United States Patent [19]

Hetherington

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[54] **SWAGED TRI-FLOW MUFFLER**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 329,395, Feb. 5, 1973, abandoned.

[52] **U.S. Cl.** ..... **181/54,** 29/157 R, 181/35 C, 181/61

[51] **Int. Cl.** **F01n 1/08**

[58] **Field of Search** ..... 181/35 C, 49, 53, 54, 57, 181/59, 61; 29/157 R, 475

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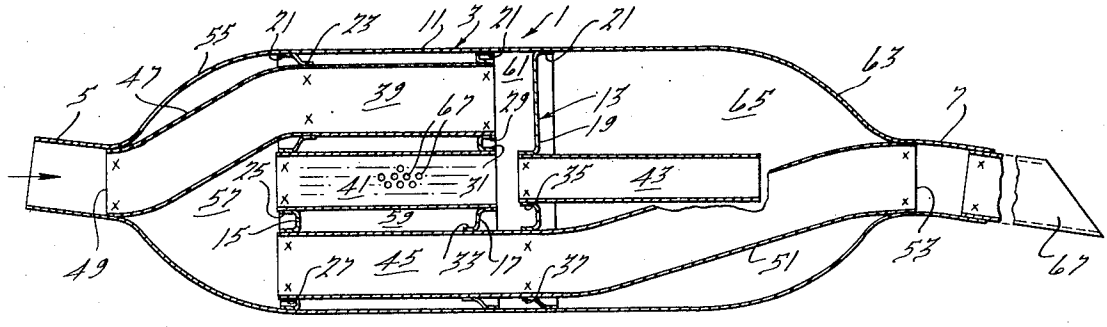
Attorney, Agent, or Firm—Harness, Dickey & Pierce

[57] **ABSTRACT**

A swaged outer muffler shell with straight or offset bushings houses a three tube structure forming a tri-flow gas passage through the muffler.

16 Claims, 4 Drawing Figures



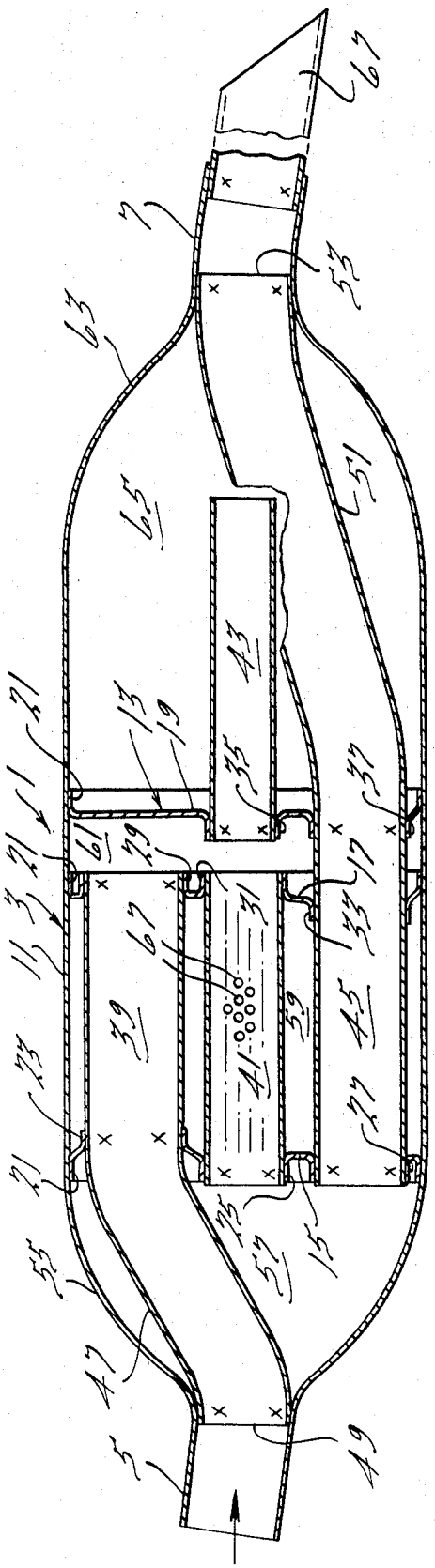


Fig. 1.

