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(54) DUAL MODE EXHAUST MUFFLER

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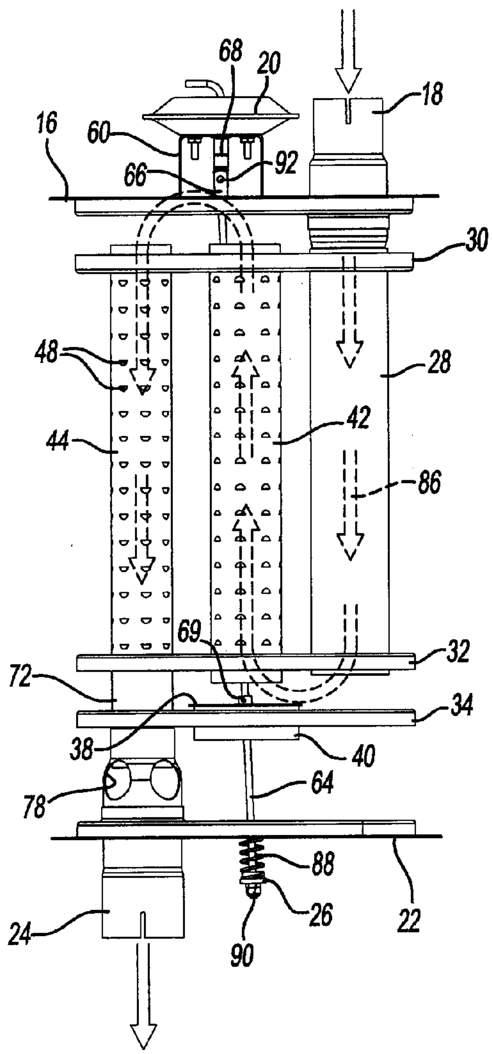
(57) **ABSTRACT**

A dual mode exhaust muffler for the engine of a vehicle that may be shifted between a quiet mode and a loud mode. A single muffler, a dual transverse muffler with two independent exhaust flow streams, and a dual transverse muffler with a combined exhaust flow stream embodiments are disclosed. An inlet tube may be a solid wall tube to minimize sound attenuation in the loud mode. The dual transverse muffler embodiments utilize an exhaust flow path that passes out through a reticulated wall of one tube and passes into a reticulated wall of a second tube. A vacuum switch having a two position on/off slide actuator may be used with any of the muffler assemblies.



