United States Patent

[11] 3,620,330

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[54] **MUFFLER CONSTRUCTION AND METHOD OF SELECTIVELY MODIFYING ITS SOUND-ATTENUATING CHARACTERISTICS**
18 Claims, 17 Drawing Figs.

[52] **U.S. Cl.** **181/65,** 235/45, 235/57
[51] **Int. Cl.** **F01n 1/16**
[50] **Field of Search** 181/64, 65, 53, 54, 57, 37, 38, 41, 45

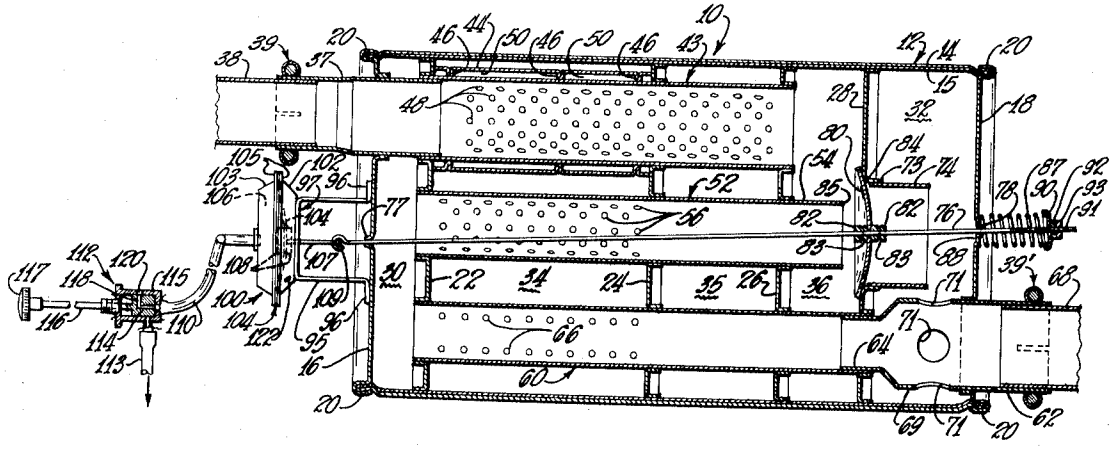
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Primary Examiner—Stephen J. Tomsky
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ABSTRACT: The disclosure embraces a muffler construction and a method of flowing exhaust gases from an internal combustion engine through a muffler construction whereby the gases flow in one path through the muffler through several sound-attenuating components to an outlet in a manner to secure attenuation of sound waves in a broad range of sound frequencies and selectively diverting the incoming gases from an inlet tube directly to the outlet thereby bypassing several sound-attenuating components and reducing sound attenuation providing a noise performance or noise mode.



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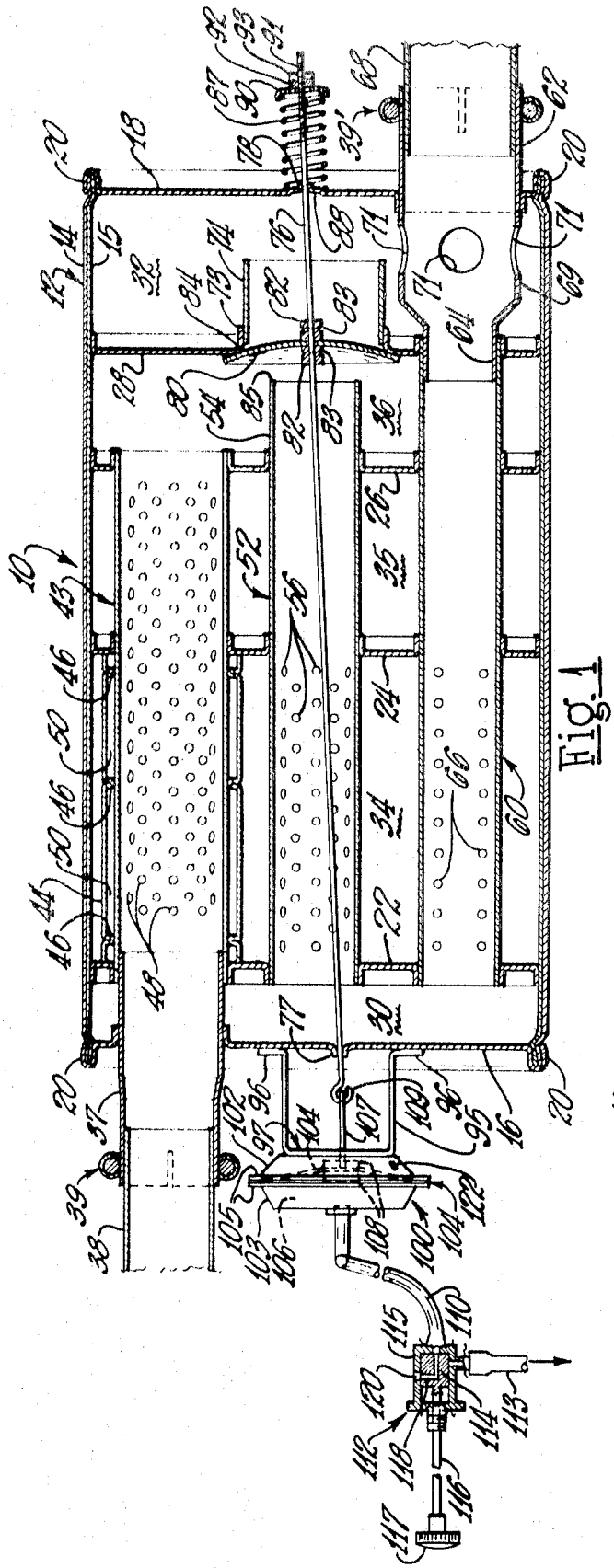


Fig. 1

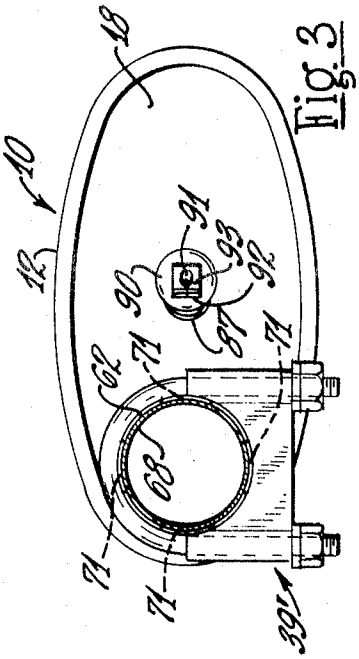


Fig. 3

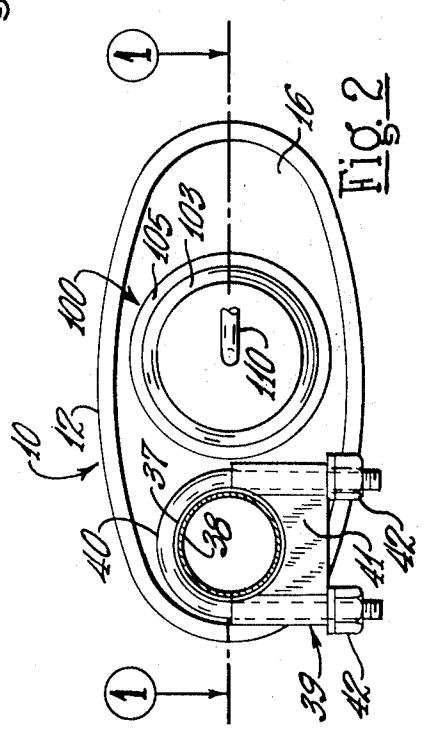


Fig. 2

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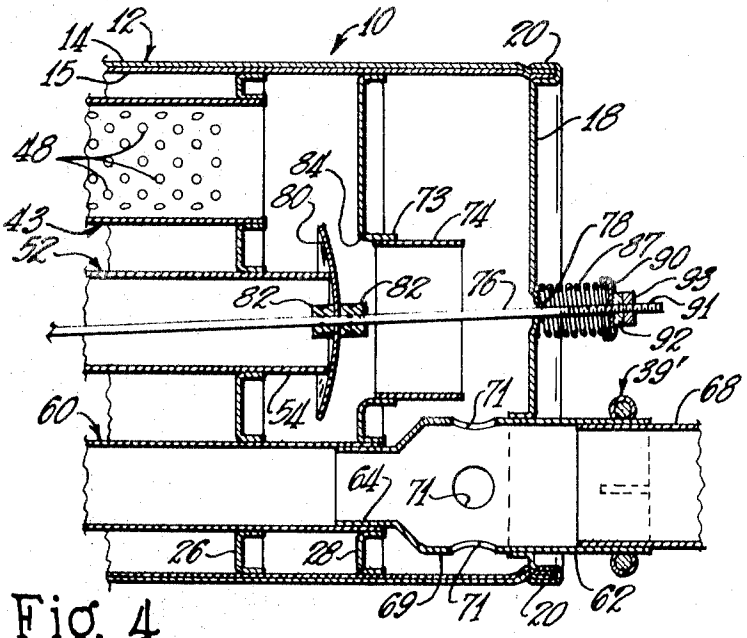


