown in FIGS. 1–3, so that a helical flow path is created causing the gases to follow a spiral path until they exit outlet 22. When the inlet conduits are connected to respective manifolds of an internal combustion engine, such as those present in a V-type engine, the gases are received within the space 43 and traverse the unit to outlet 22. It is apparent that a major portion of the gases will come into direct contact with inner surface 44 of the first body 24 so that a substantial portion of the sound waves in the gases will be dampened by the absorption qualities of the material forming the body 24 as they pursue the helical swirling flow path through muffler 10. Also, as the gases flow through the muffler 10, a portion of the sound energy will also be dampened by virtue of the wave interference around the annular circumference and the lined expansion chamber characteristic of the entire unit. The second body 26 of acoustical material is positioned so that a portion of the sound waves will necessarily engage its outer surface 46 so that it will be effective to likewise dampen a portion of the sound energy present in the fluid as it flows through its helical path in the unit. In order to assure dampening of low frequency acoustical energy in some installations it would be necessary to incorporate the resonator assembly 30 as illustrated in FIG. 1. Likewise, the cylindrical member 40 is effective as a resonator to dampen low frequency energy existing in the fluid when received by the swirling muffler 10. More specifically, the perforated cylindrical resonator 40 attenuates sound frequencies in the range of 85 Hz. The resonator assembly 30, including sleeves 28 and 38, is designed to provide maximum attenuation sound frequencies in the vicinity of 200 Hz. Since the bodies 24 and 26 of acoustical material are effective to dampen sound energy having frequencies above 500 Hz with excellent dampening characteristics above 1,000 Hz, the assembly 10 is effective to substantially dampen vehicle engine sounds at all frequency levels.

While the embodiment shown, for purposes of illustration only, includes the resonator assembly 30 and the perforated cylindrical sleeve 40, it is not essential that these units be provided in every installation. Desirable results can be obtained by positioning the second body 26 of acoustical material relative to the first body 24 so that the sound waves will be required to substantially engage both of these layers as the gases enter the inlet conduits 18 or 20 and traverse the unit to outlet 22 through the helical path which must necessarily result because of the tangential connection of the inlet 18 and the outlet port 22. Further, the acoustical characteristics of the swirling flow muffler 10 can be enhanced by extending the axial length of the second body 26 of acoustical material for the full length of the unit so that it engages end 16. Of course, this would eliminate use of the resonators 30 and 40.

While two inlets 18 and 20 are shown, the unit would be equally operative if one inlet only were used and the outlet was positioned at the end remote from the inlet, for example at end 16 away from inlet 18, so that the gases would be required to travel the full length of the muffler unit 10.

The bodies 24 and 26 of acoustical material can be composed of any material which is capable of resisting the heat applied by internal combustion engine exhaust gases. Examples of acceptable materials include metal foams, perforated metal or various fiberglass compositions, any of which are well known in the art. In a specific embodiment, a metal foam was used which was pressed to 25 percent density from an initial thickness of one-half inch, finally resulting in a layer of 1/10 inch thickness. A ¾ inch space 48 was provided between layer 24 and the inner surface of the closed cylinder 12 while a ⅜ inch space 50 was provided between layer 26 and the first sleeve 28 of the resonator assembly 30. The metal foam can be a nickel alloy or any other metal composition but an iron or iron-chromium composition would be preferable because they provide better durability characteristics. As shown in FIG. 4, the bodies 24 and 26 of acoustical material can be of a fiberglass composition and can be of a thickness to engage the inner surface of the container 12 and the outer surface of the sleeve 28. It is necessary that the fiberglass be heat resistant while providing sound dampening qualities. Use of any desirable material for the bodies 24 and 26 is, of course, within the purview of this invention.

In operation, engine exhaust gases enter inlet conduits 18 and 20 and follow a helical flow path until they exit outlet conduit 22. While following the helical path, a major portion of the sound waves contact surfaces 44 and 46 of the bodies 24 and 26 allowing the acoustical material to absorb a significant portion of the sound energy at high and medium frequencies. A portion of the sound energy is canceled because the wavelengths are related to the annular circumferential distance. The entire unit also acts as a lined expansion chamber for sound reduction. The resonator assembly 30 can be tuned or acoustically coupled to the container to meet a particular requirement and cancel a substantial portion of the remaining low frequency sound energy.

The swirling flow muffler 10 of the subject invention is capable of providing desirable sound attenuation results while creating a significantly low pressure drop across the unit. This is primarily due to the fact that the gases flow through an unbaffled path and are not required to pass through a sound absorbing material in traversing the muffler 10.

While a preferred embodiment of the subject invention has been described for purposes of illustration, it is not intended to limit the scope of my invention except as required by the following appended claims:

I claim:

1. A sound attenuating device for an internal combustion engine characterized by low pressure drop thereacross comprising: means defining a generally cylindrical silencing chamber having end walls and a lon-

gitudinal axis; inlet and outlet conduits communicating with axially spaced points on said means and tangentially disposed with respect thereto adjacent the outer periphery thereof and extending into the interior of said body to direct exhaust gases from said engine in an unbaffled helical flow path through said chamber; a first cylindrical body of acoustical absorbing material coaxially disposed within said chamber and adjacent to the outer periphery of said chamber so that its inner periphery is exposed to sound waves in the flow path for absorbing the latter; and a second cylindrical body of acoustical absorbing material coaxial with said chamber and within said first mentioned body of acoustical absorbing material interiorly peripherally bounding the exhaust gas helical flow path on its outer surface to helically direct the gas flow against the interior surface of said first cylindrical body of acoustical material, the annular circumference being effective to attenuate related wavelength sound waves and said bodies of acoustical material being effective to absorb ranges of sound wavelengths in the high and medium portion of the frequency spectrum, whereby said device cancels a substantial portion of sound energy in the fluid pass therethrough.

2. A sound attenuating device for an internal combustion engine characterized by low pressure drop thereacross comprising: means defining a generally cylindrical silencing chamber having end walls and a longitudinal axis; inlet and outlet conduits communicating with axially spaced points on said means and tangentially disposed with respect thereto adjacent the outer periphery thereof; a first cylindrical body of acoustical absorbing metal foam coaxial with said chamber and inside the same adjacent to and spaced from the outer periphery of said chamber so that its inner periphery is exposed to sound waves in the flow path for absorbing the latter; a second cylindrical body of acoustical absorbing metal foam interiorly peripherally bounding the exhaust gas helical flow path on its outer surface to direct the sound waves against the interior surface of said first cylindrical body of metal foam; said bodies consequently defining a flow path space therebetween and said inlet and outlet conduits extending into the interior of said first body directing exhaust gases from said engine in an unbaffled helical flow path through the space in said chamber; and a resonator member centrally disposed within said second cylindrical body and acoustically coupled to said cylindrical chamber, the annular circumferential path being effective to attenuate sound waves of related wavelength and said bodies of acoustical metal foam being effective to absorb high and medium frequency ranges of sound wavelengths; said resonator member further attenuating low frequency sound waves in the exhaust gases, whereby said device cancels a substantial portion of sound energy in the fluid passing therethrough.

3. A sound attenuating device as described in claim **2** further comprising the resonator member being attached to one end of said means and extending substantially to the mid-portion of said silencing chamber; and a perforated second resonator member attached to the opposite end of said means and extending toward said resonator but terminating so as to provide a space therebetween; said resonators being acoustically coupled to said silencing chamber whereby said bodies of acoustical metal foam, the annular circumferential path and said resonators cooperate to substantially cancel the sound energy in exhaust gases flowing through said device.

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