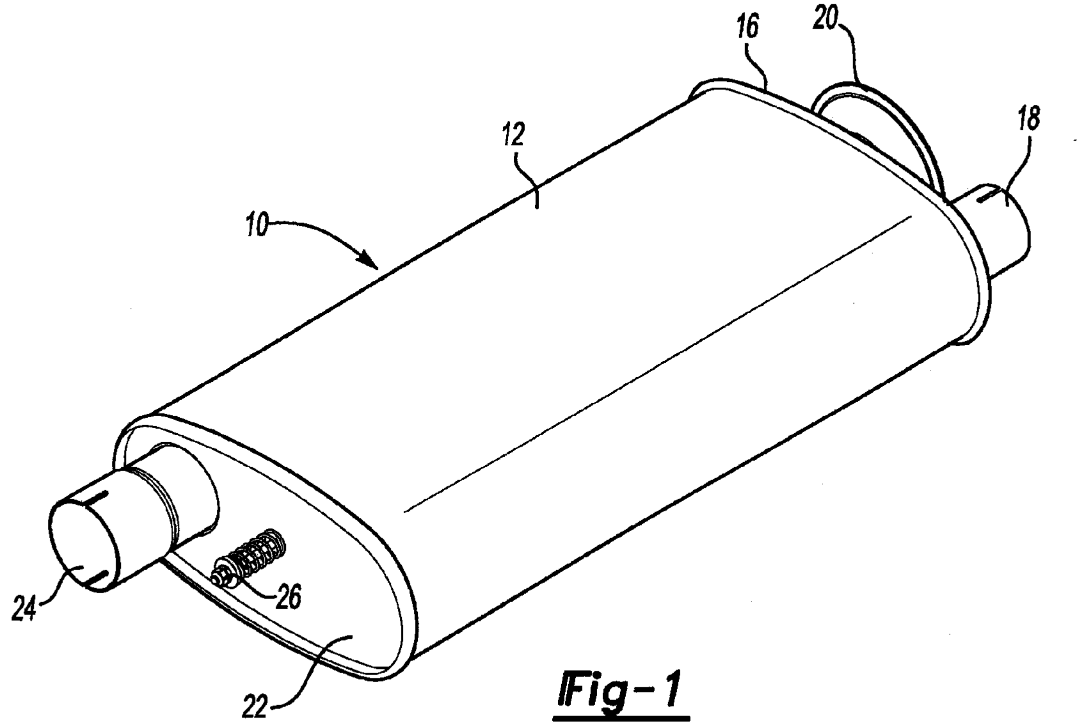


Fig-1

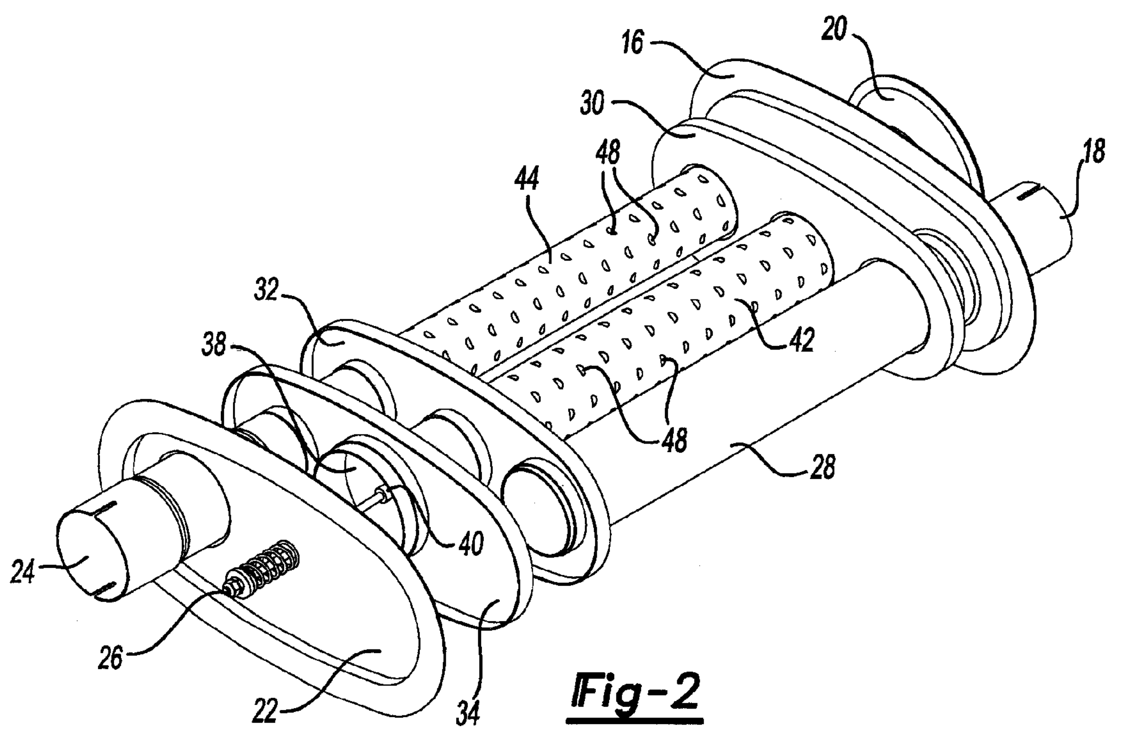


Fig-2

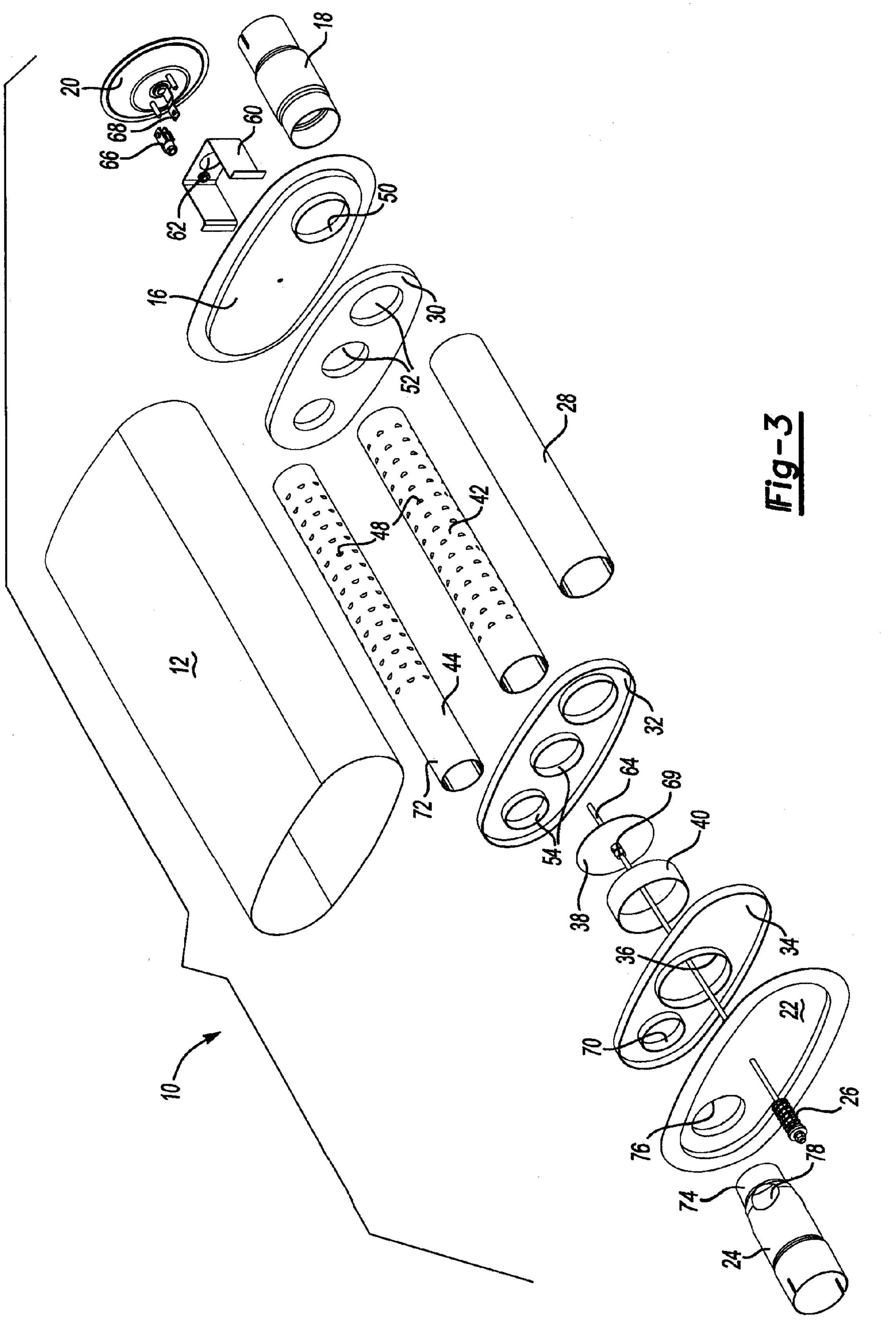

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Fig-3

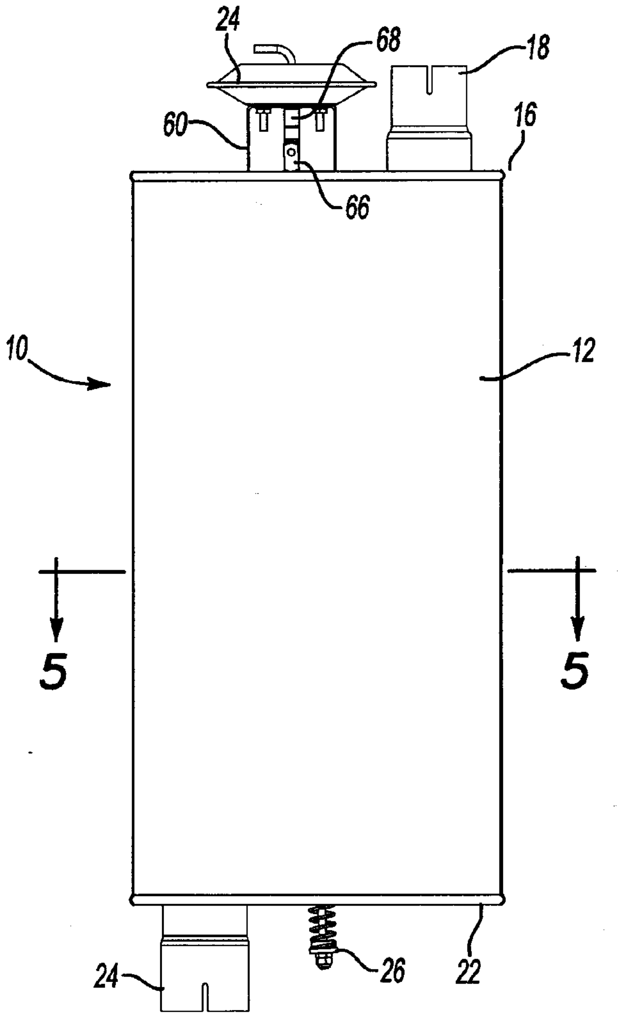

Fig-4

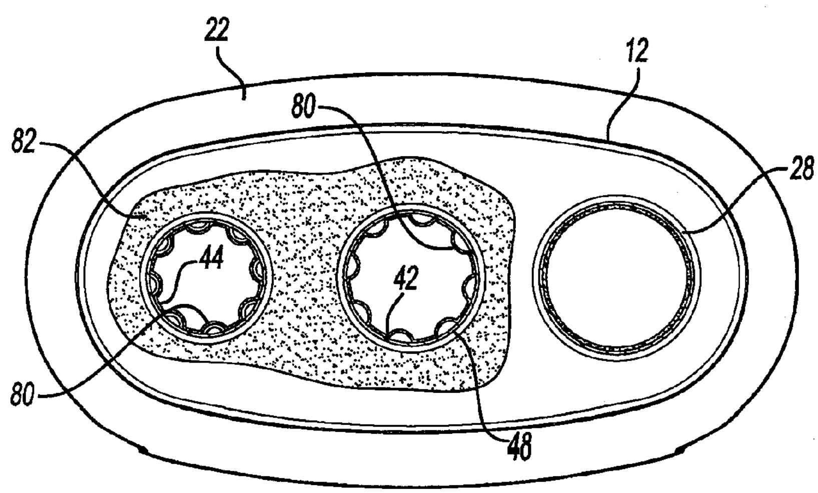

Fig-5

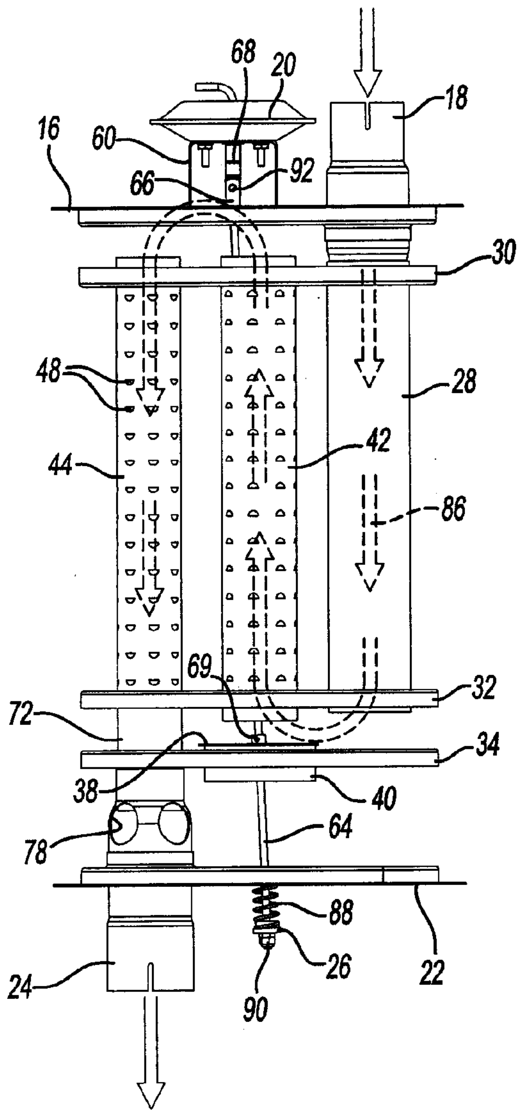
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Fig-6