Fig. 4

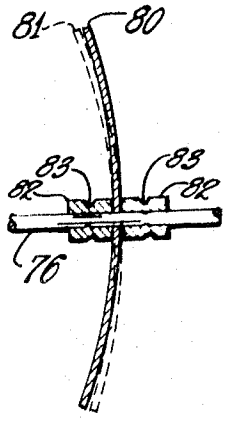


Fig. 5

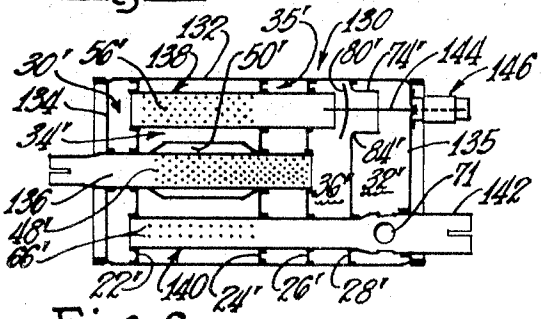


Fig. 6

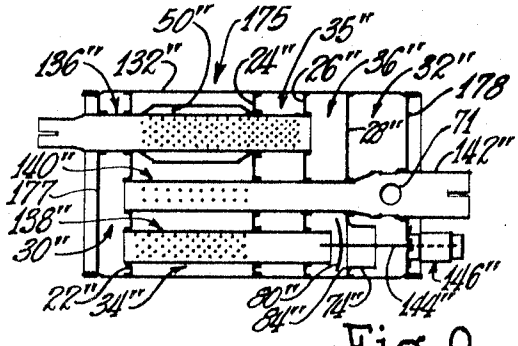


Fig. 9

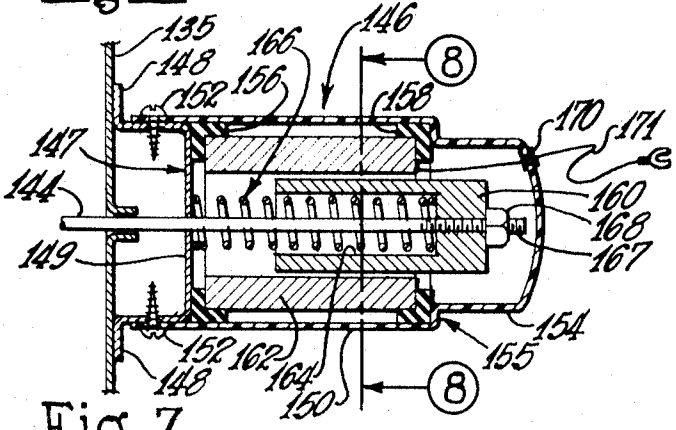


Fig. 7

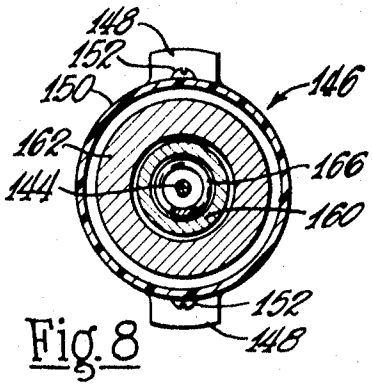


Fig. 8

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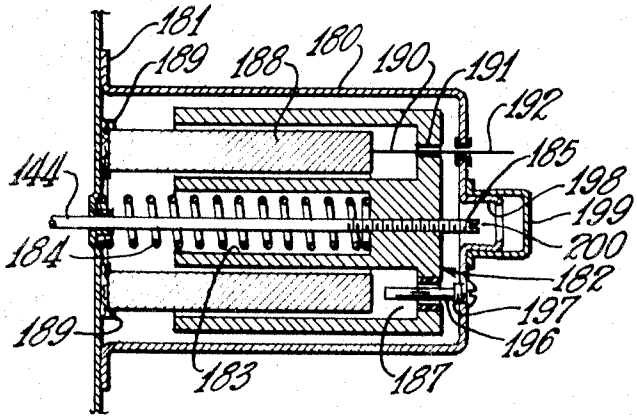


Fig. 10

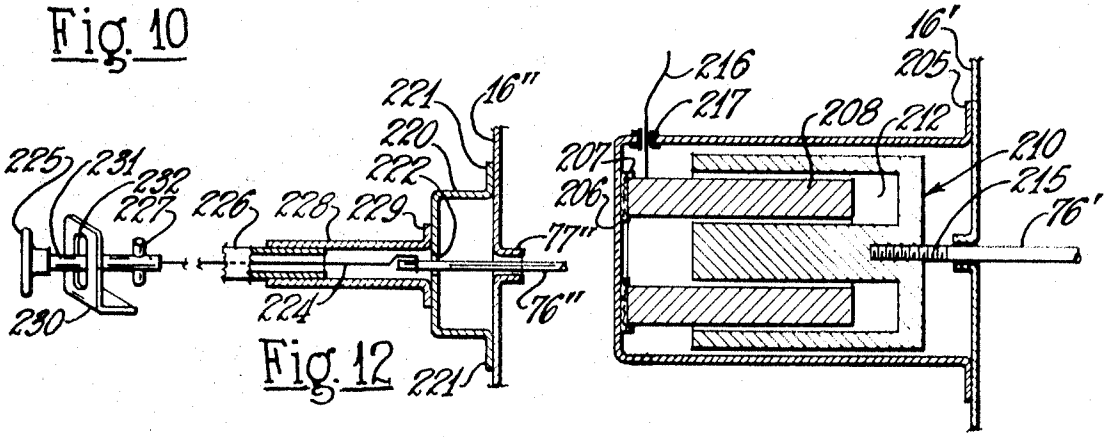


Fig. 12

Fig. 11

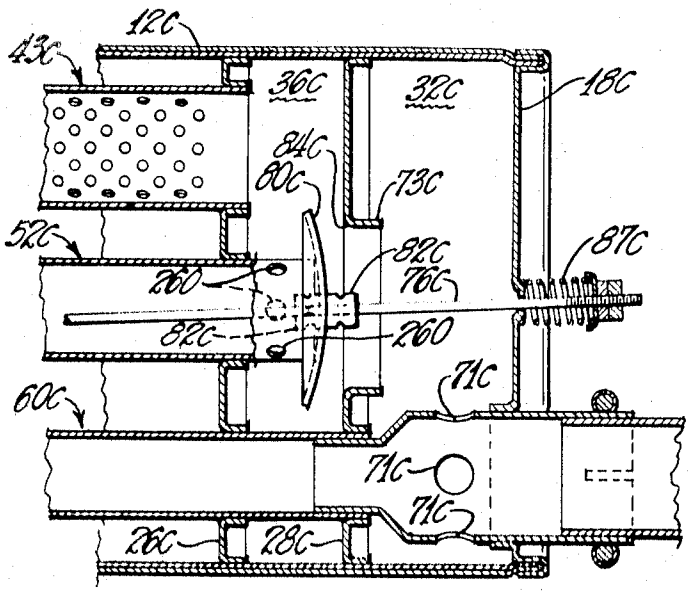


Fig. 17

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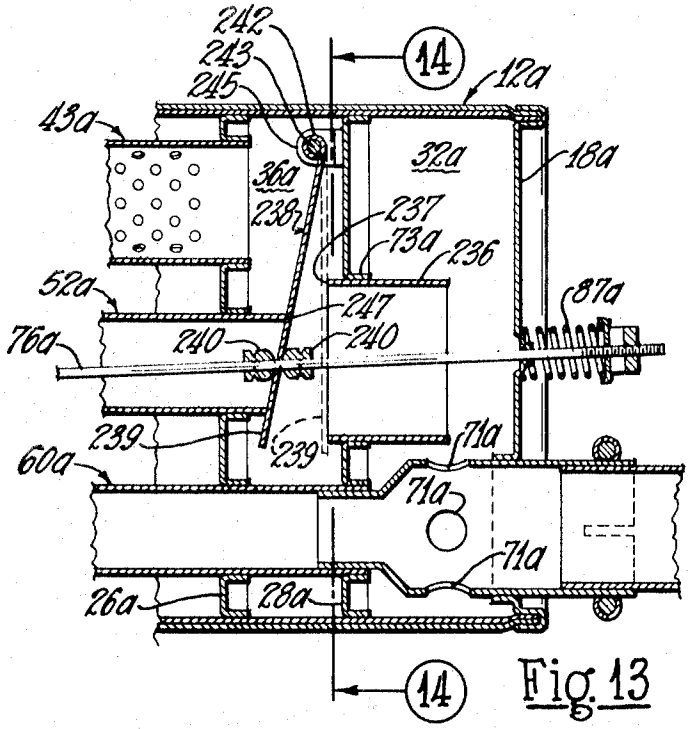


Fig. 13

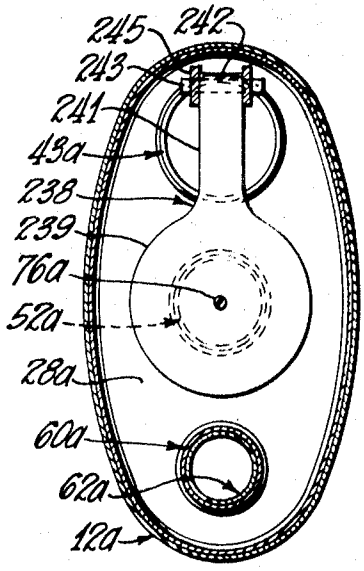


Fig. 14

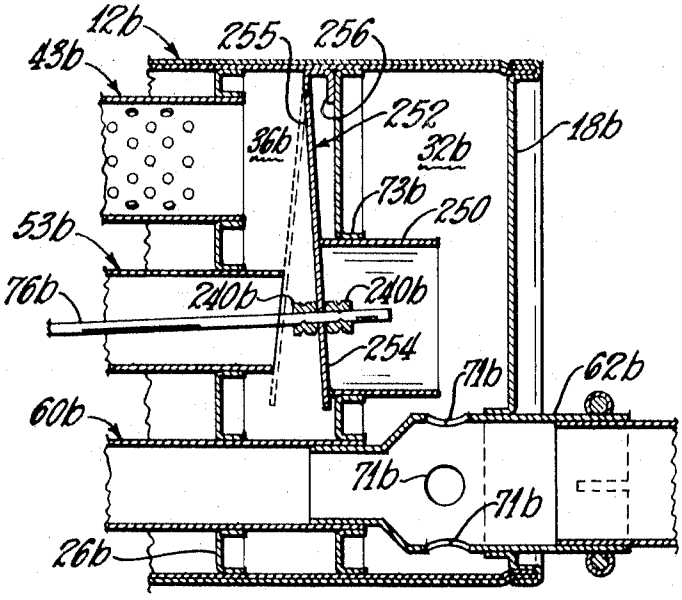


Fig. 15

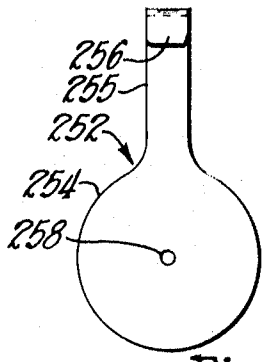


Fig. 16

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MUFFLER CONSTRUCTION AND METHOD OF SELECTIVELY MODIFYING ITS SOUND-ATTENUATING CHARACTERISTICS

Heretofore mufflers or silencers used with the exhaust gas streams from internal combustion engines, especially with engines of automotive vehicles have been for the purpose of attenuating, as far as is practicable, a broad range of sound frequencies so as to reduce the noise factor of the moving gas stream to a minimum. Such mufflers usually embody a plurality of gas passage tubes and sound-attenuating chambers or components arranged to secure a maximum of sound attenuation without undue back pressure of the exhaust gases moving through the muffler.

