Dec. 6, 1966 J. C. WALKER 3,289,785

SILENCER WITH OUTER HOUSING CONTACTING INNER CONDUIT TO DEFINE RESONANCE CHAMBERS

Original Filed Oct. 24, 1963

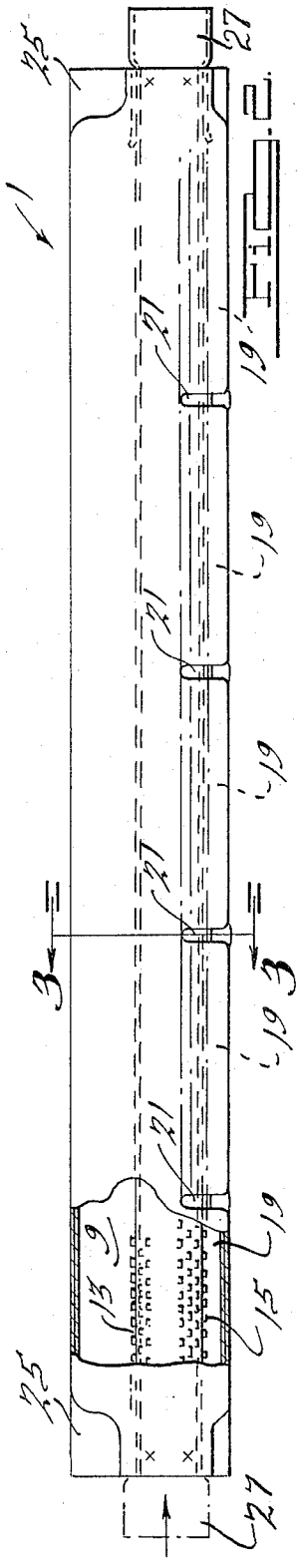


Fig. 2.

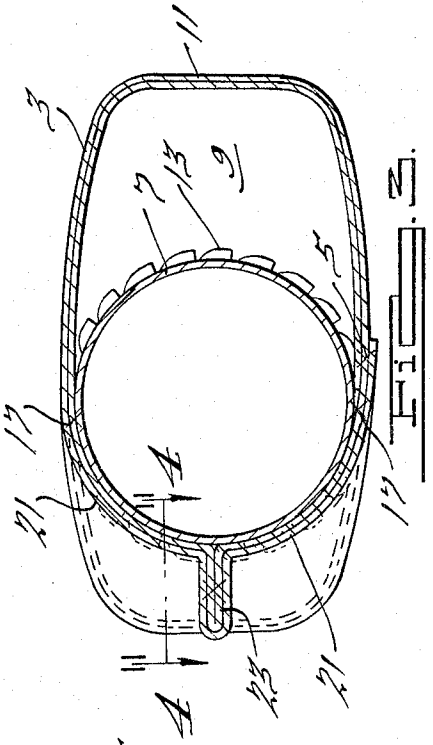


Fig. 3.

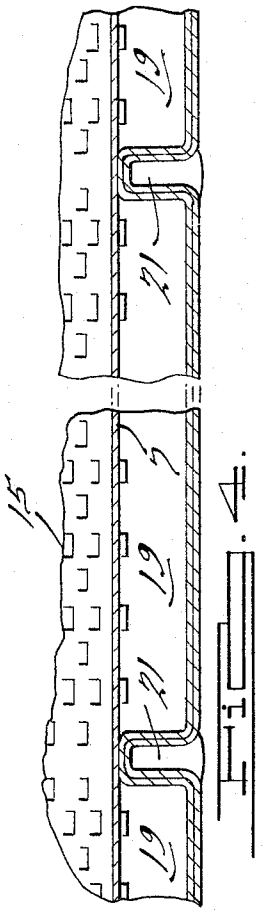


Fig. 4.

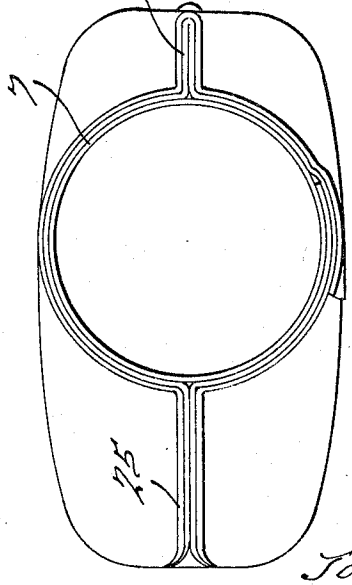


Fig. 1.

