# United States Patent

**Haren**

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[54] **COMPACT MUFFLER**


[72] Inventor: **Ralph J. Haren,** Jackson, Mich.

[73] Assignee: **Tenneco, Inc.,** Racine, Wis.



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[52] **U.S. Cl.**.....**181/54,** 181/47 R, 181/57

[51] **Int. Cl.**.....**F01n 1/02,** F01n 1/08

[58] **Field of Search**.....181/41, 44, 47–49, 181/53–57, 59, 60



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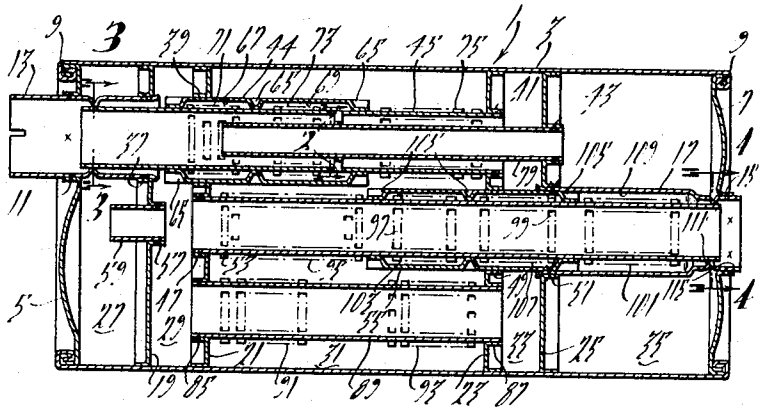
*Primary Examiner*—Richard B. Wilkinson
*Assistant Examiner*—John F. Gonzales
*Attorney*—Harness, Dickey & Pierce



[57] **ABSTRACT**

A triflow automobile muffler has a long tuning tube located inside the inlet gas passage and charged directly by incoming gas and also has a velocity reducing directly charged gas bleed-off adjacent the inlet of the muffler as well as other features providing improved performance and construction.


**16 Claims, 4 Drawing Figures**



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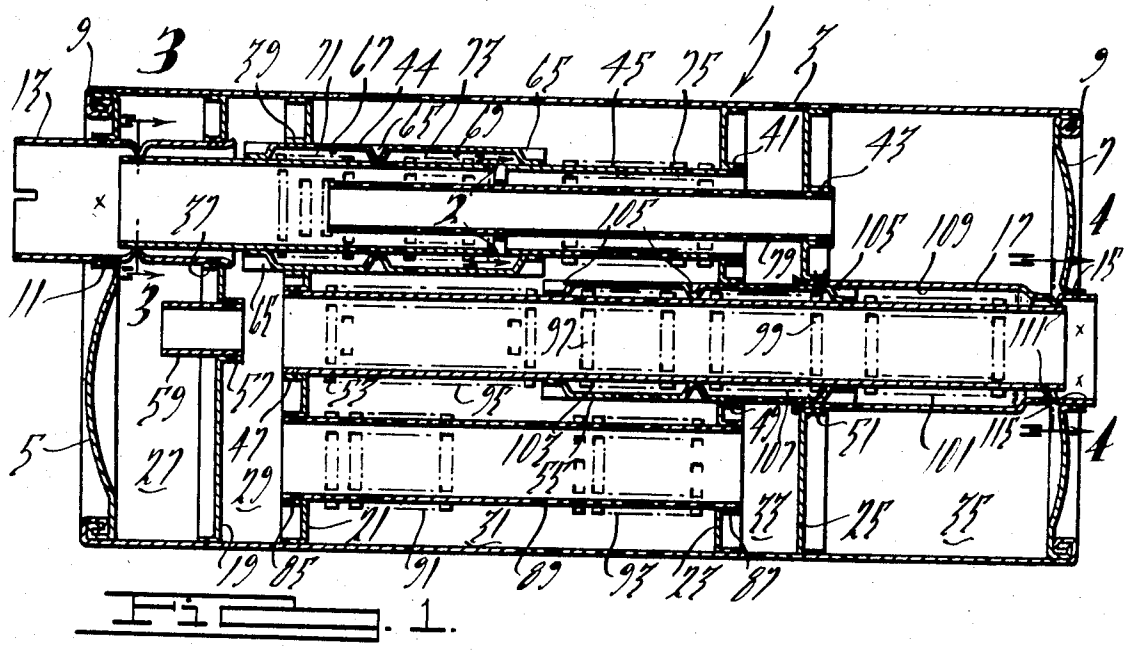


FIG. 1.