In order to attain attenuation of a broad range of sound waves entrained in gas exhaust streams from engines, it is desirable to flow the gases through several gas passage tubes having small outlets in the walls providing acoustic couplings with adjacent chambers wherein the gases move in reverse directions through certain of the tubes providing an increased length of travel of the gases through the muffler whereby sound waves of various lengths may be effectively attenuated to reduce the noise performance or mode to a minimum.

More recently mufflers have been designed and used with exhaust gas streams or internal combustion engines of automotive vehicles wherein sound waves of certain frequencies are substantially unattenuated in order to attain a distinctive noise mode of a roaring, booming or harsh character. This trend is particularly evident in the performance of so-called sport cars.

The present invention embraces a method of controlling or directing flow of exhaust gases from an internal combustion engine through a muffler construction whereby the gases normally flow through gas passage tubes having openings forming acoustic couplings with sound-attenuating chambers to an outlet to promote a high efficiency of attenuation of sound waves of a broad range of frequencies entrained in the exhaust gas stream to attain maximum quiet or silencing, and selectively modifying the flow path of the gases to the gas outlet whereby to impede flow of the gases through certain gas passage tubes in the muffler and thereby provide for passage of unattenuated sound waves through the muffler to attain an increased noise mode or harsh noise of a booming or roaring sound character.

Another object of the invention resides in a method of controlling attenuation of sound waves entrained in a stream of exhaust gases from an internal combustion engine flowing through a muffler by selectively modifying the flow path of the gases away from sound-attenuating relation with certain sound-attenuating components in the muffler to thereby change the noise level of emitted sound.

Another object of the invention is the provision of a muffler construction incorporating multiple gas passage tubes acoustically coupled with sound-attenuating chambers in combination with relatively movable gas deflecting or valve means interiorly of the muffler for impeding gas flow through certain gas passage tubes when desired and thereby change or modify the range of attenuation of sound waves entrained in a stream of exhaust gases from an internal combustion moving through the muffler.

Another object of the invention resides in a muffler construction embodying valve means interiorly of the muffler for selectively modifying the flow path of exhaust gases through the muffler, the arrangement embodying motive means exteriorly of the muffler for actuating the valve means.

Further objects and advantages are within the scope of this invention such as relate to the arrangement, operation and function of the related elements of the structure, to various details of construction and to combination of parts, elements per se, and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification and drawing of a form of the invention, which may be preferred, in which:

FIG. 1 is a longitudinal sectional view of a form of muffler construction embodying a movable gas-deflecting means for carrying out the method of the invention, the view being taken substantially on the line 1—1 of FIG. 2;

FIG. 2 is an elevational view of the left end of the construction shown in FIG. 1;

FIG. 3 is an elevational view of the right end of the muffler shown in FIG. 1;

FIG. 4 is a fragmentary sectional view of a portion of the muffler construction shown in FIG. 1 illustrating the gas deflecting means in a position modifying the gas flow path through the muffler;

FIG. 5 is a detailed sectional view illustrating a method of mounting the gas-deflecting means on a movable actuator;

FIG. 6 is a schematic longitudinal sectional view illustrating a modified form of muffler construction embodying the invention;

FIG. 7 is a longitudinal sectional view illustrating one form of electrically energizable motive means for controlling the gas deflecting or valve means;

FIG. 8 is a sectional view taken substantially on the line 8—8 of FIG. 7;

FIG. 9 is a schematic longitudinal sectional view illustrating another modification of the invention;

FIG. 10 is a sectional view illustrating another form of electrically energizable motive means for the gas-deflecting valve means;

FIG. 11 is a sectional view illustrating a further form of electrically energizable motive means for the valve means;

FIG. 12 is a sectional view illustrating an arrangement for manually actuating the gas-deflecting valve means;

FIG. 13 is a fragmentary longitudinal sectional view illustrating another form of means for modifying the gas flow path in a muffler;

FIG. 14 is a transverse sectional view taken substantially on the line 14—14 of FIG. 13;

FIG. 15 is a fragmentary longitudinal sectional view illustrating a further form of means for modifying the gas flow path in a muffler;

FIG. 16 is an elevational view of the gas-deflecting means shown in FIG. 15, and

FIG. 17 is a fragmentary detail view illustrating a modified arrangement of gas flow path in the muffler.

Referring initially to FIGS. 1 through 4, the muffler construction 10 is inclusive of an elongated shell or housing 12 which, in the embodiment illustrated, is fashioned of two layers 14 and 15 of thin sheet metal, the shell being of generally oval configuration as illustrated in FIGS. 2 and 3. Secured to the ends of the shell or housing 12 is an inlet end head or end wall 16 and an outlet end head or end wall 18.

The peripheral regions of the end heads are engaged with the ends of the shell 12 and are lock-seamed to the shell or casing 12 as shown at 20. As shown in FIG. 1, the muffler includes lengthwise spaced transversely disposed baffles, partitions or walls 22, 24, 26 and 28, the peripheries of which snugly fit the inner layer 15 of the muffler shell 12 and may be spot welded to the shell. The inlet end wall 16 and the baffle 22 define a chamber 30 and the end wall 18 and baffle 28 define a chamber 32. The baffles 22, 24, 26 and 28 define chambers 34, 35 and 36.

The inlet end head 16 and the baffle 22 are fashioned with circular openings defined by circular flanges accommodating an inlet bushing or nipple 37 which is adapted for overlapping connection with an exhaust pipe 38, the latter conveying exhaust gases from an internal combustion engine (not shown) to the muffler. The nipple 37 is securely clamped to the end region of the exhaust pipe 38 by a clamp means 39. The clamp means 39 illustrated is preferably of the character disclosed in Riker U.S. Pat. No. 2,719,345, but any suitable clamp means may be employed.

The clamp structure illustrated includes a U-shaped member 40, a saddle 41 having tubular portions telescoped on the leg portions of the member 40 and nuts 42 received on

threaded regions of the leg portions which are drawn up to tube-clamping position. The baffles 22, 24 and 26 are fashioned with aligned circular openings defined by circular flanges on the baffles through which extends a first gas passage means or gas passage tube 43 which overlaps the bushing or nipple 37, the nipple 37 and the tube 43 comprising an inlet gas passage means. The gas passage tube 43 terminates adjacent the baffle 26, opening into the transverse chamber 36.

Disposed between the baffles 22 and 24 and surrounding the gas passage tube 43 is a tube or sleeve 44 having inwardly extending lengthwise spaced portions 46, the portions 46 being in snug engagement with the exterior surface of the gas passage tube 43. The gas passage tube 43 is provided with a large number of small outlets or orifices 48 some of which open into the annular chambers 50 provided by the adjacent inwardly extending portions 46.

The outlets 48 in the wall of the tube 43 in registration with the chambers 50 provide acoustic couplings with the chambers 50, the latter forming means for attenuating short, high-frequency sound waves thus substantially attenuating high-pitched sounds entrained in the exhaust gas stream. The arrangement of the tube or sleeve 43 and the portions 46 engaging the gas passage tube 43 is fashioned according to the method disclosed in the U.S. Pat. No. 3,242,558 to Selig. The small outlets or orifices 48 in registration with the transverse chamber 35 provide acoustic couplings with the chamber 35 for attenuating sound waves of lower frequency than those attenuated through the medium of the annular chambers 50.

The muffler is fashioned with a second or intermediate gas passage means or tube 52 extending through aligned circular openings defined by circular flanges in the transverse baffles 22, 24 and 26. A portion 54 of the tube 52 extends into the chamber 36 to the extent shown in FIG. 1. The opposite end of the tube 52 opens into the transverse chamber 30 at the gas inlet end of the muffler.

The wall of the gas passage tube 52 at the region between the baffles 22 and 24 is fashioned with a plurality of closely spaced small orifices or outlets which form acoustic couplings with the chamber 34 for attenuating sound waves of frequencies less than the frequencies of sound waves attenuated in the chambers 50. The outlets or openings 56 also facilitate transverse passage of gases through the chamber.

The muffler construction embodies a third gas passage means comprising a gas passage tube 60 and a gas outlet nipple or tube 62. The gas passage tube 60 extends through circular openings defined by circular flanges in the baffles 22, 24, 26 and 28. The flanges are spot welded to the gas passage tubes. The outlet nipple or tube 62 is fashioned with a portion 64 of reduced diameter snugly telescoped within an end of the gas passage tube 60. The opposite end of the gas passage tube 60 opens into the transversely disposed chamber 30.