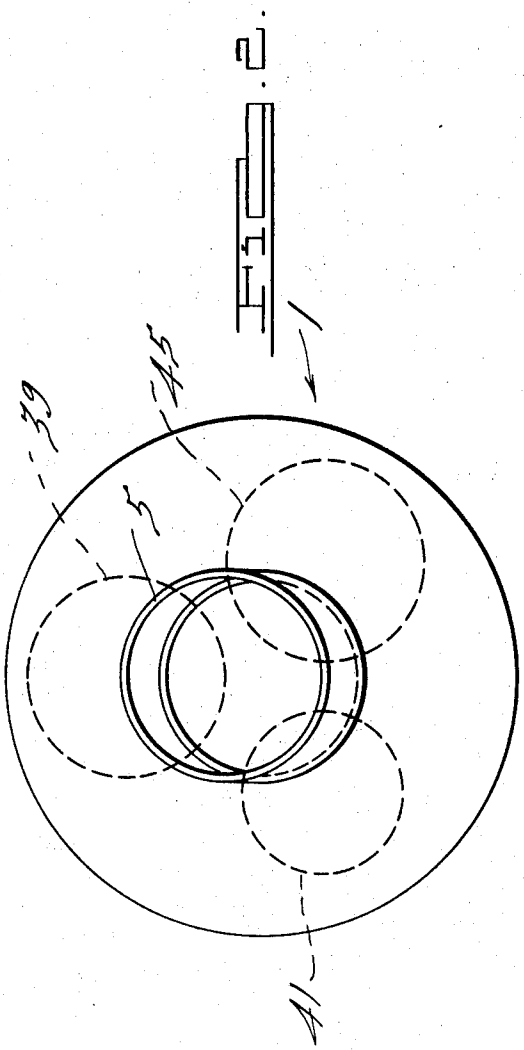


Fig. 2.

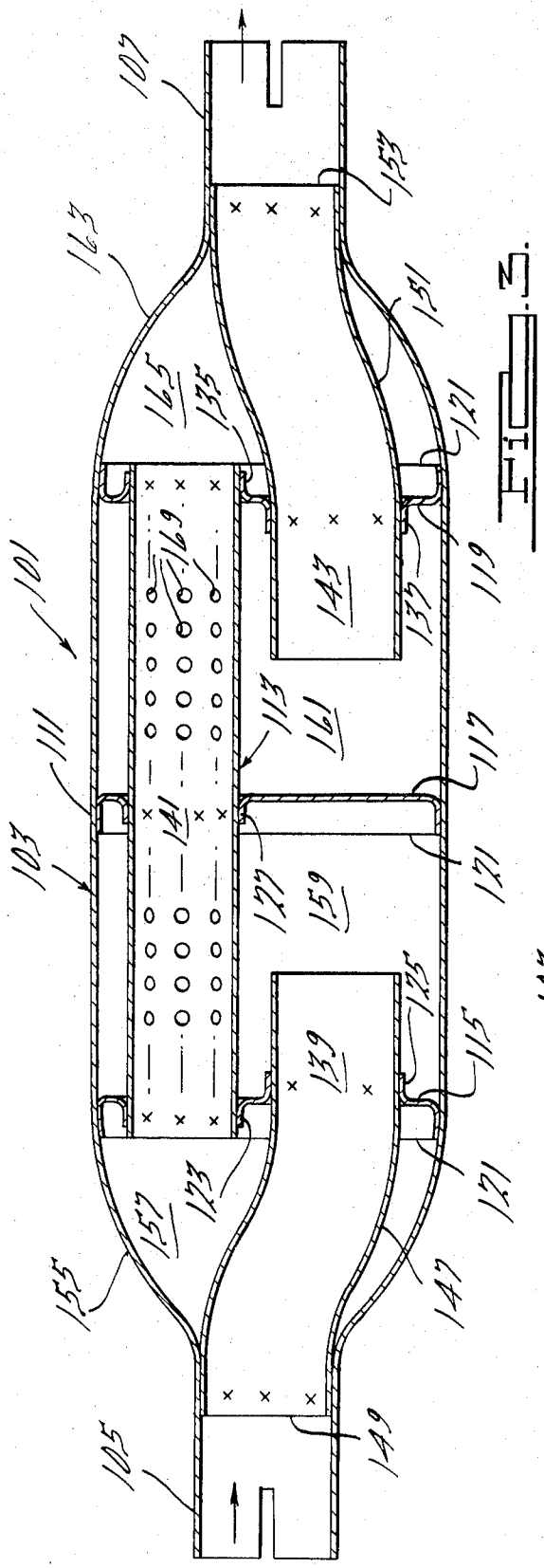

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Fig. 3.