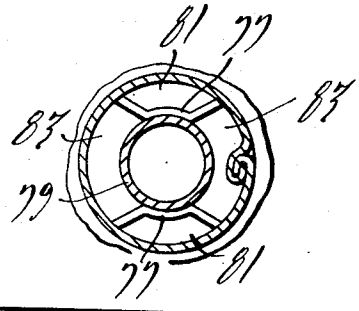


FIG. 2.

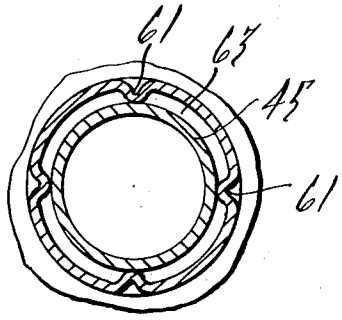


FIG. 3.

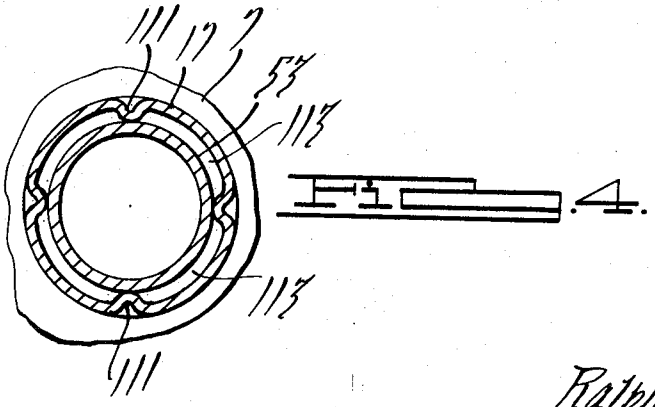


FIG. 4.

INVENTOR.
Ralph V. Haren.
BY
Harness, Dickey & Pierce
ATTORNEYS

# COMPACT MUFFLER

## BRIEF SUMMARY OF THE INVENTION

It is the purpose of this invention to provide a compact triflow muffler construction that produces superior attenuation across a bread band of sound frequencies as encountered in present automotive exhaust systems.

The invention accomplishes this by means of a triflow structure incorporating a compact tuning tube and gas flow passage arrangement and preferably including directly charged, controlled area bleed-off openings to lower the gas velocity, as well as other structural features, including a nesting arrangement, that attenuate a broad band of sound within a small volume of muffler housing.

## DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal cross section through a muffler embodying the invention, the muffler preferably being oval in cross section;

FIG. 2 is an enlarged cross section along the line 2—2 of FIG. 1;

FIG. 3 is an enlarged cross section along the line 3—3 of FIG. 1; and

FIG. 4 is an enlarged cross section along the line 4—4 of FIG. 1.

## DESCRIPTION OF THE INVENTION

The muffler 1 has a tubular housing or shell 3 which is preferably oval in cross section and has its ends closed by an inlet header 5 and an outlet header 7 which are secured to the ends of the shell 3 by gas-tight interlock joints 9 or the equivalent. The inlet header 5 has an outwardly extending collar 11 located adjacent one side of the header which receives and is welded to an inlet bushing 13. The outlet header 7 has an outwardly extending collar 15 which is located close to or on the axis or centerline of the muffler and which receives and is welded to a combination outlet bushing and chamber forming member 17.

Disposed within the shell 3 and welded to it are a series of transverse partitions 19, 21, 23, and 25 which are preferably substantially imperforate except for the flanged openings shown in the drawings and referred to hereinafter. The partitions acting with the headers 5 and 7 subdivide the interior of the muffler into a series of longitudinally separated chambers 27, 29, 31, 33, and 35 which extend across the full width of the housing 3. The two end chambers 27 and 35 constitute tuned resonator chambers acting in conjunction with tuning tubes, to be described, to attenuate predetermined frequencies in a lower range. The two chambers 29 and 33 constitute cross-over chambers in which the gas flows transversely of the length of the muffler as will be described. The central chamber 31 constitutes an attenuation chamber that is effective on medium and high frequencies and in which some transverse cross flow from one triflow section to another may occur, as will become apparent.

The partitions 19, 21, 23, and 25 have axially aligned collars 37, 39, 41, and 43, respectively, which are located in alignment with the inlet 13. The collar 37 supports and is spotwelded to the inner end of the inlet bushing 13. The collar 39 receives and supports a shell 44 that extends partly into chamber 29. The collar 41 supports and is spotwelded to the outlet end of an inlet tube 45.