The wall region of the gas passage tube 60 between the baffles 22 and 24 is fashioned with a plurality of outlets or openings 66 preferably of a lesser number of openings 56 in the tube 52. The openings 66 provide acoustic couplings with the chamber 34 for attenuating sound waves of comparatively low frequencies and for facilitating transverse flow of exhaust gases from openings 56 in tube 52 through the chamber 34 into the tube 60, reducing internal gas pressures in the muffler. Telescoped into the gas outlet nipple or tube 62 is a tailpipe 68, the tube 62 being secured to the tailpipe by a clamp 39′ of the character illustrated at 39.

The portion 69 of the outlet nipple or tube 62 intermediate the baffle 28 and the end wall 18 is provided with open areas or openings 71 establishing communication between the chamber 32 and the gas outlet provided by the nipple 62. In the embodiment illustrated there are four circular openings 71 of comparatively large diameter, viz each about 1 inch in diameter.

The arrangement illustrated in FIGS. 1 and 4 is inclusive of a relatively movable means or surface for selectively modifying or changing the flow path of gases through the muffler for changing the range of sound frequency attenuation whereby the flow of gases in one path through sound-attenuating components provides a maximum of sound attenuation over a broad range of frequencies, and wherein a change in position of the relatively movable means changes the flow path of the gases thereby limiting or restricting the range of sound frequency attenuation for increasing the noise level by permitting passage of unattenuated sound waves of certain frequencies entrained in the stream of exhaust gases.

The method involves moving a gas-deflecting means, valve or surface to selected positions, one position providing a long flow path for the gases for attaining maximum attenuation of sound waves of various frequencies, the other position of the valve or surface shortening the gas flow path through the muffler, and attenuating sound waves of high-frequency and short length in the short flow path whereby sound waves of greater length and lower frequencies in the gas stream are unattenuated to provide an audible booming or roaring noise mode.

With particular reference to FIGS. 1 and 4, the baffle or partition 28 is fashioned with an opening defined by a circular flange 73 in which is secured a tube 74 of short length opening into the chamber 32. In the embodiment illustrated, the central axis of the tube 74 is substantially in longitudinal alignment with the central axis of the gas passage tube 52. An actuating or operating rod or member 76 extends lengthwise through the muffler. The rod extends through an opening defined by a circular flange 77 in the inlet end wall 16, and through an opening defined by a circular flange 78 on the outlet end wall 18.

The openings defined by the flanges 77 and 78 are of a dimension to snugly, yet slidably, receive the rod 76. Mounted or supported on the rod 76 is a gas directing or diverting member or valve 80 of a diameter greater than the opening in the partition or baffle wall 28 defined by the flange 73 so that the valve member 80 closes the opening when in the position shown in FIG. 1. The valve or gas deflector 80 has a central opening to snugly receive the rod 76.

Disposed on the rod 76 at each side of the valve plate or member 80 is a collar 82, particularly illustrated in detail in FIG. 5, each collar being secured on the rod as by staking by impressing recesses 83 therein to securely anchor the collars to the rod 76 and thereby position the valve plate 80 on the rod 76 for movement with the rod. The valve plate 80 is preferably of curved or dished configuration as illustrated to foster a substantially gastight engagement of the plate with the circular valve seat provided by the circular region 84 of the partition or baffle 28 at the flange 73 defining the opening in the partition.

The valve plate 80 in the selected position shown in FIG. 1 closes the opening defined by the flange 73 of the baffle 28 and directs, guides or deflects the gases in the chamber 36 into the right-hand open end of the portion 54 of the intermediate gas passage tube 52. The curved or dished configuration of the valve plate 80 assures a substantially gastight engagement or seal with the end 85 of the tube portion 54 when the plate 80 is moved by the rod 76 to such other selected position.

The method of positioning and securing the valve plate or member 80 on the rod 76 through the use of the collars 82 provides for a slight lost motion of the plate with respect to the collars, the lost motion being indicated in broken lines at 81 in FIG. 5. This looseness or lost motion of the valve plate with respect to the rod 76 further promotes an effective seating of the valve plate 80 with the portion 84 as shown in FIG. 1 and, in the other selected position, engaging the end 85 of the gas passage tube 52 as shown in FIG. 4.

In the embodiment illustrated in FIG. 1, the valve plate 80 is biased to the position shown in FIG. 1 under the influence of an expansive coil spring 87, one end of the spring engaging the exterior surface of the muffler end wall 18, the spring being centered by a raised circular ridge 88 provided on the end wall. The other end of the spring engages a cuplike member 90 mounted on the rod 76. A portion of the rod 76 is threaded as at 91 to receive securing nuts 92 and 93. The pressure of the spring biasing the rod 76 to seat the valve plate 80 against the

circular region 84 may be adjusted by manipulating the securing nuts 92 and 93.

Motive means is provided for actuating the rod 76 to move the valve plate 80 to its other selected position, shown in FIG. 4, closing the right-hand end of the gas passage tube 52. Mounted on the inlet end wall 16 is a bracket or support member 95 having flange portions 96 welded or otherwise secured to the end wall 16. The bracket 95 is fashioned with a platform or planar portion 97 to which is secured a vacuum-actuated servomotor 100. The servomotor 100 is of conventional construction comprising hollow sheet metal housing sections 102 and 103 with a flexible diaphragm 104 disposed between mating peripheral flanges 105 on the housing sections 102 and 103.

The housing sections and the diaphragm are held in assembled relation by means (not shown). A comparatively short rod 107 is operatively connected with the diaphragm 104 by means of members 108 disposed at each side of and secured to the diaphragm. The distal end of the short rod 107 is fashioned with an eye which is engaged by a hook portion 109 fashioned on the end of the rod 76 exteriorly of the inlet end head 16. Movement or flexure of the diaphragm 104 effects longitudinal movement of the rod 76 and the valve plate or member 80 carried thereby.

A tube 110 is connected with the housing section 103 and is in communication with the unvented chamber 106 provided between the diaphragm 104 and the hollow housing section 103. The tube 110 is connected with a control means or valve construction 112, the latter being connected by tubular means 113 with a source of reduced pressure or vacuum, for example, the intake manifold of the internal combustion engine with which the muffler construction is used. The valve means 112 is of conventional construction for establishing communication between the source of vacuum or reduced pressure and the unvented chamber 106 provided by the housing 103.

The valve means 112, in the embodiment illustrated, is inclusive of a piston or plunger valve 114 slidable in a bore in a valve housing 115, the tube 110 being in communication with the bore or chamber in the valve housing. The plunger 114 is provided with a stem 116 having a manipulating button 117 for moving the plunger valve 114. The plunger 114 has a vent passage 118 which is adapted for registration with a vent 120 in one position of the valve plunger 114.

When it is desired to move the valve plate 80 to the position shown in FIG. 4, the manipulating button 117 is moved in a left-hand direction which moves the plunger to the left-hand end of the bore in the valve housing 115 thus establishing reduced pressure or vacuum in the diaphragm chamber 106 through communication of the tube 113 with the tube 110 through the valve chamber, the reduced pressure moving the diaphragm to its left-hand position. In such position of the valve plunger 114, the vent 120 is out of registration with the passage 118 in the plunger.

The chamber, provided by the housing 102 at the right side of the diaphragm 104, is vented to the atmosphere by a vent opening 122, so that the diaphragm 104, rod 76 and valve plate 80 may be moved in a right-hand direction under the influence of the spring 87 when atmospheric pressure is reestablished in the chamber 106 in the housing 103. In the arrangement shown in FIG. 1, the rod 76 is disposed at a slight angle with respect to the lengthwise axis of the gas passage tube 52 to facilitate mounting the servomotor 100 on the end head 16 without interference with the tubular inlet 37 and the clamp construction 39.

The method of operation of the muffler construction shown in FIGS. 1 through 4 is as follows: The tubular inlet component 37 of the inlet or first gas passage tube 43 is connected with the exhaust pipe 38 from the engine exhaust manifold by a clamp 39, and the gas outlet tube component 62 of the outlet gas passage tube 60 may be connected with a conventional tailpipe 68 by the clamp 39'. With the valve plunger 114 of the control means or valve 112 in the position shown in FIG. 1, the spring 87 exerts pressure on the rod 76 in a right-hand direction, engaging the valve plate 80 with its circular seat provided by the circular region 84 at the flange 73 defining the gas bypass opening in the partition or baffle 28.

This is the normal position of the valve 80 when the servomotor 100 is deactivated. The valve plate 80 in this position closes the gas bypass provided by the short tube 74 between the transverse chamber 36 and the chamber 32 between the baffle 28 and the end wall 18. As the baffle plate 80 is positioned on the rod 76 by the collars 82, the plate 80 is capable of slight angular movement with respect to the rod 76 as shown in broken lines at 81 in FIG. 5. This slight movement facilitates an effective seating of the plate 80 with the circular seat or region 84 to provide a substantially gastight fit of the plate 80 with its circular seat at the region 84.

This selected position of plate 80 impedes or blocks gas flow from chamber 36 into chamber 32 through the short tube 74. With the valve plate 80 in this position, the exhaust gases move through the gas passage tubes 43, 52 and 60 successively and through transverse chambers 30, 34 and 36, this being a long flow path to secure maximum sound attenuation over a broad range of sound frequencies. The gas flows from the exhaust pipe 38 through the nipple 37 and the inlet gas passage tube 43, herein referred to as a first gas passage tube.

Substantially all of the gases flow through the tube 43 into the transverse gas passage chamber 36. high-frequency sound waves entrained in the exhaust gas stream moving through the inlet gas passage tube 43 are attenuated by the high-frequency sound-attenuating chambers 50. As some of the openings 48 in the wall of the tube 43 are in registration with the chamber 35 there is slight gas movement within the chamber 35.