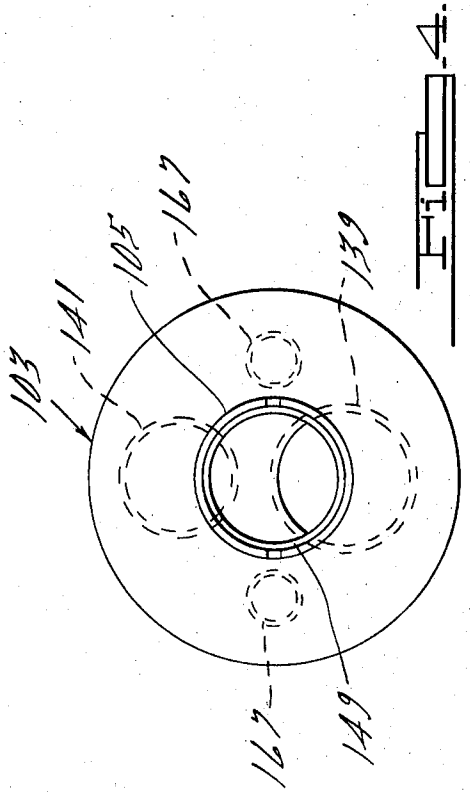
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Fig. 4.

SWAGED TRI-FLOW MUFFLER

RELATED APPLICATION

This application is a continuation-in-part of my copending U.S. application, Ser. No. 329,395, filed Feb. 5, 1973, now abandoned and assigned to the assignee hereof.

BRIEF SUMMARY OF THE INVENTION

It is the purpose of the invention to provide a durable, compact, highly effective muffler that may be used in an automotive exhaust system.

In one embodiment the invention accomplishes this purpose by means of a one piece outer shell or housing with offset bushings to provide durability and compactness and a three tube silencing structure plus a resonator structure inside the housing to provide highly effective, broad band sound attenuation. In another embodiment, the resonator structure is omitted and a long, perforated intermediate tube is utilized.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal cross section through a muffler embodying the invention with the various tubes rotated into the plane of the section;

FIG. 2 is an end view of the muffler of FIG. 1 and showing the actual location of the tubes;

FIG. 3 is a longitudinal cross section through a second embodiment of the invention; and

FIG. 4 is an end view of the muffler of FIG. 3.

In the drawings, the symbol "*x*" designates a spotweld.

DESCRIPTION OF THE INVENTION

The muffler **1** comprises an outer shell **3** which is originally a seamless steel tube but which is swaged down at opposite ends to form reduced diameter inlet and outlet bushings **5** and **7**, respectively. The inner ends of the bushings are preferably coaxial with the main, full diameter body **11** of the shell but, preferably, and as illustrated, the bushings are angled or offset in opposite directions a slight but equal amount to facilitate a neat installation in the exhaust system of a particular make automobile manufactured outside the United States. The shell is reduced down into the bushings after a tube and partition subassembly **13** is inserted.

The subassembly **13** comprises three longitudinally separated partitions **15, 17,** and **19** which have annular peripheral flanges **21** that fit the inside surface of the shell main body portion **11** but are preferably not spotwelded or otherwise affixed to the shell whereby relative longitudinal adjustment between the partitions and shell may occur. Partition **15** has three openings as defined by necks **23, 25,** and **27** and these are longitudinally aligned with three openings in partition **17** as defined by necks **29, 31,** and **33.** Partition **19** has two openings as defined by necks **35** and **37,** and these are longitudinally aligned with necks **31** and **33** in partition **17.** Imperforate open ended tube **39** is supported in and spotwelded to necks **23** and **29**; perforate open ended tube **41** is supported in necks **25** and **31,** being spotwelded to neck **25**; imperforate open ended tube **43** is supported in and spotwelded to neck **35**; and open ended imperforate tube **45** is supported in necks **27, 33,** and **37,** being spotwelded to necks **27** and **37.** It will

be appreciated that by virtue of the various weld connections between the symmetrically arranged tubes and partitions the parts are secured to each other and may be readily handled as the subassembly **13** for insertion into and positioning within the shell **3** prior to formation of bushings **5** and **7.** After insertion, the spotwelding of the tubes to the bushings holds the subassembly in place. Differential expansion is accommodated by the slip fit of the partition in the shell and of tube **45** in partition **17.**

The tube **39** has an offset or angled portion **47** terminating in an inlet opening **49** and the tube **45** has an offset or angled portion **51** terminating in an outlet opening **53** which is coaxial with opening **49** and with the axis of the shell **3.** The end portions of the tubes defining openings **49** and **53** serve as jig and fixture means for the swaging of the ends of the shell **3** into the bushings **5** and **7,** the shell being reduced in diameter into tight contact with the ends of the tubes so that the tubes and shell can be spotwelded together as indicated. After the swaging of the ends of the shell into bushings **5** and **7,** the bushings can be offset or angled in opposite directions as shown, though spotwelding of the ends of the tubes to the bushings is preferably done prior to the offsetting.