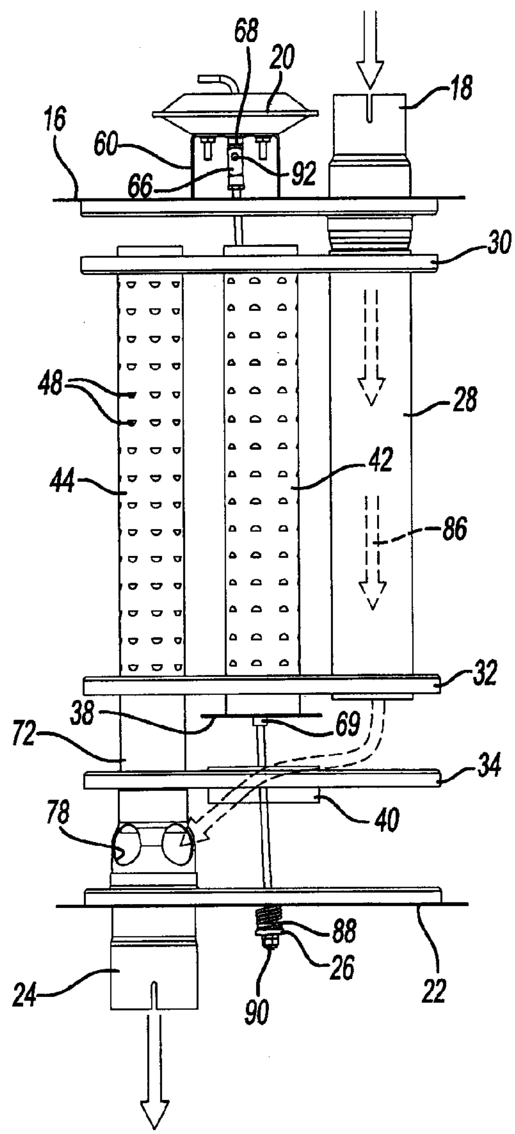
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Fig-7

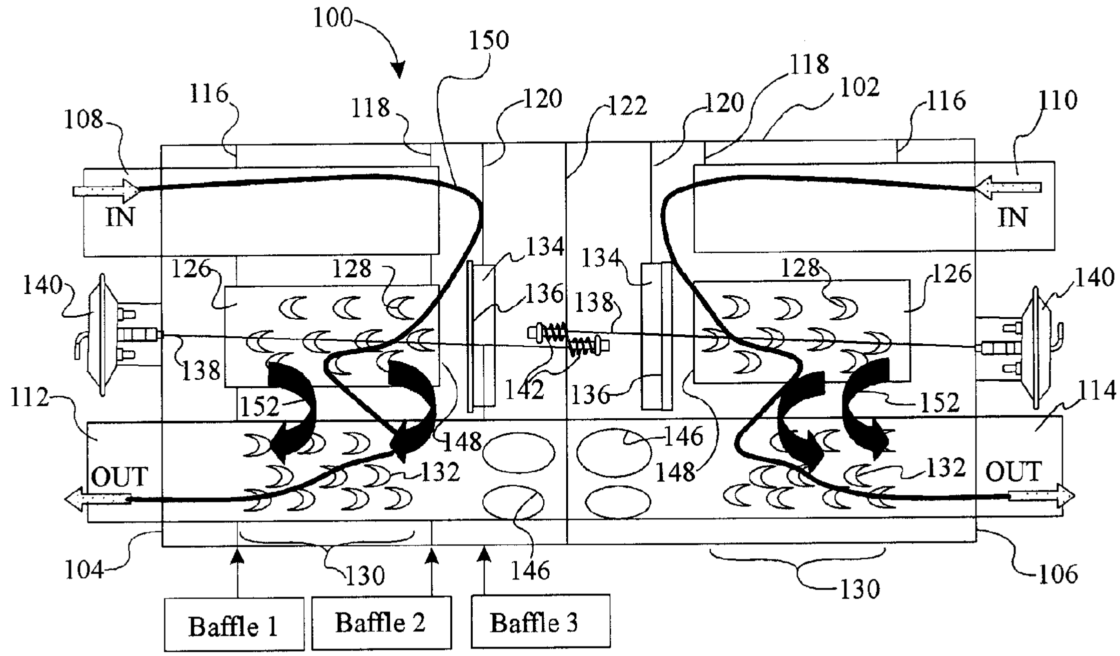
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Fig - 8

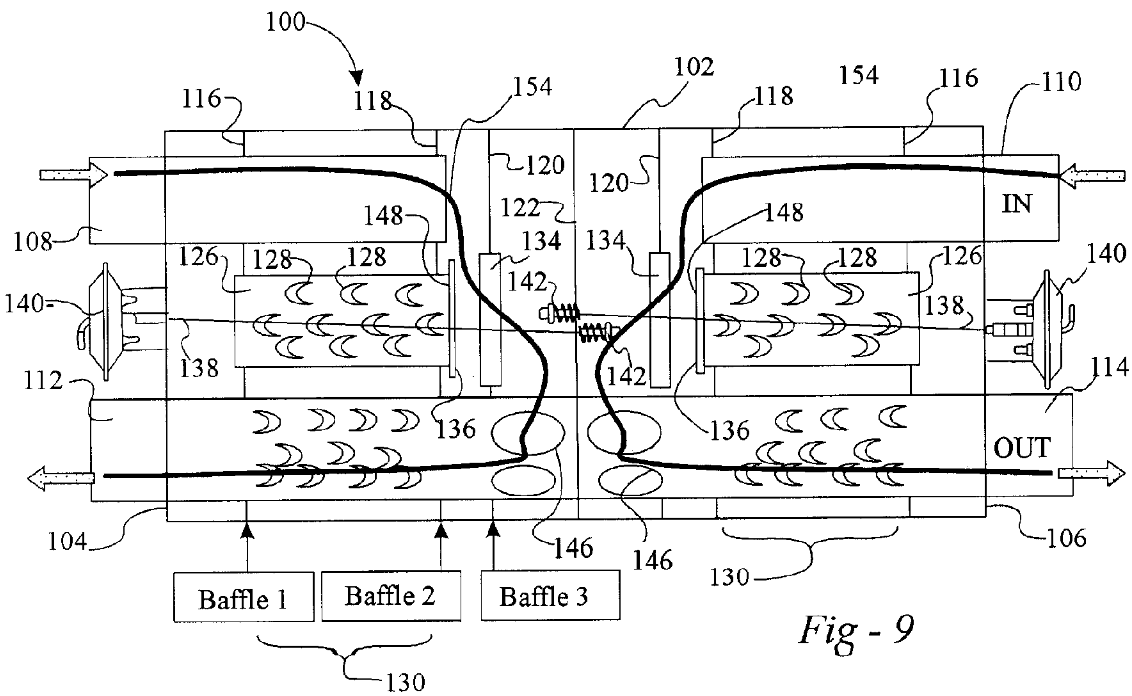
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Fig - 9

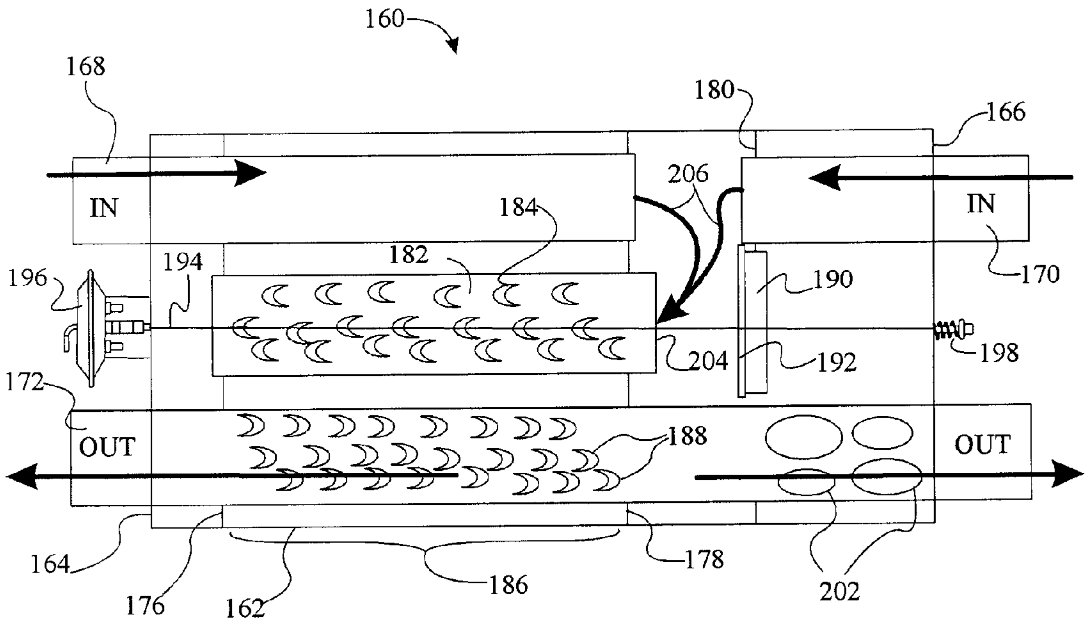
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Fig - 10