The openings 48 in registration with the chamber 35 provide acoustic couplings for attenuation of sound waves in the gas stream of high intermediate frequencies. The gas delivered into the chamber 36 from the inlet gas passage tube 43 flows into the right-hand end of the intermediate gas passage tube 52 as the valve plate 80 closes the entrance opening to the tube 74. The gas flows through the intermediate gas passage tube 52 in a direction reverse to the direction of gas flow in the first gas passage tube 43.

The openings 56 in the gas passage tube 52 are in registration with the transverse chamber 34, the openings 56 providing acoustic couplings for attenuation of sound waves of intermediate and low frequencies in the chamber 34. The major amount of gas moving through the gas passage tube 52 flows into the transverse chamber 30 thence into the left end of the third gas passage tube 60 and through the outlet provided by the tube 62 which, in effect, is a component or extension of the gas passage tube 60.

The openings 66 in the gas passage tube 60 are in registration with the transverse chamber 34, the openings forming acoustic couplings with the chamber whereby sound waves of low and intermediate frequencies are attenuated in the chamber 34. The openings 56 in the wall of tube 52 and the openings 66 in the wall of tube 60 facilitate transverse flow through the chamber 34 of some of the gases from the tube 52 into the tube 60 without transversing the chamber 30, this arrangement facilitating reduction in gas back pressure in the gas passage tubes.

The exhaust gases flow through the outlet gas passage tube arrangement 60 and 62 to the tailpipe 68. Sound waves of a broad range of frequencies are attenuated during the flow of the gases through the muffler in the long flow path through the gas passage tubes 43, 52 and 60 in sequence so that a high efficiency of attenuation of sound waves is attained providing a comparatively quiet delivery of exhaust gases from the tail pipe 68.

When the vehicle operator desires to change or modify the range of attenuation of sound waves entrained in the stream of exhaust gases, the operator manipulates the button 117 moving the valve plunger 114 to its left-hand position thereby establishing communication of the chamber 106 with the intake manifold vacuum or other source of reduced pressure communicated to the chamber through the tubes 113 and 110.

The vacuum or reduced pressure established in the chamber 106 flexes or moves the diaphragm 104 and the rod 76 in a left-hand direction against the pressure of the spring 87 to a position wherein the valve plate 80 is in seating arrangement with the circular edge 85 of the right-hand end of the gas passage tube 52, this position of the plate 80 being shown in FIG. 4, closing the gas entrance end of the intermediate gas passage tube 52.

This position of the plate 80 away from the seat 84, directs or deflects the gases flowing into chamber 36 from the inlet gas passage tube 43 through the passage or bypass provided by the short tube 74 and openings 71 in the tube component 62 through the outlet into the tailpipe for discharge to the atmosphere. The valve 80 remains in this selected position closing the entrance to the tube 52 so long as the vacuum or reduced pressure is maintained in the chamber 106 of the motive means or actuator 100.

Through this method, substantially all of the gases flowing through the inlet tube 43 are bypassed or directed through the opening in the baffle 28 and through the tube 74 and openings 71 into the outlet of the muffler, and substantially no gases move through the intermediate gas passage tube 52 and the third gas passage tube 60. The high-frequency sound waves, entrained in the gases moving through the inlet gas passage tube 43, are attenuated in the high-frequency-attenuating chambers 50 and sound waves of lesser or high intermediate frequencies are attenuated in the chamber 35 through the acoustic couplings 48.

The intermediate and low-frequency sound waves entrained in the gas stream are not attenuated when the gases flow through the port or passage provided by the tube 74 so that the unattenuated low-frequency sound waves in the exhaust gas stream delivered through the outlet provide an increased noise level as an audible booming or roaring noise mode. With the valve plate 80 in a position closing the end of the gas passage tube 52, the gas flow path through the muffler is greatly reduced or shortened as the gases from the inlet gas passage tube 43 flow through chamber 36, short tube 74, and through the ports or open areas 71 in the tubular outlet component 62 and away from the muffler.

When the operator desires to attain maximum sound attenuation, he moves the button 117 in the right-hand direction, as viewed in FIG. 1, the valve 114 interrupts communication of the chamber 106 in the housing 103 with the source of reduced pressure and the chamber 106 vented to the atmosphere through the passage 118 in the valve 114 in registration with the vent 120. When atmospheric pressure is reestablished in the chamber 106, the expansive pressure of the spring 87 moves the rod 76 and the valve plate 80 in a right-hand direction to engage the valve plate with the circular seat 84 defining the opening in the baffle 28, closing the opening and thereby preventing flow of exhaust gases through the bypass provided by the tube 74 and chamber to the outlet 62.

The plate 80, in the position shown in FIG. 1, provides a long flow path for gases through the tubes 52 and 60 to attain maximum sound attenuation of the sound attenuating components in the muffler. Thus, the operator selects the position desired for the valve plate 80 by manipulating the button 117 controlling the position of the valve plunger 114. Through the use of a plate or surface movable to selected positions, the noise level or noise mode may be quickly changed by this method of modifying the gas flow path through a muffler. It should be noted that the rod 76 is slidable in openings in the end walls 16 and 18 facilitating lubrication of the rod from the exterior of the muffler.

The method of the invention may be employed with different orientation of the gas passage tubes in a muffler construction. FIG. 6 is a semischematic illustration of a modified gas passage tube arrangement in a muffler embodying a selectively movable means or valve for changing the flow path of exhaust gases through the muffler and thereby change or modify the range of attenuation of sound waves of various frequencies entrained in the exhaust gas stream. In this form the relative position of the gas deflecting or diverting valve means is preferably controlled by an electrically actuated motive means mounted on the rear or outlet end head of the muffler construction.

The muffler 130 comprises a shell 132 of elliptically shaped cross section of the same or similar construction as the shell shown in FIG. 1. The shell or housing 132 is provided with an inlet end head or wall 134 and an outlet end head or wall 135. The interior of the muffler is equipped with transverse partitions or baffles 22', 24', 26' and 28'. The central region of the end head 134 is provided with an opening accommodating an inlet or first gas passage tube 136, the tube 136 extending through openings in the baffles 22', 24' and 26' and opening into the transverse chamber 36'.

The second or intermediate gas passage tube 138 is arranged in parallelism with the tube 136 and extends through openings in the baffles 22', 24' and 26', one end of the tube 138 opening into the chamber 36' and the other end of the tube opening into the chamber 30'. The third or outlet gas passage tube 140 extends through openings in all of the transverse baffles, the portion 142 providing a gas outlet from the muffler. Openings 48' in the wall of the tube 136 in registration with an annular sound attenuating chamber 50' provide acoustic couplings with the chamber for attenuating high-frequency sound waves.

Openings 48' in registration with the chamber 35' provide for attenuation of sound waves of lesser frequency than those attenuated in the chamber 50'. The tubes 138 and 140 open into the transverse chamber 30' which conveys gases from the intermediate gas passage tube 138 to the outlet gas passage tube 140. The openings 56' in the wall of the intermediate tube and the openings 66' in the wall of the third gas passage tube 140 provide for attenuation in the chamber 34' of intermediate and low frequency sound waves and facilitate transverse flow of gases from the tube 138 to the tube 140 through the chamber 34'.

In the form shown in FIG. 6, the gas inlet tube 136 is positioned centrally of the muffler shell, the intermediate or second gas passage tube 138 disposed at one side of the inlet tube, and the third or outlet gas passage tube 140 at the opposite side of the inlet tube. The baffle 28', which defines with the end wall 135 a chamber 32', is fashioned with an opening or passage defined by a circular region 84' and a short length of tube 74' registering with the opening in the baffle or wall 28'.

This form of construction includes a selectively movable gas deflector or valve member 80' mounted upon a lengthwise movable operating rod or member 144 which, in the embodiment illustrated, extends through an opening in the muffler end wall 135 and aligned with the axis of the gas passage tube 138. In this form the motive means 146, shown in detail in FIG. 7, for actuating the valve plate 80 and the rod 144 may be of a solenoid-operated type hereinafter described.

The valve 80 is selectively movable to two positions, a first position in which the plate 80' seats against the circular region 84' defining the opening in the baffle 28' so that the gases from the inlet tube 136 through the chamber 36' are deflected or directed by the valve plate 80' into the right-hand end of the intermediate or second gas passage tube 138 whereby the gases flow through tubes 138 and 140 in a long path through the muffler to the outlet in the same manner as the long gas flow path illustrated in FIG. 1.

The wall of the tubular portion 142 of the gas outlet tube arrangement is fashioned with open areas or openings 71' of the same character as shown in FIG. 1. When the operating rod 144 is moved in a left-hand direction, the valve plate 80' is engaged with the right-hand end of the intermediate gas passage tube 138 closing the tube so that gases in the chamber 36' are prevented from flowing through the gas passage tube 138 and through the portion of the tube 140 at the left of the openings 71'.

With the valve plate 80' in this position, the gases from the inlet tube 136 flow through the chamber 36' through the short

length tube 74' thence through the chamber 32' and through the open areas or openings 71' and are delivered out of the muffler through the outlet portion 142. Thus, the valve plate 80', in a position closing the end of the tube 138, provides for a short flow path of the exhaust gases through the muffler with the intermediate and low frequency sound waves unattenuated whereby the noise level is increased to an audible booming or roaring noise mode.

When the valve plate 80' is in its other selected position closing the opening in the baffle 28', the exhaust gases travel through a long flow path through the tubes 136, 138 and 140 in succession so that a broad range of sound frequencies are attenuated providing a maximum attenuation or quiet mode for the gases discharged through the outlet.

A form of motive means 146 for actuating the rod 144 and the valve plate 80' is illustrated in FIG. 7. Secured to the outlet end wall 135 of the muffler construction, shown in FIG. 6, is a bracket 147 having flange portions 148 which may be welded or otherwise secured to the end wall 135. Mounted on a planar portion 149 of the bracket 147 is a cuplike housing 150 having diametrically opposed ear portions adjacent the bracket 147 which are secured thereto by screws 152. The housing 150 has an end portion 154 of reduced diameter providing an annular ledge 155.