The partitions 21, 23, and 25 have axially aligned collars 47, 49, and 51, respectively, which are located in alignment with the outlet 15. The collar 47 supports and is spotwelded to the inlet end of an outlet tube 53. The collar 49 receives and supports a shell 55. The collar 51 receives and is spotwelded to the inner end of the outlet bushing 17 and this in turn receives the end of the shell 55 so that the shell 55 is nested within the bushing 17 and located partially in chamber 35 after extending through chamber 33. Preferably, the partition 19 has a collar 57 to receive and support a tuning tube 59 for resonator chamber 27.

The inlet tube 45 is supported at its inlet end by inwardly extending deformations 61 in the inlet bushing 13, as seen best in FIG. 3. The deformations 61 define segments 63 of an annular opening or passage between the inlet bushing 13 and the tube 45, the area of which is controlled by control of the size and/or the number of the deformations. Inlet gas in the bushing 13 flows directly with dynamic energy through the openings 63 into the transverse chamber 29.

The shell 44 preferably has pinched down sections 65 which reduce the diameter of the shell so that it tightly corresponds to and is supported on the tube 45 to define spit chambers 67 and 69. The tube 45 has perforations, preferably in the form of a louver patch 71, opening into the chamber 67 and perforations, preferably in the form of a louver patch 73, opening into the chamber 69. The tube 45 is further perforated outside of the shell 43 to open into the transverse chamber 31, these perforations preferably being in the form of a louver patch 75.

The inlet tube 45 has diametrically opposite pairs of slits or bayonet slices formed to isolate opposed bands 77 which are inwardly deformed so as to partially embrace and serve as a support for a tuning tube 79, the downstream end of which is received in and spotwelded to the collar 43. The forming of sections 77 leaves slits in the wall of tube 45 and defines openings 81 whereby gas in the tube 45 can communicate with and be tuned into the chamber 69, though it will be recognized that the segment 77 could be located outside of the shell 44 so that the slits and the openings 81 communicate with the chamber 31. The spaces 83 between the openings 81 as well as the openings 81 permit gas in the tube 45 to flow past the support structure 77 into chamber 33 for out continuation and turn-around in the direction of the main path of gas flow.

The partitions 21 and 23 have axially aligned collars 85 and 87 which receive and support opposite ends of a return flow or intermediate tube 89. This tube is perforated within the chamber 31, as by means of a pair of louver patches 91 and 93.

The outlet tube 53 is perforated throughout its length, as by means of four louver patches 95, 97, 99, and 101. The patch 95 opens into the chamber 31. The patch 97 opens into a spit chamber 103 which is formed within the shell 55 by means of the pinched down sections 105 which embrace the tube 53 to form the chamber 103 as well as a spit chamber 107. The louver patch 99 opens into the chamber 107; and the louver patch 101 opens into a chamber 019 that is formed around tube 53 by the outlet bushing 17.

As shown in FIG. 4, the outlet bushing 17 may have deformations 111, corresponding to deformations 61, which project inwardly to engage and support the outlet end of the outlet tube 53 and define between them segments 113 of an annular opening that permits bleeding of the chamber 109 to the outlet end 115 of the outlet bushing 17. This arrangement is particularly desirable in installations in which an antinode or high pressure point falls just outside and downstream of chamber 109.

In operation, gas enters the inlet bushing 13 where most of it flows into the inlet tube 45 to pass through that tube into the crossover chamber 33. From the cross-over chamber 33, gas returns toward the front of the muffler through the flow tube 89 to enter the cross-over chamber 29. From the chamber 29 it enters the outlet tube 53 to flow out of the muffler through the outlet end of the outlet bushing 17. During the gas passage just described, medium and high frequencies are attenuated by communication of the gas through the various louver patches with the various spit chambers and with the chamber 31 as well as by the changing cross sectional area of the gas passage as it goes through the chambers 33 and 29. Attenuation is facilitated by the dynamic bleed-off through passages 63 which are located as close as possible to the inlet end of the inlet bushing 13 and which permit a controlled amount of incoming gas to flow straight and with high energy into the cross-over chamber 29 and against partition 21. This bleed-off reduces the gas velocity and takes out some pulses and roughness and tends to knock off peak pressures and give a broad-banding effect. It tends to make the gas velocity more uniform and improve the performance of the other silencing devices within the muffler. The bleed-off gas flowing into chamber 29 will bypass the tubes 45 and 89 and flow directly into the outlet tube 53 but in this tube it is subjected to the action of the four louver patches described as well as to the effect of the bleed-off provided by areas 113.

The tuning tube 79 is of long length due to its location within the inlet tube 45 and this enables it, in combination with the chamber 35, to attenuate very low frequencies. The location of the tuning tube 79 within the tuning tube 45 has the additional advantage of holding the tube at a more uniform temperature due to the heat of the gas flowing in the annular space around it thereby tending to improve the design performance of the resonator combination. Further, the tube 79 is charged directly by the incoming gas tending further to improve the performance of the resonator arrangement.