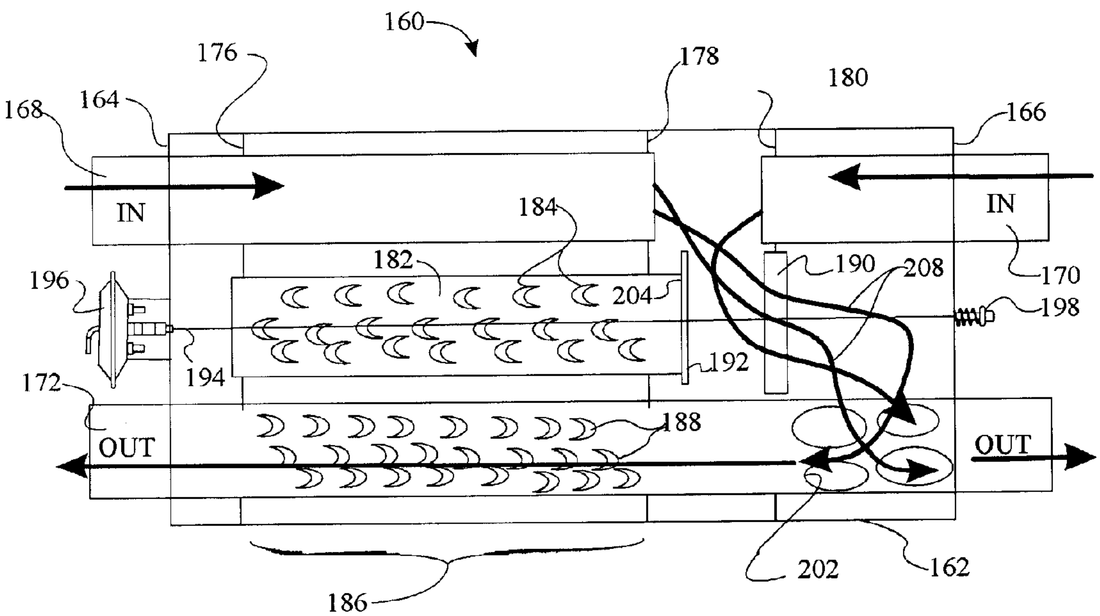
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Fig - 11

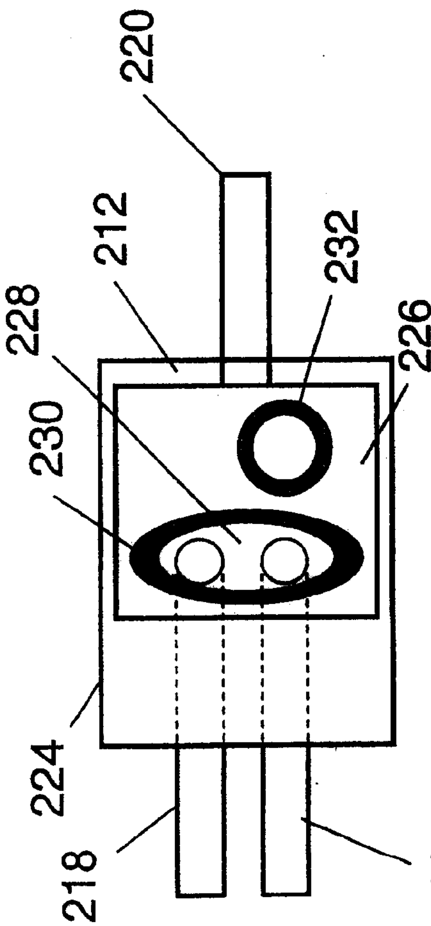
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Fig. 12

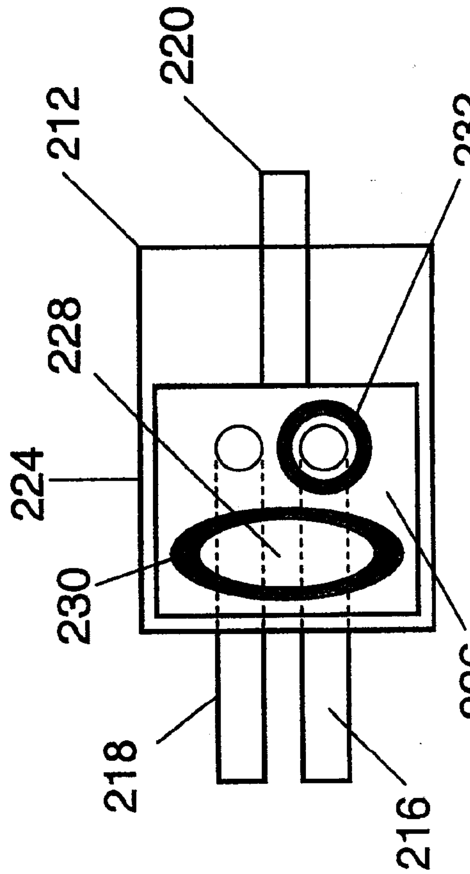
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Fig. 13

DUAL MODE EXHAUST MUFFLER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. provisional application Ser. No. 61/027,173 filed Feb. 8, 2008.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an exhaust muffler for a vehicle that is shiftable between a quiet mode and a loud mode.

[0004] 2. Background Art

[0005] Vehicle mufflers receive exhaust gases from an engine, such as an internal combustion engine or a diesel engine, for the purpose of attenuating the noise associated with the moving gas stream. Mufflers generally include a plurality of tubes and sound attenuating chambers formed by baffles and/or chambers within a shell. The walls of the tubes may include small openings to attenuate sound waves and reduce noise levels. While in most instances mufflers are designed to reduce noise and provide a low sound volume/low sound pressure level, absent undesirable resonance, some drivers of high performance vehicles prefer a louder sound and reduced back pressure.

[0006] A durable and reliably manufactured high performance exhaust muffler offering dual operating modes is provided by Applicants' invention. As shown in the attached drawings, the following detailed description is of several illustrated embodiments.

SUMMARY OF THE INVENTION

[0007] According to one embodiment of the present invention, a muffler assembly is provided for a vehicle. The muffler assembly comprises a shell, an inlet tube, a plurality of sound attenuating tubes, a valve, and an outlet tube. The inlet tube is disposed within the shell and extends from an inlet end to a first chamber. The inlet tube is a solid wall tube. All of the exhaust gases flow through the inlet tube from the inlet end to the first chamber. The plurality of sound attenuating tubes are disposed within the shell that have a plurality of sound attenuating orifices spaced along the length of the sound attenuating tubes. The sound attenuating tubes extend from the first chamber through a plurality of baffles disposed inside of the shell. The valve closure element directs the exhaust gases through the sound attenuating tubes in a first mode of operation. The valve closure element directs exhaust gases after flowing through the inlet tube that does not have sound attenuating orifices from the first chamber into a second chamber in a second mode of operation. The outlet tube receives exhaust gases that are routed through the sound attenuating tubes in the first mode of operation. The outlet tube has a direct flow port through which exhaust gases are received from the second chamber in the second mode of operation that have not been circulated through the sound attenuating tubes. The outlet tube discharges the exhaust gases from the muffler assembly in both modes.

[0008] According to another embodiment of the present invention, a dual transverse muffler assembly for a vehicle is provided that has a combined flow path. The dual transverse muffler assembly with a combined flow path comprises a first inlet tube through which exhaust gases flow into a shell. The first inlet tube is partially disposed within the shell and extends from the a first end wall to an interior chamber. A second inlet tube is partially disposed within the shell that extends from a second end wall to the interior chamber. A sound attenuating tube is disposed within the shell that has a first plurality of sound attenuating orifices spaced along its length, The sound attenuating tube extends from the interior chamber through a plurality of baffles disposed inside of the shell. A valve closure element directs the exhaust gases through the sound attenuating tube in a first mode of operation. The valve closure element directs exhaust gases from the first chamber into a second chamber in a second mode of operation. An outlet tube extends through the shell from a first outlet tube opening through the first end wall to a second outlet tube opening through the second end wall. The outlet tube receives exhaust gases that are received from the sound attenuating tube in the first mode of operation through a portion of the outlet tube that has a second plurality of sound attenuating orifices. The outlet tube also has a direct flow opening through which exhaust gases are received from the second chamber in the second mode of operation. Exhaust gases are discharged from the shell in both the first and second modes of operation through the first and second outlet openings.