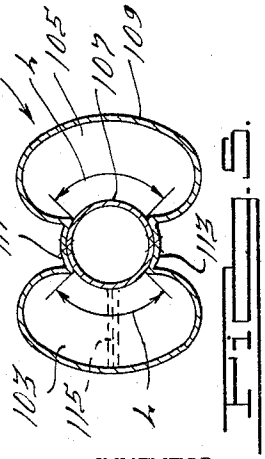


Fig. 5.

INVENTOR.

John C. Walker

BY

Harness, Dickey & Pierce.

ATTORNEYS.

United States Patent Office

3,289,785

Patented Dec. 6, 1966

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SILENCER WITH OUTER HOUSING CONTACTING INNER CONDUIT TO DEFINE RESONANCE CHAMBERS

John C. Walker, Jackson, Mich., assignor to Walker Manufacturing Company, a corporation of Delaware

Continuation of application Ser. No. 318,652, Oct. 24, 1963. This application Oct. 4, 1965, Ser. No. 496,240

23 Claims. (Cl. 181—48)

My invention relates to gas silencing devices and, in particular, concerns a silencing device that is useful in the exhaust systems of automotive internal combustion engines and is a continuation of my copending patent application, Serial No. 318,652, filed October 24, 1963, now abandoned.

It is an object of my invention to provide a silencing device that may be readily manufactured, which silences more than one frequency or type of noise, and which is adapted for use in an automotive exhaust system developed by the assignee hereof wherein a multiplicity of small size silencing components are distributed over the entire length of the system.

Another object of the invention is to provide a silencer that may be used in conjunction with a more or less conventional muffler to provide better performance than a resonator type muffler.

The invention accomplishes the foregoing and other objects by means of a simple, essentially two-part assembly of perforated gas flow conduit and housing which is formed so as to provide a series of spit chambers and a quarter wave length or quincke tuning chamber.

A preferred form of the invention is illustrated in the accompanying drawings in which:

FIGURE 1 is an end view taken from the left of FIGURE 2;

FIGURE 2 is a top elevation of the structure of FIGURE 1 on a reduced scale, partly broken away, and with an inlet bushing shown in phantom lines;

FIGURE 3 is an enlarged section along the line 3—3 of FIGURE 2;

FIGURE 4 is a section along the line 4—4 of FIGURE 3; and

FIGURE 5 is a cross-section similar to FIGURE 3 of a modified form of the invention.

The silencing device 1 has a housing 3 that is formed of an open-ended tube of double wrap construction, i.e., comprises a layer of metal wrapped upon itself in helical fashion, to form a two layer, sound deadened sheet and spotwelded together at the three layer joint 5. If desired, the housing could be a double layer construction formed of two different tubes, one inside the other, such as stainless steel inside of aluminized steel for optimum corrosion resistance. The housing 3 is preferably of the generally rectangular shape illustrated and running substantially the full length of it, and in contact with opposite sides of it, is a louvered gas conveying tube 7 which may be of lock-seam (not shown) construction.

In the embodiment illustrated, the tube 7 is offset from the center line of the housing 3 and forms a chamber 9 with the side 11 of the housing 3. Chamber 9 runs the full length of the housing 3 in the form illustrated but it may be made shorter if desired. A bank of louvers 13, adjacent the inlet end of the tube 7 provides an accoustic coupling with the chamber 9 and by properly selecting the length of the chamber 9 in proper relationship to the frequency to be silenced, it may be used to act as a quincke or quarter wave tuning tube. In the case, the distance from the downstream end of the bank of louvers 13 to the downstream end of chamber 9 would be one-quarter of the wave length of the frequency to be silenced subject to such adjustments as may seem desirable to obtain maximum silencing effect. For example, in one application the theoretical quarter wave length was 41 inches but the best total silencing in the system was obtained with a length of 37 inches.

The use of flat louvers as the communication with the chamber 9 gives some anti-roughness or high frequency attenuating effect. However, it is possible to use one large or several small openings at either end of the tube 7 or to use other types of communication between tube 7 and chamber 9, various such forms of acoustic connection being known in the art. The bank of louvers 13 should be located as close as possible in the exhaust system to an antinode of the frequency to be silenced, preferably the first antinode.