An additional relatively low frequency is attenuated by tuning of the tube 59 and chamber 27 to the desired frequency.

The features mentioned plus the nesting of shells 44 and 55 within adjacent chambers reduces the overall length of the muffler so that three retroverted gas passes and a variety of silencing means are housed in a minimum sized envelope.

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

I claim:

1. A muffler comprising an elongated shell having an inlet at one end and an outlet at the other end, gas passage conduit structure in the shell providing a retroverted three pass gas path connecting the inlet and outlet, partition means in the shell providing a resonator chamber adjacent an end of the shell, a tuning tube located inside one of the three passes and opening into said resonator chamber, and support means supporting the tubing tube inside said one pass and providing for gas flow through the pass outside the tuning tube.

2. A muffler as set forth in claim 1 wherein said resonator chamber is located adjacent the outlet end of the muffler and said tuning tube is inside the inlet pass.

3. A muffler as set forth in claim 1 including predetermined area bleed-off means in the conduit structure adjacent the inlet end of the shell providing for bypassing of gas by the first pass.

4. A muffler as set forth in claim 1 including means providing a sound attenuating chamber around the third pass adjacent the outlet end of the muffler, and predetermined area bleed-off means connecting said sound attenuating chamber to said outlet.

5. A muffler as set forth in claim 4 wherein said sound attenuating chamber is located within said resonator chamber.

6. A muffler comprising an elongated shell having an inlet header at one end and an outlet header at the other end, first and second transverse partitions in the shell located adjacent the inlet end and defining a first chamber at the inlet end and a second chamber adjacent the first chamber, an inlet bushing supported in the inlet header and the first partition and opening into the second chamber, an inlet gas flow tube telescoped inside the inlet bushing and extending through the second chamber, support means for the inlet tube supporting it inside the bushing, said support means providing a predetermined open area for gas in the bushing to flow around the inlet tube into the second chamber, an outlet bushing in the outlet header, and an outlet gas flow tube connecting the second chamber to the outlet bushing.

7. A muffler as set forth in claim 6 wherein said outlet tube is telescoped inside the outlet bushing, and second support means supporting the outlet tube inside the outlet bushing and including an open area for gas to flow out of the bushing on the outside of the outlet tube.

8. A muffler as set forth in claim 6 wherein the second partition defines one side of a third chamber, and a spit chamber shell mounted on the inlet tube and extending through said second partition into said second and third chambers.

9. A muffler as set forth in claim 8 including a third transverse partition acting with the second partition to define said third chamber, and a fourth partition acting with the third partition to define a fourth chamber and with the outlet header to define a fifth chamber, said outlet tube extending through the third and fourth partitions and being telescoped inside the outlet bushing, and a spit chamber shell mounted on the outlet tube and in the third and fourth chambers and extending into the outlet bushing in the fifth chamber.

10. A muffler as set forth in claim 9 including second support means supporting the outlet tube inside the outlet bushing, said outlet tube being perforated inside the outlet bushing, said second support means including an open area for gas to flow out of the bushing on the outside of the outlet tube.

11. A muffler comprising an elongated shell having an inlet header with an inlet at one end and an outlet header with an outlet at the other end, gas passage means connecting the inlet to the outlet and including an outlet bushing in the outlet and an outlet tube in the outlet bushing, said outlet tube opening into and having a perforated area in the outlet bushing, means supporting the outlet tube in the outlet bushing and including an open area for gas to flow out of the bushing on the outside of the outlet tube.

12. A muffler comprising an elongated shell having an inlet at one end and an outlet at the other end, partition means in the chamber defining a resonator chamber, gas passage and silencing means in the shell connecting the inlet and outlet and including an elongated gas passage tube, a tuning tube located inside the gas passage tube and opening into the resonator chamber and tuned therewithin to attenuate a predetermined relatively low frequency, and support means supporting the tuning tube inside the gas passage tube and providing for gas flow through the gas passage outside the tuning tube.

13. A muffler as set forth in claim 12 wherein said support means comprises band sections severed from the gas passage and providing an opening inside the gas passage tube for gas flow on the outside of the tuning tube.

14. A muffler as set forth in claim 13 wherein said band sections provide an opening in the gas passage tube connecting the inside of the gas passage tube with the space surrounding the tube.

15. A muffler as set forth in claim 14 wherein said gas passage tube is perforated adjacent the band sections and including a spit chamber forming shell on the gas passage tube embracing the band sections and perforated tube area.

16. A muffler as set forth in claim 15 wherein said gas passage tube and the inlet end of said tuning tube are located adjacent and in axial alignment with said shell inlet.

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