The partitions divide the interior of shell **3** into a series of longitudinally adjacent chambers. Thus, partition **15** and the inlet end **55** of shell **3** form a chamber **57**; partitions **15** and **17** form a chamber **59**; partitions **17** and **19** form a chamber **61**; and partition **19** and the outlet end **63** of the shell form a chamber **65.** Chambers **57** and **61** serve as cross over chambers and also function to provide sound attenuation; chamber **59** serves as a resonator chamber for intermediate and high frequencies in combination with the perforations **67** in tube **41**; and chamber **65** has a volume coordinated with the length and cross sectional area of tube **43** to serve as a Helmholtz resonator for attenuating a predetermined relatively low frequency of sound in the exhaust system.

In operation, an exhaust pipe (not shown) is attached to the inlet bushing **5** to conduct exhaust gas from an internal combustion engine to the open end of inlet pipe **39.** The gas flows from pipe **39** to chamber **61** where it reverses direction to enter perforated tube **41** and flow to chamber **57.** It reverses direction in chamber **57** and flows to outlet bushing **7** via outlet tube **45.** A predetermined low frequency is attenuated by connection of tube **43** and chamber **65** to chamber **61.** Gas at the outlet bushing **7** can flow to atmosphere via a tailpipe **67** secured to the bushing.

The three tube arrangement is known to produce very effective silencing and the shape and size of chamber **57** is thought to increase the usual attenuation. If desired, the portions of tubes **39** and/or **45** in chamber **59** may be perforated to provide acoustic communication as well as some cross bleeding for back pressure reduction.

Referring to the second embodiment shown in FIGS. **3** and **4,** the muffler **101** comprises an outer shell **103** which is originally a seamless steel tube but which is swaged down at opposite ends to form reduced diameter inlet and outlet bushings **105** and **107,** respectively. The inner ends of the bushings are preferably coaxial with the main, full diameter body **111** of the shell. The shell **103** is reduced down into the bushings after a tube and partition subassembly **113** is inserted.

The subassembly **113** comprises three longitudinally separated partitions **115, 117,** and **119** which have annular peripheral flanges **121** that fit the inside surface of the shell main body portion **111** but are preferably not spotwelded or otherwise affixed to the shell whereby relative longitudinal adjustment between the partitions and shell may occur. Partition **115** has two openings as defined by necks **123** and **125,** neck **123** being longitudinally aligned with an opening in otherwise imperforate partition **117** as defined by neck **127.** Partition **119** has two openings as defined by necks **135** and **137,** neck **135** being longitudinally aligned with neck **127.** Imperforate open ended tube **139** is supported in and spotwelded to neck **123;** perforate open ended tube **141** is supported in and spotwelded necks **123, 127,** and **135;** and imperforate open ended tube **143** is supported in and spotwelded to neck **137.** The various weld connections between the symmetrically arranged tubes and partitions secure them to each other so that they may be readily handled as the subassembly **113** for insertion into and positioning within the shell **103** prior to formation of bushings **105** and **107.** After insertion, the spotwelding of one or both tubes **139** and **143** to one or both bushings holds the subassembly in place. Differential expansion is accommodated by the slip fit of the partitions in the shell.

The tube **139** has an offset or angled portion **147** terminating in an inlet opening **149** and the tube **143** has an offset or angled portion **151** terminating in an outlet opening **153** which is coaxial with opening **149** and with the axis of the shell **103.** The end portions of the tubes defining openings **149** and **153** may be used as jig and fixture means for the swaging of the ends of the shell **103** into the bushings **105** and **107,** the shell being reduced in diameter into tight contact with the ends of the tubes so that the tubes and shell can be spotwelded together as indicated. The bushings can be offset or angled as in FIGS. **1–2,** if desired.

The partitions divide the interior of shell **103** into a series of longitudinally adjacent chambers. Thus, partition **115** and the inlet end **155** of shell **103** form a chamber **157;** partitions **115** and **117** form a chamber **159;** partitions **117** and **119** form a chamber **161;** and partition **119** and the outlet end **163** of the shell form a chamber **165.** Tubes **139** and **145** project about halfway into the chambers **159** and **161,** respectively. Tube **141** is preferably perforated along its entire length so that there is communication between the inside of the tube and chambers **159** and **161.**

In operation, an exhaust pipe (not shown) is attached to the inlet bushing **105** to conduct exhaust gas from an internal combustion engine to the open end of inlet pipe **139.** The gas flows from pipe **139** to chamber **159** where it reverses direction to flow through two holes formed by two necks **167** in partition **115** and flow to chamber **157.** It reverses direction in chamber **157** and flows to chamber **165** via intermediate tube **141.** The gas reverses direction in chamber **165** and flows through gas passage means in the form of two holes (not shown) in partition **119** formed by necks similar to necks **167** and flow into chamber **161.** From there it reverses direction to flow out of the muffler via the outlet tube **143.** The perforations in tube **141** permit cross bleeding from chamber **159** into the tube and from the tube into chamber **161** thereby tending to reduce back pressure.