By offsetting the tube 7 from the center line of the housing 3, the chamber 9 is made larger for a given size housing 3 than would be the case if the tube were on center. This gives a larger volume and cross sectional area to the chamber 9 which may be desired in some applications.

The space inside housing 3 on the other side of the conduit from chamber 9 is divided into a series of separate spit chambers which communicate with the inside of the pipe 7 through banks of louvers 15 which may be the flat type but are preferably the round type. The opposite sides of the tube 7 that are in contact with the shell 3 may be spot-welded to it as indicated at 17. The various spit chambers 19 can be formed by pinching down sections 21 of the housing 3 into surface contact with one side of the tube 7, the metal being gathered into four layer reversely bent bites or folds 23 that may be spot-welded together. The spit chambers 19 pass low and medium frequencies and act to take out roughness and high frequency sounds. The lengths of the respective spit chambers can be varied by spacing the pinches 23 and the number of louvers and rows of louvers in them can be varied among the spit chambers, thus providing a varying attenuation to cover a wider range of sound than if the chambers are all uniform.

The opposite ends of the shell 3 are closed by being pinched down as indicated at 25. These ends are fastened together in some manner to prevent leakage of gas, such as by arc-welding. Preferably, inlet and outlet bushings 27 of the type normally used in muffler manufacturing are inserted between the tube 7 and the housing at opposite ends to provide a means for attachment to other components in an exhaust silencing system. If desired, however, the inner tube 7 may be extended out of one or both ends to provide the attachment bushings.

In use, gas flow through the tube 7 will be subject to the silencing effect of the series of spit chambers 19 on the one side and the quincke chamber 9 on the other side.

The structure illustrated is capable of substantial modification, especially with respect to the number and size of chambers 19 and 9. One or more spit chambers could be put on the same side as chamber 9 by using the pinch down technique 21. Of course, that side of the conduit 7 in such spit chambers would then be perforated or louvered. As previously indicated, the bank of louvers 13 is preferred but other openings may be used and they may be located at the outlet end or such other point along the length of chamber 9 as may be desired. If desire, instead of spit chambers 19, a second independent quincke or quarter wave length chamber may be formed on that side of the conduit 7 in which case limited communication will be provided between the conduit 7 and such chamber. The opposite modification is also pos-

sible, i.e., form all spit chambers on both sides of the tube **7** by pinching down at desired points on each side. Two or more quincke chambers could be provided on one side by using the pinch down technique **21**. If a single wrap shell **3** is used, the ends may be swaged down into contact with the inlet and outlet bushings and the tube **7** instead of using the pinched joints at **25**. In a silencing system, one or more of these units of same or different sizes may be employed and it will be seen that the unit **1** can be bent after it has been assembled. Bending in some cases may be facilitated by disposing the pinched sections **21** at different advantageous angles.

FIGURE 5 shows a modified silencer **101** in which the cross-sectional area of the two longitudinal chambers **103** and **105** on opposite sides of the center tube **107** is increased so as to give more chamber volume and more area for louver openings, as indicated by arcs "L." The center tube **107** and shell **109** are shown as concentric but they could be offset as shown in FIGURES 1–4.

In the silencer **101** the shell **109** is substantially higher than center tube **107** but longitudinal inwardly extending channels **111** and **113** are formed in the top and sides of it to engage and be spotwelded at "*x*" to the top and bottom of the tube **107** along the full length that the two are coextensive. Otherwise, the silencer **101** may be of the same construction as the unit **1** previously described. Thus, pinched down folds **115** may be formed on one side of the shell to divide the chamber **103** into a series of short length spit chambers corresponding to chambers **19**.

Modifications may be made in the structure illustrated without departing from the spirit and scope of the invention.

What is claimed is:

1. A gas silencing device for silencing a note having a predetermined frequency comprising an elongated housing, a conduit inside the housing and extending substantially the full length thereof, said conduit being substantially less in width than said housing, opposite sides of said conduit being in engagement with opposite sides of the housing to divide the housing into two longitudinal spaces separated by said conduit, the first of said spaces extending over a substantial part of the length of the housing, said conduit having a wall with a perforate portion opening into said first space and said first space being substantially one quarter the wave length of said note whereby said first space acts as a quarter wave length tuning chamber for said note, the side of said housing over the second of said spaces having inwardly extending portions at a plurality of sections in engagement with one side of said conduit to divide said second space into a series of separate chambers, said conduit having perforate areas opening into each of said series of separate chambers whereby said chambers act as a series of spit chambers to silence high frequencies and roughness in the gas.