[0009] According to yet another embodiment of the present invention, a dual transverse muffler assembly for a vehicle is provided that has a dual independent flow path. The dual transverse muffler assembly with a dual independent flow path comprises a shell that is divided by a central baffle that divides the shell into two parts. First and second sets of muffler components are provided within the shell on opposite sides of the central baffle with one set of muffler components being provided in each of the two parts. Each set of muffler components has a first baffle provided within the shell proximate the end wall, a second baffle provided within the shell at a spaced location relative to the first baffle on the opposite side of the first baffle from the end wall, an a third baffle provided within the shell between the second baffle and the central baffle. An inlet tube directs the flow of exhaust gases into the shell through the first and second baffles to an interior chamber. A sound attenuating tube is disposed within the shell that has a first plurality of sound attenuating orifices spaced along the length of the sound attenuating tube. The first sound attenuating tube extends from an inlet that opens into the interior chamber through the first and second baffles to a first end chamber defined between the end wall and the first baffle. A valve opening ring is disposed in the third baffle and is provided with a valve closure element. The valve closure element directs the exhaust gases through the sound attenuating tube in a quiet mode of operation. The valve closure element directs exhaust gases from the first interior chamber through the valve opening ring and into a direct exhaust chamber defined between the third baffle and the central baffle in a loud mode of operation. An outlet tube extends through the shell from a outlet tube opening through the first end wall to the central baffle, the outlet tube has a plurality of sound attenuating orifices that receive exhaust gases that pass through the first plurality of sound attenuating orifices of the sound attenuating tube in the quiet mode of operation. The outlet tube has at least one direct flow opening through which exhaust gases are received from the direct exhaust chamber in the loud mode of operation that have not been circulated through the sound attenuating tube. Exhaust gases are discharged from the shell in both the first and second modes of operation through the tailpipe opening.

[0010] The above features and other advantageous features of the present invention will be better understood in view of the attached drawings and the following detailed description of the disclosed embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** is a perspective view of an exhaust muffler assembly;

[0012] FIG. **2** is a perspective view of an exhaust muffler assembly with the shell removed;

[0013] FIG. **3** is an exploded perspective of the exhaust muffler assembly;

[0014] FIG. **4** is a plan view of an exhaust muffler assembly;

[0015] FIG. **5** is a cross-sectional view taken along line **5-5** in FIG. **4**;

[0016] FIG. **6** is a plan view of an exhaust muffler assembly with the shell removed and operating in a quiet mode;

[0017] FIG. **7** is a plan view of an exhaust muffler assembly with the shell removed and operating in a loud mode;

[0018] FIG. **8** is a diagrammatic plan view of a dual transverse driver controlled exhaust having two independent exhaust flow streams operating in a quiet mode;

[0019] FIG. **9** is a diagrammatic plan view of a dual transverse driver controlled exhaust having two independent exhaust flow streams operating in a loud mode;

[0020] FIG. **10** is a diagrammatic plan view of a dual transverse driver controlled exhaust system having a combined exhaust gas flow stream operating in a quiet mode;

[0021] FIG. **11** is a diagrammatic plan view of a dual transverse driver controlled exhaust system having a combined exhaust gas flow stream operating in a loud mode;

[0022] FIG. **12** is a diagrammatic plan view of a vacuum switch in an open position; and

[0023] FIG. **13** is a diagrammatic plan view of a vacuum switch in a closed position.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0024] Referring to FIG. **1**, a muffler assembly **10** is illustrated that is made in accordance with one embodiment of the present invention. Other embodiments of the invention are possible within the scope of the present invention. The muffler assembly **10** includes a shell **12** that may be oval, circular or oblong in shape. The component parts of the muffler assembly **10** may be formed of stainless steel or ferritic stainless steel to eliminate or minimize corrosion. An inlet end wall **16** is assembled to one end of the shell **12** by welding or by a hem flange connection. An inlet tube **18** is received in the inlet end wall **16**. A vacuum diaphragm actuator **20** is also assembled to the inlet end wall **16**. Instead of the illustrated vacuum diaphragm actuator **20**, a manual actuator or an electrical solenoid actuator may be provided. An outlet end wall **22** is provided at the opposite end of the shell **12** from inlet end wall **16**. An outlet tube **24** is received in the outlet end wall **22**. A return spring adjustment mechanism **26** is assembled to outlet end wall **22**. The internal components and structure of the muffler assembly **10** that are enclosed by the shell **12** will be more specifically described with reference to FIGS. **2-7** below.

[0025] Referring to FIG. **2**, portions of the muffler assembly **10** are shown with the shell **12** removed. The inlet tube **18** extends through the inlet end wall **16** and also through an inlet end interior baffle **30**. An inlet tube extension **28** extends from the inlet tube **18** between inlet end interior baffle **30** and an intermediate interior baffle **32**. Inlet tube **18** and inlet tube extension **28** may be formed from a single piece of tubing or may be made from different pieces of tubing and assembled together. A valve opening ring **40** is provided on a valve plate baffle **34** that defines a valve opening **36**. The valve opening is adapted to be opened and closed by means of a valve closure element **38**, or valve closure plate. The valve closure element **38** engages the valve opening **36** when the muffler assembly is in its normal, or quiet, mode of operation. The valve closure element **38** may be flat, curved or partially spherical in shape to facilitate better sealing against the valve opening ring **40**. A first reticulated tube **42** and a second reticulated tube **44** are oriented parallel to the inlet tube extension **28** and extend between the inlet end interior baffle **30** and the intermediate interior baffle **32**. A plurality of openings **48** are formed in the first and second reticulated tubes **42**, **44**. The openings **48** form small outlets in the walls of the tubes **42** and **44** through which exhaust gases may flow. The flow of exhaust gases into the openings **48** attenuates sound waves of various wavelength and reduces the noise emitted from muffler assembly **10**.

[0026] Referring to FIG. **3**, the muffler assembly **10** is shown in an exploded perspective view. The muffler assembly includes the shell **12** which encloses all of the other components of the muffler assembly **10** located between the inlet end wall **16** and the outlet end wall **22**. Inlet tube **18** is connected to the inlet tube extension **28**. Alternatively, the inlet tube **18** and inlet tube extension **28** may be formed from a single piece of tubing, as previously noted. The inlet tube **18** extends through the inlet end wall **16** through an inlet tube opening **50**. The inlet tube extension **28** extends through a tube receiving opening **52** formed in the inlet end interior baffle **30**. Additional tube receiving openings **52** are formed in the inlet end interior baffle **30** to receive the reticulated tubes **42** and **44**. Additional tube receiving openings **54** are formed in the intermediate interior baffle **32**. In this way, the inlet tube extension **28** and first and second reticulated tubes **42** and **44** are supported on opposite ends by the inlet end interior baffle **30** and the intermediate interior baffle **32**.

[0027] A support bracket **60** is assembled to the inlet end wall **16**. The vacuum diaphragm actuator **20** is assembled to a bracket **60** to hold it in a fixed relationship relative to the inlet end wall **16**. The support bracket **60** includes an actuator rod opening **62** through which an actuator rod **64** is connected to the vacuum diaphragm actuator **20**. A clevis **66** is attached to the actuator rod **64** and to an operator **68** that is moved by the vacuum diaphragm actuator **20**. The operator **68** moves axially relative to the vacuum diaphragm actuator **20** to in turn move the actuator rod **64** in a generally axial direction. The actuator rod **64** extends from the return spring adjustment mechanism **26** located on the outer side of the outlet end wall **22** to the clevis **66**. The valve closure element **38** is secured to the actuator rod **64** by two collars **69**. The actuator rod **64** extends through the first reticulated tube **42** and the outlet end wall **22**, valve plate baffle **34**, intermediate interior baffle **32**, the inlet end interior baffle **30** and the inlet end wall **16**. The actuator rod **64** may be disposed at an angle relative to the central axis of the first reticulated tube **42**.

[0028] The valve plate baffle **34** includes a tube receiving opening **70** that receives an extended portion **72** of the second reticulated tube **44**. The extended portion **22** does not include openings **48**. The extended portion **72** is received over a necked down portion **74** of the outlet tube **24**. The outlet tube **24** is received in an outlet opening **76** formed in the outlet end wall **22**. Direct flow ports **78** are provided in the outlet tube **24** through which exhaust gases may flow directly from the inlet tube **18** through the inlet tube extension **28** and the valve opening ring **40** when the valve closure element **38** is shifted to its open position.

[0029] Referring to FIG. **4**, the muffler assembly **10** is shown in a plan view with the shell **12** assembled over the internal components of the muffler assembly **10**. The inlet tube **18** is assembled to the inlet end wall **16**. The vacuum diaphragm actuator **20** is attached by means of the support bracket **60** to the inlet end wall **16**. The clevis **66** is secured by a pin or other appropriate connector to the operator **68** of the vacuum diaphragm actuator **20**. The outlet tube **24** and return spring adjustment mechanism **26** are both connected to the outlet end wall **22**.