Disposed within the housing 150 adjacent the portion 149 of the bracket is an annular member 156 of insulating material, and disposed within the housing and in engagement with the annular ledge 155 is an annular member 158 of insulating material. Mounted on the valve-actuating rod 144 is a solenoid core 160 which may be of soft iron. Surrounding the core and secured in position by the annular insulating members 156 and 158 is a solenoid coil 162, the interior diameter of the coil being slightly larger than the exterior diameter of the core to facilitate slidable movement of the core within the coil.

The core 160 is fashioned with a lengthwise bore 164 extending partially through the core, the bore accommodating an expansive coil spring 166, one end of the spring engaging the bracket portion 149 and the other end engaging the core at the bottom of the bore. The expansive spring 166 normally biases the core 160 in a right-hand direction whereby the valve plate 80', shown in FIG. 6, is engaged with the valve seat 84' defining the opening in the baffle wall 28'.

A threaded end region 167 of the rod 144 is received in a threaded opening in the core providing for adjustment of the position of the core on the rod 144. A locknut 168 may be drawn up to hold the core in adjusted position on the rod 144. The portion 154 of the housing 150 is fashioned with an opening in which is inserted an insulating grommet 170 accommodating a flexible conductor 171 for connecting the coil with a switch means (not shown) convenient to the operator, the switch means being connected with a source of electric energy. The operator manipulates the switch means to energize or deenergize the coil 162.

The conductor (not shown) at the other end of the coil is grounded to the muffler or frame of the vehicle in a conventional manner. As shown in FIG. 7, the core normally extends substantially beyond the right-hand end of the coil so that when the coil is energized, the electromagnetic forces move the core 160 and operating rod in a left-hand direction, moving the valve member or gas deflector plate 80', shown in FIG. 6, into engagement with the end of the gas passage tube 138 to prevent entrance of exhaust gases into the tube 138.

With the valve plate 80 in this position the exhaust gases move through the inlet or first gas passage tube 136 into chamber 36' thence through the short length tube 74' into chamber 32' and through the openings 71' in the outlet member 142 for delivering the gases away from the muffler. When the operator opens the switch means (not shown) deenergizing the coil 162, the expansive pressure of the spring 166 moves the core 160 and rod 144 in a right-hand direction, engaging the valve plate 80' with the circular seat 84', shown in FIG. 6, to close the bypass and block the shortened flow path of gases through the muffler.

FIG. 9 illustrates a further modification of orientation of gas passage tubes in the muffler. The muffler construction 175 includes a shell or housing 132'', an inlet end head or end wall 177 and an outlet end head or wall 178. Disposed within the muffler are transversely extending partitions 22'', 24'', 26'' and 28'' defining transverse chambers 30'', 34'', 35'', 36'' and 32''. Aligned openings in the end wall 177 and baffles 22'', 24'' and 26'' accommodate an inlet or first gas passage tube 136'' of substantially the same construction as the gas passage tube 136, shown in FIG. 6, the gas passage tube being equipped with a high-frequency sound-attenuating chamber 50'' of annular cross section.

In this form the inlet gas passage tube 136'' is at one side of the central region of the oval-shaped muffler casing 132''. The baffles 22'', 24'' and 26'' have aligned openings in which is disposed an intermediate or second gas passage 138'' of substantially the same construction as the tube 138, shown in FIG. 6, the tube 138'' being disposed at the opposite side of the central region of the muffler. The baffles 22'', 24'' and 26'' are fashioned with aligned central openings accommodating the outlet or third gas passage tube 140'', positioned on the central axis of the muffler, having a gas outlet portion 142'' extending rearwardly and exteriorly of the muffler.

The baffle 28'' is fashioned with a circular opening defined by a circular region 84'', a short length tube 74'' providing a passage from chamber 37'' into chamber 32''. The portion of the tube 140'' adjacent the chamber 32'' is fashioned with openings or open areas 71'', there being preferably four openings, establishing communication between the chamber 32'' and the outlet gas passage tube 140''. Aligned with the axis of the tubes 138'' and 74'' is an actuating rod 144'' equipped with a valve plate or gas-directing member 80'' movable with the rod 144''. The rod 144'' is adapted to be actuated by a solenoid motive means 146'' of the character shown in detail in FIG. 7.

The valve plate 80'' is adapted to be moved to two selective positions. When the valve is in engagement with the circular seat 84'', the exhaust gases flow through the inlet tube 136'' into the chamber 36'', then transversely of the chamber, the gases entering the gas passage tube 138'' and flowing therethrough in a reverse direction into chamber 30'', thence into the outlet or third gas passage tube 40'' for delivery through the outlet portion 142'' away from the muffler.

This long flow path of the gases in sound-attenuating relation with the acoustic couplings in the three gas passage tubes provides a maximum silencing or attenuation of sound waves over a broad range of frequencies. When the solenoid coil of the motive means 146'' is energized, the core of the solenoid, the rod 144'' and the valve plate 80'' move in a left-hand direction, the valve plate 80'' closing the entrance end of the intermediate gas passage tube 138''. In this position, the gases flow through the inlet tube 136'' into the chamber 36'' and are bypassed or directed through the short length tube 74'' and through the openings 71'' into the gas outlet portion 142 of the tube 140'', providing a short flow path for the gases through the muffler. The high-frequency sound waves are attenuated in the chamber 50'' and sound waves of high intermediate frequencies attenuated in the chamber 35'' so that an increased noise level or noise mode results by reason of unattenuated sound waves in the gases moving in the short flow path.

In reference to the forms of muffler construction shown in FIGS. 6 and 9, the valve operating rods 144 or 144'' may be of a length projecting through openings in the inlet end heads or end walls of the muffler and arranged to be actuated by a vacuum operated servomotor 100 and retracted by a spring 87 as in the arrangement illustrated in FIG. 1 in lieu of the electrically energizable means shown in FIG. 7.

FIG. 10 illustrates a modified form of electromotive means of the solenoid type for actuating the rod 144 in the form shown in FIG. 6, or for actuating the rod 144'' of the construction shown in FIG. 9. The arrangement of FIG. 10 includes a cuplike housing or casing 180 secured to the rear end wall of

the muffler construction through a flange 181 welded or otherwise secured to the rear end wall of a muffler construction, such as shown in FIG. 6 and in FIG. 9. The actuating rod 144 extends through an opening in the end wall, a soft iron core 182 being mounted on the rod.

The core 182 is fashioned with a bore 183 extending partially through the core to accommodate an expansive coil spring 184, one end of the spring engaging the muffler end wall, the other end engaging the bottom of the bore 183 in the core. The rod has a threaded portion 185 cooperating with a threaded opening in the core whereby the position of the core on the rod may be adjusted. The core 182 is fashioned with an annular chamber 187, the annular chamber accommodating a coil 188, the coil being supported by an annular member 189 of insulating material.

A current conductor 190 for one end of the coil extends through an opening 191 in the core structure and through a grommet 192 disposed in an opening in the housing 180, for connecting the coil with a switch means (not shown) convenient to the operator, the switch means being connected with a source of electric energy. Manipulation of the switch means energizes or deenergizes the coil 188. The conductor at the other end of the coil is grounded to the muffler or frame of the vehicle in a conventional manner.

As illustrated in FIG. 10, the core 182 extends substantially beyond the right-hand end of the coil 188 so that when the coil is energized, the electromagnetic forces move the core 182 in a left-hand direction which, through the operating rod 144, moves the valve member or deflector plate 80', shown in FIG. 6, into engagement with the end of the gas passage tube 138 preventing entrance of exhaust gases into the tube 138. In this position, the gases flow through the shortened flow path through the muffler.

When the coil 188 is deenergized by the operator, the expansive force of spring 184 moves the rod 144 in a right-hand direction to move the valve plate into engagement with the opening in the baffle 28', the valve seating against the circular area 84' to direct the gases in the long flow path through the tubes 138 and 140 to the discharge outlet of the muffler. The arrangement shown in FIG. 10 may be used for operating the rod 144'' and the valve plate 80'' of the construction shown in FIG. 9.

With further reference to FIG. 10, a web portion of the core 182 is provided with an opening accommodating a grommet 195, a pin 196 extending through the grommet. The pin has a threaded portion 197 threaded into an opening in the housing 180 whereby the pin is fixed to the housing and serves to prevent rotation of the core 182. The end wall of the housing 180 has a raised cylindrical portion 198 forming a support for a cap 199 frictionally engaged with the portion 198 to close an opening in the portion 198. By removing the cap 199, a suitable tool may be inserted in a kerf 200 in the end of the rod 144 to adjust the position of the core 182 on the rod 144.

FIG. 11 illustrates an electrically energizable motive means or solenoid arrangement which may be employed in lieu of the fluid pressure operated servomotor 100, shown in FIG. 1, for actuating the rod 76 and valve plate 80 in the arrangement shown in FIG. 1. The motive means shown in FIG. 11 includes a cuplike housing 204 having a flange 205 welded or otherwise secured to the inlet end head of the muffler construction of the character shown in FIG. 1. Mounted upon the planar portion 206 of the cuplike member 204 is a disc or member 207 of insulating material supporting a coil 208 of the motive means or solenoid.

Disposed in the housing 204 is a slidable solenoid core 210 having an open-ended annular chamber 212 accommodating the coil 208. The valve-plate-actuating rod 76' extends through an opening in the muffler end wall 16', the end region 215 of the rod being threaded and extending into a threaded bore in the solenoid core 210. In the use of this form of motive means with the muffler construction shown in FIG. 1, the rod 76' may be disposed coincident with the axis of the intermediate gas passage tube 52 whereby the core 210 is slidable along the axis of the gas passage tube 52.