2. The invention set forth in claim **1** wherein the gas conduit is offset from the center line of the housing so that one of said two spaces is larger than the other.

3. The invention set forth in claim **1** wherein said housing is provided with said series of spit chambers by means of sections of opposite sides extending inwardly into contact with the conduit and one side of the conduit with folds extending radially to the conduit.

4. The invention set forth in claim **3** wherein the opposite ends of the housing extend inwardly so that opposite sides thereof are in contact with each other and with the full circumference of said conduit.

5. The invention set forth in claim **1** wherein said housing is of substantially the same height as the conduit.

6. The invention set forth in claim **1** wherein said housing is substantially higher than said tube and has inwardly extending longitudinal channels formed therein to engage opposite sides of said conduit.

7. The invention set forth in claim **1** wherein said housing comprises a laminate of two layers of metal.

8. The invention set forth in claim **1** wherein the perforate portion comprises means defining a plurality of openings.

9. The invention set forth in claim **1** wherein said perforate portion comprises a bank of louvers.

10. The invention set forth in claim **9** wherein the distance from the louvers in said louver bank closest to said tuning chamber to the remote end of said tuning chamber is approximately one quarter of the wave length of said note.

11. The invention set forth in claim **9** wherein said housing comprises a two layer metal laminated shell.

12. The invention set forth in claim **9** wherein said tube and housing are substantially the same height.

13. The invention set forth in claim **9** wherein said housing is of greater height than said tube and has inwardly extending longitudinal channels formed on opposite sides thereof to contact the top and bottom of said tube.

14. A gas silencing device for silencing a note having a predetermined frequency comprising a straight through gas flow tube, a housing around the outside of the tube but in contact with the top and bottom of the tube whereby it is divided into first and second separate longitudinal spaces located on opposite sides of the tube, said tube being perforated on opposite sides to open into each of said spaces whereby said spaces act as silencing chambers, said tube being perforated only near one end of the first space and said first space being substantially as long as a quarter wave length of said note.

15. The invention set forth in claim **14** including means dividing the second of said spaces into a series of spit chambers.

16. A gas silencing device for attenuating a note having a predetermined frequency comprising a tubular housing having a long chamber therein and a plurality of small chambers therein, said long chamber having a length substantially equal to one quarter wave length of said note, a gas flow tube running through the housing and having an inlet and an outlet end, an opening in the tube adjacent an end thereof into said long chamber whereby it comprises a tuned chamber, and openings in the tube into each of the small chambers whereby they comprise spit chambers.

17. A gas silencing device comprising a straight through gas flow tube, a continuous housing extending around said flow tube and contacting said tube on opposite sides thereof, said housing being closed at opposite ends thereof and being in engagement with said tube along its contained length on opposite sides thereof to define first and second longitudinal tuning chambers on opposite sides of said tube, and at least one opening through said tube into each of said chambers for silencing the gas flow, one of said chambers being adapted to silence a note having a predetermined frequency and the opening into said one chamber is spaced substantially one quarter of the wave length of said note from at least one end of said one chamber.

18. A gas silencing device as set forth in claim **17** wherein the opening into the one chamber is formed adjacent one end of said one chamber.

19. A gas silencing device comprising a straight through gas flow tube, a housing positioned around said tube, said housing being in engagement with said tube on opposite sides thereof and spaced from said tube between the points of contact to define separate chambers on opposite sides of said tube, means forming closures for opposite ends of each of said spaces, said last named means being effective to provide a different volume in one of said spaces than in the other of said spaces, and at least one opening through said tube into each of said spaces for silencing gas flow.

20. A gas silencing device as set forth in claim **19**

wherein the opening into one of the spaces comprises a louvered portion of the tube.

21. A gas silencing device as set forth in claim **20** wherein the one space is adapted to silence a note of a predetermined frequency and the distance from the louvered portion to one end of the space is substantially equal to one quarter of the wave length of said note.

22. A gas silencing device as set forth in claim **21** wherein the louvered portion is positioned adjacent the other end of the one space.

23. A gas silencing device as set forth in claim **19** further including means for dividing the space at one side of the tube into a plurality of separate longitudinally spaced chambers, there being at least one opening through said tube into each of said chambers.

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RICHARD B. WILKINSON, *Primary Examiner.*

R. S. WARD, *Assistant Examiner.*