[0030] Referring to FIG. **5**, the arrangement of the inlet tube extension **28**, first and second reticulated tubes **42** and **44** and the shell **12** are shown in cross-section. The openings **48** of the first and second reticulated tubes **42** and **44** are provided with louvers **80** that are arcuate or linear recesses in the first and second reticulated tubes **42** and **44** formed adjacent to and in conjunction with the openings **48**. As gas flows through the reticulated tubes **42**, **44**, a portion of the exhaust gases flowing through the tubes may be diverted into the space between the inlet end interior baffle **30** and the intermediate interior baffle **32**. This space may also be filled with an acoustic absorption medium **82**. The acoustic absorption medium **82** may be glass wool, steel wool, stainless steel wool, ceramic wool, or the like. Combinations of different acoustic absorption materials may be used and various preformed media may also be used. The acoustic absorption medium **82** serves to absorb acoustic energy from the exhaust gas flow and deaden or quiet the noise emitted from the muffler assembly when the exhaust gases flow through the first and second reticulated tubes **42** and **44**. A stainless steel wool sock **83**, or tube, may be assembled over the reticulated tubes **42** and **44** to inhibit particles of the acoustic absorption medium **82** from flowing into the reticulated tubes **42** and **44**.

[0031] Referring to FIG. **6**, operation of the muffler assembly **10** in a quiet mode is illustrated. In the quiet mode, exhaust gases are received in the inlet tube **18** that directs the exhaust gases through the inlet tube extension **28** that extends between the inlet end interior baffle **30** and the intermediate interior baffle **32**. Exhaust gas flow is shown diagrammatically by means of the phantom arrows **84**. The exhaust gas flow reverses direction after passing through the intermediate interior baffle **32** and is directed through the first reticulated tube **42**. The gas flow then reverses direction again as it passes between inlet end wall **16** and the inlet end interior baffle **30**. After reversing direction, the exhaust flow path **84** flows through the second reticulated tube **44** and into the extended portion **72**, and ultimately through the outlet tube **24**. As the exhaust gases flow through the first and second reticulated tubes **42** and **44**, a portion of the exhaust gases pass through the openings **48** and into the space defined between inlet end interior baffle **30** and the intermediate interior baffle **32**. The acoustic absorption medium **82** is preferably wrapped or assembled around the tubes **42** and **44** to provide additional sound attenuation and desired acoustic properties.

[0032] Referring to FIG. **7**, the muffler assembly **10** is shown in its loud mode with the valve closure element **38** shifted by the vacuum diaphragm actuator **20** to open the valve opening **36** (shown in FIG. **3**). In the loud mode, exhaust gases flow into the inlet tube **18** and through the inlet end wall **16** and inlet end interior baffle **30** to the inlet tube extension **28**. A loud mode exhaust flow path **86** is shown by phantom arrows in FIG. **7**. As shown in FIG. **7**, the exhaust flows from the inlet tube extension **28** into the space between the intermediate interior baffle **32** and the valve plate baffle **34**. The exhaust gas flow is then directed through the valve opening ring **40**. The valve closure element **38** is separated from the valve opening ring **40** and closes off the reticulated tube **42** to direct the exhaust gases to flow through the valve opening **36** and into the space defined between valve plate baffle **34** and the outlet end wall **22**. An exhaust flow path **86** then flows into the direct flow ports **78** formed in the outlet tube **24** and through the outlet tube **24**. In the loud mode shown in FIG. **7**, exhaust flow is not directed through the reticulated tubes **42** and **44**. No portion of the acoustic energy is absorbed by the openings **48** or the acoustic absorption medium **82** and no sound attenuation is provided by the inlet end interior baffle **30** or the intermediate interior baffle **32**. A limited amount of sound attenuation is obtained as the loud mode exhaust flow path **86** flows through the inlet tube extension **28** and through the valve opening ring **40** to the direct flow port **78**.

[0033] The driver of the vehicle can shift the muffler assembly **10** from the quiet mode shown in FIG. **6** to the loud mode shown in FIG. **7** by selectively porting vacuum from the engine or other vacuum source to the vacuum diaphragm actuator **20**. A vacuum valve control, such as that illustrated in FIGS. **12** and **13**, or an electrical switch (not shown) may be assembled to the dashboard of the vehicle (not shown) may be actuated to provide vacuum to the vacuum diaphragm actuator **20**.

[0034] In FIG. **7**, vacuum provided to the vacuum diaphragm actuator **20** retracts the operator **68** into the actuator **20**. This movement of the operator **68** is communicated through the clevis **66** to the actuator rod **64**. The actuator rod **64** is shifted toward actuator **20** when vacuum is provided. Shifting the actuator rod **64** causes the return spring adjustment mechanism **26** to compress a spring **88** of the return spring adjustment mechanism **26**. When the actuator rod **64** shifts, the valve closure element **38** is moved into engagement with one end of the reticulated tube **42**. This shifts the gas flow from flowing through the reticulated tubes **42** and **44** to cause the gas to flow through the valve opening ring **40**, as previously described.

[0035] The return spring adjustment mechanism **26** may be adjusted by tightening a nut **90** or other conventional adjustment mechanism to locate the valve closure element **38**. The return spring adjustment mechanism **26** should be adjusted to facilitate sealing between the valve closure element **38** and the valve opening ring **40** in the quiet mode shown in FIG. **6**. The return spring adjustment mechanism **26** should also be adjusted to facilitate sealing between the valve closure element **38** and the end of the reticulated tube **42** in the loud mode.

[0036] The clevis **66** is connected to the operator **68** of the vacuum diaphragm actuator **20** by means of a pin **92** that accommodates the slight axial offset of the actuator rod **64** relative to actuator **20**. The pin **92** and clevis **66** permits the actuator **20** to be connected to the actuator rod **64** without binding or restriction because the clevis **66** is permitted to pivot on the pin **92**. The position of the valve closure element

38 may be adjusted by manipulating the clevis **66**, pin **92** and actuator rod **64**. These three parts together constitute an adjustable actuator connector.

[0037] The dual transverse muffler **100** is described with reference to the left side of the muffler **100** shown in FIGS. **8** and **9**. The right and left sides of the dual transverse muffler **100** are essentially mirror images of each other and the description of the right side is not repeated for brevity. The same reference numerals are used to describe the internal parts on the left side of the muffler **100** as are used on the right side of the muffler **100**.

[0038] Referring to FIG. **8**, a dual transverse muffler having two independent flow paths is illustrated in a quiet mode. The muffler **100** includes a shell **102** that is closed on one end by a first end wall **104** and on the opposite end by a second end wall **106**. A first inlet tube **108** is partially disposed within the shell **102** and extends through the first end wall **104**. A second inlet tube **110** is partially disposed in the shell **102** and extends through the second wall **106**. A first outlet tube **112** is partially disposed within the shell **102** and extends through the first end wall **104**. A second outlet tube **114** is partially disposed within the shell **102** and is inserted through the second end wall **106**.

[0039] A first baffle **116** is assembled within the shell **102** to be the baffle that is closest to the first end wall **104**. A second baffle **118** is assembled within the shell **102** inboard of the first baffle **116**. A third baffle **120** is assembled within the shell **102** between second baffle **118** and a central baffle **122**. The baffles **116**, **118**, **120** and **122** divide the internal space within the shell **102** into chambers.

[0040] An intermediate reticulated tube **126** is assembled to the first baffle **116** and the second baffle **118**. A plurality of sound attenuating ports **128** are provided in the intermediate reticulated tube **126**. The sound attenuating ports **128** may also be referred to as openings that are provided with louvers that define arcuate or linear recesses, as previously described with reference to FIGS. **1-7**. An intermediate section **130**, or intermediate chamber, is defined between the first baffle **116** and the second baffle **118**. A plurality of sound attenuating ports **132** are provided in the intermediate section **130**. A valve opening ring **134** defines an opening (not shown) through the third baffle **120** that is similar to the opening **36** in the embodiment of FIGS. **1-7**. A valve closure plate **136**, or valve closure element, is provided to open and close the valve opening ring **134** depending upon whether the muffler **100** is to be operated in the quiet mode or loud mode.

[0041] A rod **138** is assembled to the valve closure plate **136** and extends through the intermediate reticulated tube **126** and the first end wall **104**. For the right hand side, the rod **138** extends through the second end wall **106**. Vacuum diaphragm actuators **140** are provided on each of the first end wall **104** and the second end wall **106**. The rod **138** is connected to the vacuum diaphragm actuator **140** on one end of the rod **138**. The other end of the rod **138** is provided with a return spring **142**. Return spring **142** is attached to the central baffle **122** on the opposite side of the central baffle **122** from the remainder of the rod **138**. The first and second outlet tubes **112**, **114** define direct flow ports **146** between the third baffle **120** and the central baffle **122**. An inlet end **148** of the intermediate reticulated tube **126** is selectively opened and closed by the valve closure plate **136** depending upon whether the dual transverse muffler **100** is in the quiet mode or in the loud mode. The reticulated tube **126** and intermediate section **130** may be wrapped in a stainless steel wool sock and an acoustic absorption medium as previously described with reference to FIG. **5**.