The current conductor 216, for conveying current from a current source through a switch means (not shown), extends through a grommet 217 disposed in an opening in the wall of the housing 204, the other end of the coil being grounded in a conventional manner to the muffler construction or the frame of the vehicle. The rod 76' is biased in a right-hand direction by an expansive spring of the character shown at 80 in FIG. 1.

In the operation of the motive means shown in FIG. 11, the valve plate 80, shown in FIG. 1, is biased to its position providing for a long gas flow path through the muffler under the influence of the spring at the right-hand end of the rod 76'. In this position, the core 210 is disposed in the position shown in FIG. 11. When the operator manipulates the switch means energizing the coil 208, the electromagnetic forces move the core and rod 76' in a left-hand direction to engage the valve plate 80 with the end of the gas passage tube 52, shown in FIG. 1, to thereby divert the gases in the short flow path through tube 74, chamber 32 and openings 71 into the exhaust outlet to thereby increase the noise level or noise mode by unattenuated intermediate and low-frequency sound waves entrained in the exhaust gas stream.

When the operator deenergizes the coil 208 by the switch means the spring 87, shown in FIG. 1, retracts the core 210 in a right-hand direction to the position shown in FIG. 11, thereby reestablishing the long gas flow path through the muffler by the plate 80 blocking the opening at the tube 74 in the partition 28 shown in FIG. 1.

Manually operable means may be employed for effecting selected positions of the valve plate 80, shown in FIG. 1. FIG. 12 illustrates a manual means for accomplishing this purpose in lieu of the motive means hereinbefore described. Secured to the inlet end wall 16'' of the muffler construction is a bracket 220 having flanges 221 welded or otherwise secured to the muffler end wall. The end wall has a flange 77'' defining an opening accommodating the valve-plate-acutating rod 76'' supporting a valve plate such as shown at 80 in FIG. 1.

A planar portion of the bracket 220 is fashioned with an opening 222 through which extends an end region of the rod 76''. Secured to the end of the rod 76'' is a flexible wire or cable 224 having its other end connected with a manipulating button or member 225 which may be mounted on the instrument panel of the vehicle or other position convenient to the operator. The wire or cable is contained within a tubular sheath 226, the end region of the sheath being secured within a tubular member 228 having an annular flange 229 secured to the bracket 220.

The arrangement shown in FIG. 12 may be employed in lieu of the servomotor means 100. The spring 87, shown in FIG. 1, normally biases the valve plate 80 on the actuating rod 76'' in the position closing the gas bypass opening in the baffle 28 establishing a long gas flow path for the gases through the several gas passage tubes in the muffler. When the operator moves the button 225 in a left-hand direction, the rod 76'' is moved by the cable to a position engaging the valve plate 80 with the entrance end of the gas passage tube 52, shown in FIG. 1.

Means is provided for retaining the valve plate 80 in such position. As schematically shown in FIG. 12, a pin 227 is provided on a shank portion 231 of the button 225, the shank portion being secured to an end of the cable 224. A keeper or bracket 230 is secured to a support adjacent the manipulating button 225. The keeper 230 is fashioned with a narrow slot 232 accommodating the shank 231 on the button 225.

The button 225 may be moved in a left-hand direction until the pin 227 moves through the slot 232, after which the button is rotated so that the pin 227 engages the keeper 230, preventing retraction of the valve-actuating rod under the biasing pressure of the spring 87, shown in FIG. 1, to hold the valve plate 80 in engagement with the entrance end of the gas passage tube 52 preventing flow of gases into the tube 52.

When the operator desires to reestablish the long flow path for the gases moving through the muffler, the manipulating button 225 is rotated to align the pin 227 with the slot 232 to pass through the slot, the spring 87 providing the biasing force to move the valve plate 80 to the position shown in FIG. 1.

FIGS. 13 and 14 illustrate a modified form of valve means for selectively changing the flow path of gases through the muffler. The arrangement of FIGS. 13 and 14 is illustrated as embodied in the type of muffler shown in FIG. 1 wherein the muffler includes a shell or housing 12*a*, a rear or outlet end head or wall 18*a*, baffle members 26*a* and 28*a* and other baffle members of the character shown in FIG. 1. The gas passage tubes 43*a*, 52*a* and 60*a* are of the character shown in FIG. 1, the outlet tube 60*a* having a tubular component 62*a*, the portions 60*a* and 62*a* providing the outlet gas passage means.

The baffle wall 28*a* has an opening defined by the flange 73*a* and a short length tube 236 secured in the opening. In this form the tube 236 extends in a left-hand direction beyond the wall 28*a*, the circular end 237 of the tube providing a seat for a valve means 238. The valve means 238 includes a circular disclike portion 239 which seats against the end of the tube 236 in one selected position. The valve portion 239 has an opening accommodating the rod 76*a* Collars 240 disposed on the rod at opposite sides of the valve portion 239 are staked to the rod in the manner shown in FIG. 5.

The ends of the collars are curved to provide for angular movement of the valve portion 239. Integrally formed with the valve portion 239 is an arm 241 having a cylindrical configuration 242 at its end region to accommodate a pin or stub shaft 243, the pin 243 being carried by a bracket 245 secured by welding to the baffle 28*a*. Through this arrangement the valve means is pivotally movable about the axis of the pin 243 to its selected positions.

In the position shown in broken lines in FIG. 13, the valve portion 239 closes the opening or passage provided by the short length tube 236. The valve portion 239 in the full line position shown in FIG. 13, seats against the entrance end 247 of the gas passage tube 52*a*. The end or edge 247 of the gas passage tube 52*a* is in an angular plane coincident with the surface of the valve portion 239 so as to provide an effective seat for the valve means 239 to close the tube 52*a*. The valve means is actuated by the rod 76*a*.

A motive means such as the servomotor 100 shown in FIG. 1, or an electromotive means or solenoid actuator of the character shown in FIG. 11 is employed to move the rod 76*a* in a left-hand direction whereby the valve 239 closes an end of the gas passage tube 52*a* in establishing a short flow path for the gases moving through the muffler. With the valve means 239 in this position, the exhaust gases from the inlet tube 43*a* flow through chamber 36*a* through the tube 236 and chamber 32*a* thence through the openings 71*a* into the tubular outlet 62*a*. This flow path of the gases provides an increased noise mode or audible booming or roaring sound.

When the motive means is deactivated or deenergized, the spring 87*a* moves the rod 76*a* in a right-hand direction, pivoting the valve means 238 about the pin 243 in a counterclockwise direction to engage the valve portion 239 with the valve seat provided by the end 237 of the tube 236 thus blocking flow of gases through the tube 236. With the valve 239 in the position, shown in broken lines in FIG. 13, the gases flow through the tubes 43*a*, 52*a* and 60*a* in succession and are subjected to the sound-attenuating devices to secure maximum sound attenuation or silencing of the exhaust gas stream.

FIGS. 15 and 16 illustrate a modified construction of valve means similar to that shown in FIG. 13. The muffler construction illustrated in FIG. 15 includes shell or casing 12*b* and transversely extending baffles including baffles 26*b* and 28*b* and gas passage tubes 43*b*, 52*b* and 60*b* and associated sound-attenuating acoustic couplings of the character shown in FIG. 1. The arrangement includes an opening in the baffle or wall 28*b* provided by a circular flange 73*b* in which is disposed a short length tube 250 providing a gas bypass between the transverse chambers 36*b* and 32*b*.

A valve means 252, similar in shape to the valve means illustrated in FIGS. 13 and 14, comprises a valve plate or portion 254 integral with an arm portion 255, the latter terminating in an extending portion 256 which is preferably welded or otherwise secured to the baffle 28*b*. The valve means 252 is fashioned of spring steel initially stressed to occupy the position shown in full lines in FIG. 15 closing the gas bypass tube 250.

The tube 250 extends in a left-hand direction through the opening in the baffle 28*b* as illustrated, the edge or end of the tube 250 being in a plane contiguous with the plane of the valve portion 254 of the valve means whereby the valve portion 254 seats against the angular end of the tube 250 to block or prevent flow of gases from chamber 36*b* into chamber 32*b* and thereby establish the long flow path for the gases through the gas passage tubes 43*b*, 52*b* and 60*b* in succession for delivery through the tubular components 62*b* of the gas outlet passage means.

The inherent stress initially imparted to the valve means 252 causes the valve means to normally occupy the position shown in full lines in FIG. 15 without the use of spring means as in the other forms of construction. An operating rod 76*b* extends through an opening 258 in the valve portion 254 and is provided with collars 240*b* at the respective sides of the valve portion and staked onto the rod 76*b* whereby the valve means is flexed by movement of the rod 76*b*.

A motive means, such as the servomotor 100 shown in FIG. 1 or the electromotive means shown in FIG. 11, is connected with the rod 76*b* at the inlet end of the muffler whereby activation of the servomotor or energization of the electromotive means effects longitudinal movement of the rod 76*b* in a left-hand direction, as viewed in FIG. 15, thereby flexing or distorting the valve portion 254 and the arm 255 to substantially the position shown in broken lines in FIG. 15, the valve portion or plate in this position closing the entrance of the gas passage tube 52*b*.

The end of the tube 52*b* is defined by a plane contiguous with the position of the valve portion 254, shown in broken lines in FIG. 15, whereby the valve portion 254 effectively seats against the edge or end of the gas passage tube 52*b* to thereby prevent entrance of gases into the tube 52*b*, the valve portion 254 diverting the gases from chamber 36*b* into chamber 32*b* through the tube 250 thence through the openings or open areas 71*b* for discharge through the muffler outlet. This shortened gas flow path promotes the passage of unattenuated sound waves of intermediate and low frequencies to provide an increased noise mode or audible roaring or booming sound from the gas stream discharged from the muffler.