The three tube arrangement is known to produce very effective silencing and the shape and size of end chambers **157** and **165** is thought to increase the usual attenuation.

It will be seen that the shells **3** and **103** with, if desired, offset bushings, are very compact. The shell is monolithic or one piece with no seams and is therefore particularly strong and corrosion resistant. The internal structure provides a high degree of attenuation over a wide range of frequencies. Modifications in the specific details shown may be made without departing from the spirit and scope of the invention.

I claim:

1. A muffler adapted for use in an internal combustion engine exhaust system comprising an elongated tubular monolithic shell having opposite ends reduced in diameter to form inlet and outlet bushings respectively, a plurality of transverse partitions located inside and supported on the wall of the shell, three parallel longitudinally extending open ended gas flow tubes supported in and structurally interconnecting the partitions so that the partitions and tubes form a subassembly, first and second of said tubes having offset portions extending respectively into said inlet and outlet bushings and being supported therein.

2. A muffler as set forth in claim **1** wherein said offset portions are welded to said bushings and said partitions have a slip fit with respect to the shell.

3. A muffler as set forth in claim **1** wherein there are three partitions subdividing the space inside the shell into four chambers, a first of said partitions acting with the inlet end of the shell to define a first chamber, a second of said partitions acting with the first partition to define a second chamber, a third of said partitions acting with the second partition to define a third chamber, said third partition acting with the outlet end of the shell to define a fourth chamber.

4. A muffler as set forth in claim **3** wherein at least one of the tubes has perforations along a portion of its length that is located in said second chamber.

5. A muffler as set forth in claim **4** including an open ended tuning tube mounted on the third partition and acoustically connecting the third chamber to the fourth chamber.

6. A muffler as set forth in claim **3** wherein said offset portions of said first and second tubes are located in said first and fourth chambers respectively.

7. A muffler as set forth in claim **6** wherein said first and second tubes open respectively into the third and the first chambers, the third of said tubes opening into the first and third chambers and extending through the second chamber.

8. A muffler as set forth in claim **7** wherein said third tube is perforated in said second chamber.

9. A muffler as set forth in claim **8** including a tuning tube mounted on the third partition and connecting the third chamber to the fourth chamber.

10. A muffler as set forth in claim **9** wherein said bushings extend at an angle to the longitudinal axis of the shell.

11. A muffler as set forth in claim **3** wherein said first tube opens into said second chamber, said second tube opens into said third chamber, and said first and third partitions having gas passage means therein for the flow of gas from the second chamber to the first chamber and from the fourth chamber to the third chamber, the third of said tubes opening at one end in the first cham-

ber and at the other end in the fourth chamber and extending through said second and third chambers.

12. A muffler as set forth in claim 11 wherein said third tube has an array of perforations opening into at least one of said second and third chambers.

13. A muffler as set forth in claim 11 wherein said third tube is perforated and the perforations open into both said second and third chambers and provide means for limited bypass flow of gas between the tube and said chambers.

14. The method of making a muffler which comprises forming a subassembly of a plurality of partitions and three parallel tubes extending between and welded to the partitions, one of said tubes being an inlet tube and another being an outlet tube, said inlet and outlet tubes being bent to have offset ends, inserting said subassembly into said shell and providing said partitions with a slip fit on the inner wall of the shell, and swaging the ends of the shell down into bushings extending around and in contact with the offset ends of said inlet and outlet tubes.

15. The method of claim 14 including the step of bending the bushings at angles to the axis of the shell.

16. The method of making a muffler which comprises forming a subassembly of three partitions and three parallel tubes secured to the partitions, a first of said tubes being an inlet tube and a second being an outlet tube and said first and second tubes being welded respectively to first and second of said partitions, the third tube being welded to each of said partitions, said inlet and outlet tubes being bent to have offset ends, inserting said subassembly into said shell and providing said partitions with a slip fit on the inner wall of the shell, swaging the ends of the shell down into bushings extending around and in contact with the offset ends of said inlet and outlet tubes, and welding at least one of the bushings to a tube.

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