[0042] Operation of the dual transverse muffler **100** in the quiet mode is described with continuing reference to FIG. **8**. The dual transverse muffler **100** operating in the quiet mode creates an exhaust flow path identified by reference numeral **150** in FIG. **8**. The exhaust flow path **150** is introduced into the first inlet tube **108** that directs the exhaust gases through the first end wall **104**, first baffle **116**, and second baffle **118**. The valve closure plate **136** closes the annular valve opening ring **134** which causes the exhaust gases to flow into the intermediate reticulated tube **126**. Exhaust gases flow in an intermediate flow path **152** from the sound attenuating ports **128** in the intermediate reticulated tube **126** through the intermediate section **130** to the sound attenuating ports **132** formed in the first outlet tube **112**. Exhaust gases then flow through the first outlet tube **112** and out of the muffler into the atmosphere.

[0043] Operation of the dual transverse muffler **100** is described in the loud mode with reference to FIG. **9**. In the loud mode, the exhaust gases flow through the first inlet tube **108** through the first end wall **104**, the first baffle **116**, and the second baffle **118**. In the loud mode, the valve closure plate **136** is moved to close the inlet end **148** of the intermediate reticulated tube **126**. The valve closure plate **136** is moved by the vacuum diaphragm actuator **140** and the rod **138**. An exhaust gas flow path in the loud mode is indicated by reference numeral **154**. After the exhaust gases flow through the inlet tube **108**, they flow through the chamber defined by the second baffle **118** and the third baffle **120** through the valve opening ring **134**. The exhaust gas then flows through the chamber defined between the third baffle **120** and the central baffle **122** to the direct flow ports **146** that are formed in the first outlet tube **112**. Exhaust gases then flow through the first outlet tube **112** and into the atmosphere.

[0044] Referring to FIG. **10**, a dual transverse muffler **160** having a combined exhaust flow path is described. The dual transverse muffler **160** is shown in the quiet mode in FIG. **10**. The dual transverse muffler **160** is shown in the loud mode in FIG. **11**.

[0045] The dual transverse muffler **160** includes a shell **162** that is closed on one side by a first end wall **162** and is closed on the opposite lateral side by a second end wall **166**. A first inlet tube **168** is partially disposed within the shell **162** and extends through the first end wall **164**. A second inlet tube **170** is partially disposed within the shell **162** and extends through the second wall **166**. A first outlet tube **172** extends through the shell **162** and also through the first and second end walls **164** and **166**.

[0046] A first baffle **176** is assembled inside the shell **162** near the first end wall **164**. A second baffle **178** is provided within the shell **162** near the inner end of the first inlet tube **168**. A third baffle **180** is provided within the shell **162** between the second baffle **178** and the second end wall **166**. The inner end of the second inlet tube **170** extends through the third baffle **180**. The baffles may be solid walls or may have openings depending upon the performance requirements for the muffler.

[0047] An intermediate reticulated tube **182** is assembled within the shell and is connected through the first baffle **176** and second baffle **178**. A plurality of sound attenuating ports **184** are provided in the intermediate reticulated tube **182** in an intermediate section **186** of the intermediate reticulated tube

182. The intermediate section **186**, or intermediate chamber, is defined within the shell between the first baffle **176** and the second baffle **178**. A plurality of sound attenuating ports **188** are provided in the outlet tube **172**. A valve opening ring **190** is provided in the third baffle **180**. A valve closure plate **192** closes the valve opening ring **190** when operating in the quiet mode as shown in FIG. **10**. A rod **194** connects the valve closure plate **192** to a vacuum diaphragm actuator **196** and a return spring **198**. The vacuum diaphragm actuator **196** is assembled to the first end wall **164**. The return spring **198** is assembled to the rod **194** and the second end wall **166**.

[0048] A plurality of direct flow ports **202** are provided in the outlet tube **172** between the third baffle **180** and the second end wall **166**. The inlet end **204** of the intermediate reticulated tube **182** is open as shown in FIG. **10**. The valve closure plate **192** is disposed in a sealing relationship over the valve opening ring **190** leaving the inlet end **204** open. A quiet exhaust flow path is identified by reference numeral **206** in FIG. **10**. Exhaust gases are introduced into the muffler **160** through the first inlet tube **168** and the second inlet tube **170**. Exhaust gases flow from the inlet tubes into the chamber formed between the second baffle **178** and the third baffle **180**. With the valve closure plate closing the valve opening ring **190**, exhaust gases are directed through the inlet end **204** of the intermediate reticulated tube **182**. Exhaust gases flow through the sound attenuating ports **184** in the intermediate reticulated tube **182** through the intermediate section **186** to the sound attenuating ports **188** formed in the outlet tube **172**. The reticulated tube **182** and outlet tube **172** may be wrapped in a stainless steel wool sock and an acoustic absorption medium as previously described with reference to FIG. **5**. Exhaust gases then flow through both ends of the outlet tube **172** and into the atmosphere.

[0049] Referring to FIG. **11**, a loud exhaust flow path is indicted by reference to the flow path arrows by reference numeral **208**. In the loud mode, exhaust gases are introduced into the muffler **160** through the first inlet tube **168** and the second inlet tube **170**. Exhaust gases flow from the inlet tubes into the chamber defined between the second baffle **178** and the third baffle **180**. In the loud mode of operation, the valve closure plate **192** closes or seals the inlet end **204** of the intermediate reticulated tube **182**. The exhaust gases flow through the valve opening ring **190** into the chamber defined between the third baffle **180** and the second end wall **166**. From there, the exhaust gases flow into the flow ports **202** formed in the outlet tube **172**. The exhaust gases then flow out of both ends of the outlet tube **172** into the atmosphere.

[0050] Referring to FIG. **12**, a vacuum switch **212** is illustrated that may be used to operate the vacuum diaphragm actuator in any of the above embodiments. The vacuum switch **212** is supplied from a vacuum source such as the inlet manifold of an internal combustion engine, or the like. Vacuum is provided through tubing (not shown) to the vacuum diaphragm actuator **20**, **140**, **196** to shift the muffler **10**, **100**, **160** from the quiet to the loud mode of operation. The vacuum switch **212** is actuated by moving a control rod **220**. The vacuum switch **212** includes a housing **224** and a valve body **226** that is shiftable within the housing **224**. A chamber **228** is defined between the valve body **226** and the housing **224** that selectively allows vacuum to be provided from the vacuum source port **216** to the vacuum supply port **218**.

[0051] In the loud mode position shown in FIG. **12**, the valve body **226** is shifted to the right end of the housing **224** by pulling the control rod **220**. An oval ring seal **230** is provided that also, in part, defines the chamber **228** and forms a seal between the housing **224** and the valve body **226**. In this position, vacuum is ported from the vacuum source port **216** to the vacuum supply port **218**. Vacuum is provided to the vacuum diaphragm actuators **20**, **140**, **196** that holds the valve closure elements **38**, **136**, **196** over the inlet opening of the intermediate reticulated tubes **42**, **126**, **182** and opens the respective valve openings **36**, **134**, **190**.

[0052] Referring to FIG. **13**, the vacuum switch **212** is shown in the quiet operation mode. In the quiet mode, the valve closure elements **38**, **136**, **196** close the respective valve openings **36**, **134**, **190** and open the inlet opening of the intermediate reticulated tubes **42**, **126**, **182**. A circular seal ring **232** is provided to seal the vacuum source port **216** between the housing **224** and valve body **226**. The circular seal ring **232** seals the gap between the housing **224** and the valve body **226** when the control rod **220** is pushed to shift the valve body **226** to the left side of the housing **224** as shown in FIG. **13**. In this position, vacuum supplied through the vacuum source port **216** is sealed by the circular seal ring **232**.

[0053] The vacuum switch **212** is normally set to the quiet mode operation. It should be understood that the normal mode of operation could be reversed, however, it is preferred that the muffler be in the quiet mode of operation when vacuum is not provided to the various diaphragm actuators so that in the event of a system failure the muffler would operate in the quiet mode. The system could also be operated on a pressurized fluid basis by connecting the switch **212** to a pressure source and providing a pressure diaphragm actuator to operate the mufflers.