When the valve plate or portion 254 is engaged with the seat provided by the end of the tube 250, the gases flow through all of the gas passage tubes in succession and sound waves attenuated through the acoustic couplings associated therewith for attaining maximum silencing or sound attenuation. The rod 76*b*, for controlling selected positions for the valve means 254, may be actuated by the manual means of the character illustrated in FIG. 12. In the arrangement shown in FIG. 15, the opening in the muffler wall 18*b* for the actuating rod is omitted as the rod 76*b* terminates adjacent the right-hand collar 240*b*.

FIG. 17 illustrates another modification of gas bypass means in a muffler. The arrangement includes a muffler shell 12*c*, the several transversely extending partitions or baffles including baffles 26*c* and 28*c*, the muffler having end walls, the rear end wall being shown at 18*c*.

The muffler is equipped with gas passage tubes 43*c*, 52*c* and 60*c*, the latter having an outlet component 62*c* forming a portion of the gas outlet passage tube 60*c*. In this form, the valve plate 80*c* and the actuating rod 76*c* are of the construction shown in FIG. 1. The baffle 28*c* is fashioned with an opening defined by a circular flange 73*c*.

The valve plate 80*c* is secured on the operating rod 76*c* by means of collars 82*c*. The tubular outlet component 62*c* is fashioned with openings or open areas 71*c* in communication with the transverse chamber 32*c*. The valve plate or member 80*c* in its right-hand position seats against the circular region 84*c* to close the opening in the baffle 28*c* whereby the gases flow from the inlet tube 43*c* through gas passage tubes 52*c* and

60c in succession and are delivered through the tubular component 62c, this long gas flow path providing for maximum sound wave attenuation.

The gas passage tube 52c at the region of the chamber 36c may be provided with small size openings 260 for example, three openings about three-sixteenths of an inch in diameter. The motive means connected with the operating rod 76c adjacent the inlet end of the muffler may be a servomotor 100, or an electromotive means of the character shown in FIG. 11. When the motive means is activated or energized, the rod 76c and the valve plate 80c are moved in a left-hand direction, moving the valve plate 80c into seating engagement with the entrance end of the intermediate gas passage tube 52c as shown in FIG. 17.

With the valve 80c in this position, the gases from the inlet tube 43c flow through the chamber 36c through the opening defined by the flange 73c thence through chamber 32c and openings 71c through the gas outlet. Substantially all of the gases move through the path provided by this bypass promoting an increased noise level as a booming or roaring sound of the emitted exhaust gas stream by reason of unattenuated sound waves of intermediate and low frequencies.

A small amount of exhaust gas flows through the openings 260 thence through the gas passage tubes 52c and 60c with only minor attenuation of sound waves in these gas passage tubes. The small amount of exhaust gas flowing through the openings 260 promotes a more uniform temperature throughout the muffler when the gas bypass is in use. The omission of the short length tube at the opening defined by the flange 73c in the baffle 28c tends to slightly increase the noise level where a further increase in noise level is desired.

It should be noted that in the arrangements wherein the actuating rod extends through openings in the muffler and walls, these portions of the rod may be easily lubricated from the exterior of the muffler. From the foregoing it will be apparent that the invention provides an effective method of and means for modifying or changing the ranges of attenuation of sound waves entrained in exhaust gases by changing or modifying the flow path of the gases through the muffler through the selective positioning of a relatively movable gas deflecting or bypass valve means contained within the muffler. Thus, different degrees of sound attenuation or change in noise level may be quickly effected by changing the position of the gas deflector or bypass valve means.

It is apparent that, within the scope of the invention, modifications and different arrangements may be made other than as herein disclosed, and the present disclosure is illustrative merely, the invention comprehending all variations thereof.

I claim:

1. A muffler including, in combination, a housing, a plurality of gas passage tubes in said housing, gas inlet means and gas outlet means for the housing, a plurality of lengthwise spaced transverse baffles in said housing providing a plurality of chambers, said gas passage tubes extending through openings in certain of the baffles and disposed in transversely spaced relation, one of said baffles having a gas support port, a relatively movable valve member for said port, said port being in communication with the gas outlet means, said valve member in one position substantially closing said port whereby the gases flow from the inlet means through the gas passage tubes to the outlet means, said valve member being movable to a second position substantially closing an end of one of said gas passage tubes whereby the gases are directed through the port to the gas outlet means, and means including an actuating rod extending lengthwise of the gas passage tubes for effecting movement of said valve member to its respective positions.

2. The combination according to claim 1 including fluid pressure actuated means for moving the actuating rod for effecting movement of the valve member.

3. The combination according to claim 1 including electrically energizable motive means for moving the actuating rod for effecting movement of the valve member.

4. A muffler including, in combination, a housing having end walls, a plurality of gas passage tubes in said housing in laterally spaced relation, one of said tubes providing a gas inlet through one end wall and another of said tubes providing a gas outlet through the other end wall, a gas passage tube intermediate the tubes providing the gas inlet and the gas outlet, a transversely disposed baffle intermediate the end walls and forming with one end wall a transverse chamber, said baffle having a port therein, relatively movable valve means for said port, the intermediate gas passage tube having an open end adjacent the valve means, the wall of the gas outlet tube having an open area in registration with the transverse chamber, said valve means in one position substantially closing said port whereby the gases flow through the plurality of gas passage tubes for delivery from the outlet tube, said valve means being movable to a second position substantially closing said open end of the intermediate gas passage tube and directing the gases from the inlet gas passage tube through the port and open area in the wall of the outlet tube for delivery from the outlet tube, and means for effecting movement of said valve means.

5. A muffler construction for attenuating sound waves in a stream of gases including, in combination, a muffler housing having end walls, one end wall having a gas inlet and the other end wall having a gas outlet, a plurality of lengthwise spaced transverse baffles in said housing providing transverse chambers, a plurality of gas passage tubes extending through openings in certain of the baffles and disposed in transversely spaced relation, one of the transverse baffles having a port therein, a relatively movable valve member of curved configuration selectively movable to a position substantially closing the port for thereby directing the gases through the plurality of gas passage tubes, said curved valve member in a second position opening the port whereby substantially all of the gases from the first of said gas passage tubes are directed through the port to the outlet.

6. The combination according to claim 5 wherein the walls of the gas passage tubes have openings providing acoustic couplings for attenuating sound waves entrained in the stream of gases.

7. The combination according to claim 14 including means for moving the valve member to its selected positions.

8. A muffler construction for attenuating sound waves in a stream of gases including, in combination, a muffler housing having end walls, one end wall having a gas inlet and the other end wall having a gas outlet, a plurality of lengthwise spaced transverse baffles in said housing providing transverse chambers, a plurality of gas passage tubes extending through openings in certain of the partitions and in transversely spaced relation whereby the gases may flow from the inlet through the gas passage tubes in succession, the gases flowing in the same direction in two of the tubes and in a reverse direction through another of the tubes providing a long flow path for the gases to the outlet, the walls of the gas passage tubes having openings providing acoustic couplings for the attenuation of sound waves entrained in the stream of gases, one of the transverse baffles adjacent the outlet end of the muffler having a port, valve means selectively movable to a position closing the port for thereby directing the gases through the long flow path provided by the plurality of gas passage tubes, the valve means in a second position opening the port whereby substantially all of the gases from the first of said gas passage tubes is bypassed through the port to the outlet.

9. The combination according to claim 8 including motive means for effecting relative movement of the valve means.

10. The combination according to claim 8 wherein the valve means is of curved configuration.

11. The combination according to claim 8 wherein the valve means is a pivotally supported plate.

12. The combination according to claim 8 wherein the valve means is a flexible plate adapted to be flexed to selected positions.

13. The combination according to claim 8 including resilient means normally biasing the valve in a position closing the port in the transverse baffle, and motive means for moving the valve to a position opening the port.

14. The combination according to claim 13 wherein the motive means is a fluid pressure-operated servomotor.

15. The combination according to claim 13 wherein the motive means is an electrically energizable solenoid actuator.

16. A muffler construction for attenuating sound waves entrained in a gas stream comprising, in combination, a housing having end walls, one of said walls having an opening accommodating an inlet gas passage tube, the other of said end walls having an opening accommodating an outlet gas passage tube, an intermediate gas passage tube in transversely spaced relation with respect to the inlet and outlet gas passage tubes, transversely disposed baffles in said housing having openings accommodating said gas passage tubes and forming transverse chambers in the housing, a baffle wall spaced from the end head having a gas outlet providing a transverse gas passage chamber, said baffle wall and an adjacent baffle providing a transverse gas passage chamber, said gas passage tubes being arranged to provide a gas flow path through the tubes in succession, the walls of said gas passage tubes having openings providing acoustic couplings for attenuating sound waves entrained in the gas stream, a port in said baffle wall, valve means movable to a first position for closing said port, said valve means being movable to a second position for closing the entrance of the intermediate gas passage tube, said outlet gas passage tube having open areas in a wall thereof in registration with the transverse chamber defined by the outlet end wall and the baffle wall, and means including an actuating rod for moving the valve means to its selected positions.

17. The combination according to claim 16 including motive means for actuating said rod to move said valve means to one position, and resilient means for moving said valve means to its other position.

18. A muffler including, in combination, a housing, a plurality of gas passage tubes in said housing, gas inlet means and gas outlet means for the housing, a first gas passage tube being in communication with the gas inlet means, another of said gas passage tubes being in communication with the gas outlet means, an intermediate gas passage tube spaced laterally from the gas passage tubes in communication with the gas inlet means and the gas outlet means, baffle means in said housing having a gas passage port therein, a relatively movable valve member for said port, said port being in communication with the gas outlet means, said valve member in one position closing said port whereby the gases flow from the inlet means through the plurality of tubes in succession to the outlet means, said valve member being movable to a second position substantially closing an end of the intermediate gas passage tube whereby the gases from the first of the tubes are bypassed through the port to the gas outlet means, and means including a reciprocable rod for effecting movement of said valve member to its respective positions.

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