[0054] While embodiments of the invention have been illustrated and described, it is not intended that these embodiments illustrate and describe all possible forms of the invention. Rather, the words used in the specification are words of description rather than limitation, and it is understood that various changes may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. A muffler assembly for a vehicle comprising:

a shell;

an inlet tube disposed within the shell that extends from the an inlet end to a first chamber and through which exhaust gases flow, the inlet tube is a solid wall tube;

a plurality of sound attenuating tubes are disposed within the shell that have a plurality of sound attenuating orifices spaced along the length of the sound attenuating tubes, the sound attenuating tubes extend from the first chamber through a plurality of baffles disposed inside of the shell;

a valve closure element directs the exhaust gases flowing through the inlet tube that does not have sound attenuating orifices through the sound attenuating tubes in a first mode of operation, the valve closure element directs exhaust gases from the first chamber into a second chamber in a second mode of operation; and

an outlet tube discharges the exhaust gases from the muffler assembly, the outlet tube receives exhaust gases that are routed through the sound attenuating tubes in the first mode of operation, the outlet tube has an opening through which exhaust gases are received from the second chamber in the second mode of operation that have not been circulated through the sound attenuating tubes.

2. The muffler assembly of claim **1** further comprising a vacuum diaphragm actuator that is operatively connected to the valve closure element by a rod, the rod having a clevis on one end that is pivotally connected to an operator of the actuator by a pin, wherein the rod has a collar that secures the valve closure element to the rod at a selected position, and wherein an adjustable actuator connector has a spring that biases the valve closure element into the first mode of operation.

3. The muffler assembly of claim **2** further comprising a vacuum control switch having an inlet port that is connected to a source of vacuum by a inlet tube, the vacuum control switch having an outlet port that is connected to the vacuum diaphragm actuator by an outlet tube, the vacuum control switch having a manually engaged actuator that is movable from a normal position wherein no vacuum is ported to the outlet port and the valve closure element is in the first mode of operation to an activation position wherein vacuum is ported to the outlet port and the valve closure element is shifted to the second mode of operation.

4. The muffler assembly of claim **1** wherein the valve closure element is a flat disk that is moved between a first position in which the flat disk blocks the flow of exhaust gases from the first chamber to the second chamber while permitting the flow of exhaust gases through the sound attenuating tubes and a second position in which the flat disk permits the flow of exhaust gases from the first chamber to the second chamber while blocking the flow of exhaust gases through the sound attenuating tubes.

5. The muffler assembly of claim **1** wherein the sound attenuating tubes are disposed in an acoustic absorption medium.

6. The muffler assembly of claim **5** wherein the sound attenuating tubes are wrapped in a stainless steel wool sock that inhibits the passage of particulates from the acoustic absorption medium into the sound attenuating tubes.

7. A dual transverse muffler assembly for a vehicle comprising:

a shell;

a first inlet tube through which exhaust gases flow into the shell that is partially disposed within the shell that extends from the a first end wall to an interior chamber;

a second inlet tube through which exhaust gases flow into the shell that is partially disposed within the shell that extends from a second end wall to the interior chamber;

at least one sound attenuating tube disposed within the shell that has a first plurality of sound attenuating orifices spaced along the length of the sound attenuating tube, the sound attenuating tubes extend from the interior chamber through a plurality of baffles disposed inside of the shell;

a valve closure element directs the exhaust gases through the sound attenuating tube in a first mode of operation, the valve closure element directs exhaust gases from the first chamber into a second chamber in a second mode of operation; and

an outlet tube extends through the shell from a first outlet tube opening through the first end wall to a second tailpipe opening through the second end wall, the outlet tube receives exhaust gases through a portion of the outlet tube that has a second plurality of sound attenuating orifices that were routed through the sound attenuating tube in the first mode of operation, the outlet tube has a direct flow opening through which exhaust gases are received from the second chamber in the second mode of operation that have not been circulated through the sound attenuating tube, and wherein exhaust gases are discharged from the shell in both the first and second modes of operation through the first and second tailpipe openings.

8. The dual transverse muffler assembly of claim **7** further comprising a vacuum diaphragm actuator that is operatively connected to the valve closure element by a rod, the rod having a clevis on one end that is pivotally connected to an operator of the actuator by a pin, wherein the rod has a collar that secures the valve closure element to the rod at a selected position, and wherein an adjustable actuator connector has a spring that biases the valve closure element into the first mode of operation.

9. The dual transverse muffler assembly of claim **8** further comprising a vacuum control switch having an inlet port that is connected to a source of vacuum by a inlet tube, the vacuum control switch having an outlet port that is connected to the vacuum diaphragm actuator by an outlet tube, the vacuum control switch having a manually engaged actuator that is movable from a normal position wherein no vacuum is ported to the outlet port and the valve closure element is in the first mode of operation to an activation position wherein vacuum is ported to the outlet port and the valve closure element is shifted to the second mode of operation.

10. The dual transverse muffler assembly of claim **7** wherein the valve closure element is a flat disk that is moved between a first position in which the flat disk blocks the flow of exhaust gases from the first chamber to the second chamber while permitting the flow of exhaust gases through the sound attenuating tubes and a second position in which the flat disk permits the flow of exhaust gases from the first chamber to the second chamber while blocking the flow of exhaust gases through the sound attenuating tubes.

11. The dual transverse muffler assembly of claim **7** wherein the sound attenuating tubes are disposed in an acoustic absorption medium.

12. The dual transverse muffler assembly of claim **11** wherein the sound attenuating tubes are wrapped in a stainless steel wool sock that inhibits the passage of particulates from the acoustic absorption medium into the sound attenuating tubes.

13. A dual transverse muffler assembly for a vehicle comprising:

a shell;

a central baffle provided within the shell that divides the shell into two parts;

first and second sets of muffler components provided within the shell on opposite sides of the central baffle with one set of muffler components being provided in each of the two parts, wherein each set of muffler components comprise:

a first baffle provided within the shell proximate the end wall;

a second baffle provided within the shell at a spaced location relative to the first baffle on the opposite side of the first baffle from the end wall;

a third baffle provided within the shell between the second baffle and the central baffle;

an inlet tube through which exhaust gases flow into the shell that is partially disposed within the shell and that extends from the an end wall through the first and second baffles to an interior chamber;

a sound attenuating tube is disposed within the shell that has a first plurality of sound attenuating orifices spaced along the length of the sound attenuating tube, the first sound attenuating tube extends from an inlet that opens into the interior chamber through the first and second baffles to a first end chamber defined between the end wall and the first baffle;

a valve opening ring disposed in the third baffle;

a valve closure element disposed in the shell between the inlet in the sound attenuating tube and the valve opening ring that directs the exhaust gases through the sound attenuating tube in a quiet mode of operation, the valve closure element directs exhaust gases from the first interior chamber through the valve opening ring and into a direct exhaust chamber defined between the third baffle and the central baffle;

an outlet tube extends through the shell from a outlet tube opening through the first end wall to the central baffle, the outlet tube has a plurality of sound attenuating orifices that receive exhaust gases that pass through the first plurality of sound attenuating orifices of the sound attenuating tube in the quiet mode of operation, the outlet tube has at least one direct flow opening through which exhaust gases are received from the direct exhaust chamber in the loud mode of operation that have not been circulated through the sound attenuating tube, and wherein exhaust gases are discharged from the shell in both the first and second modes of operation through the tailpipe opening.

14. The dual transverse muffler assembly of claim **13** wherein the muffler components further comprise a vacuum diaphragm actuator, a rod that is operatively connected to the vacuum diaphragm actuator, a clevis is provided on one end of the rod that is pivotally connected to the actuator by a pin, a collar secures the valve closure element to the rod at a selected position, and wherein a return spring biases the valve closure element into engagement with the valve opening ring in the first mode of operation.

15. The dual transverse muffler assembly of claim **14** further comprising a vacuum control switch having an inlet port that is connected to a source of vacuum by a inlet tube, an outlet port is connected to the vacuum diaphragm actuator by an outlet tube, the vacuum control switch having a manually engaged actuator that is movable from a normal position wherein no vacuum is ported to the outlet port in the quiet mode of operation to an activation position wherein vacuum is ported to the outlet port and the vacuum diaphragm actuator is shifted to the loud mode of operation.

16. The dual transverse muffler assembly of claim **13** wherein the valve closure element is a flat disk that is moved between a first position in which the flat disk blocks the flow of exhaust gases from the interior chamber to the direct flow chamber while directing the flow of exhaust gases through the sound attenuating tube and a second position in which the flat disk permits the flow of exhaust gases from the interior chamber to the direct flow chamber while blocking the flow of exhaust gases through the sound attenuating tube.

17. The dual transverse muffler assembly of claim **13** wherein the sound attenuating tube is disposed in an acoustic absorption medium.

18. The dual transverse muffler assembly of claim **17** wherein the sound attenuating tubes are wrapped in a stainless steel wool sock that inhibits the passage of particulates from the acoustic absorption medium into the sound attenuating tubes.

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