United States Patent

Pierce

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[54] GAS FLOW BAFFLE FOR WAVE INTERFERENCE SILENCING SYSTEMS

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[73] Assignee: **General Motors Corporation**, Detroit, Mich.

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[52] **U.S. Cl.** **181/44**, 181/56, 181/67

[51] **Int. Cl.** **F01n 1/12**

[58] **Field of Search** ..... 181/44, 46, 67, 69, 36 B, 56

[56] **References Cited**

UNITED STATES PATENTS

1,612,584	12/1926	Hunter et al.	181/44
2,027,359	1/1936	Wood et al.	181/67 X
2,031,451	2/1936	Austin	181/44
2,359,365	10/1944	Katcher	181/67
3,113,635	12/1963	Allen et al.	181/46 X

FOREIGN PATENTS OR APPLICATIONS

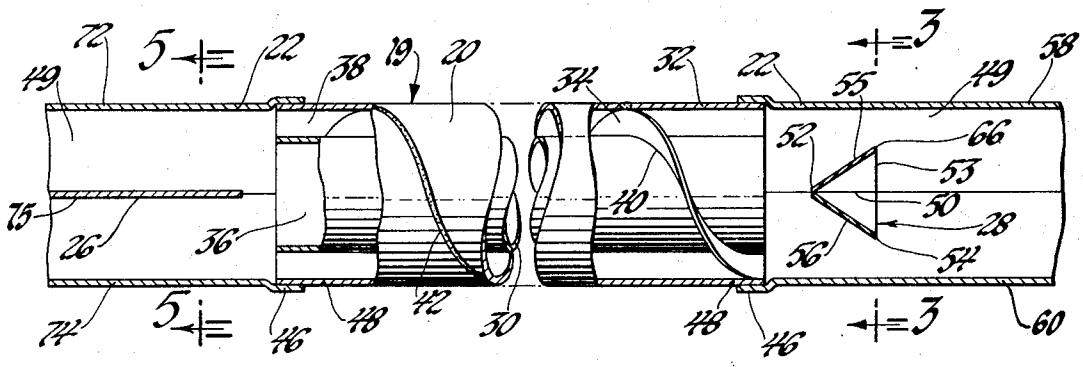
646,808	1928	France	181/67
278,493	1927	Great Britain	181/44

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Assistant Examiner—John F. Gonzales
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[57] **ABSTRACT**

A wave interference silencing system of the type having an acoustical equalization conduit downstream of an attenuating section which includes an inner axial flow path and an outer helical flow path wherein a gas flow baffle housed in the equalization conduit adjacent the end of the transitted attenuating section is positioned so as to cause turbulent interaction between the gases in the separate flow paths by establishing a barrier to continued relative circumferential gas movement thereby promoting complete mixing and stabilization of the gas stream prior to entering a succeeding attenuating section.

4 Claims, 5 Drawing Figures



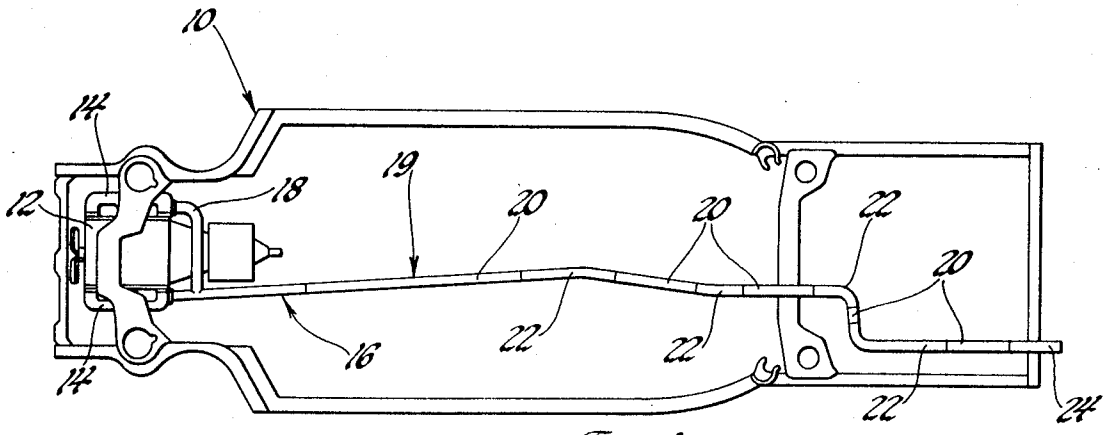


Fig. 1

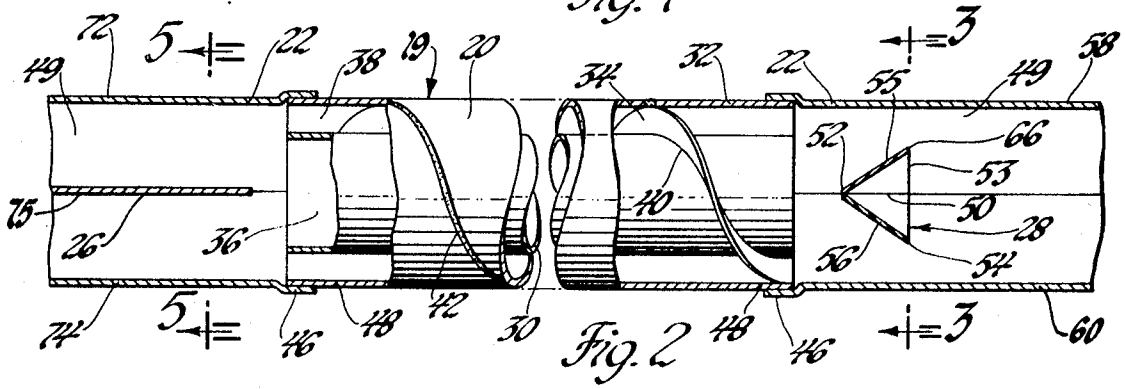


Fig. 2

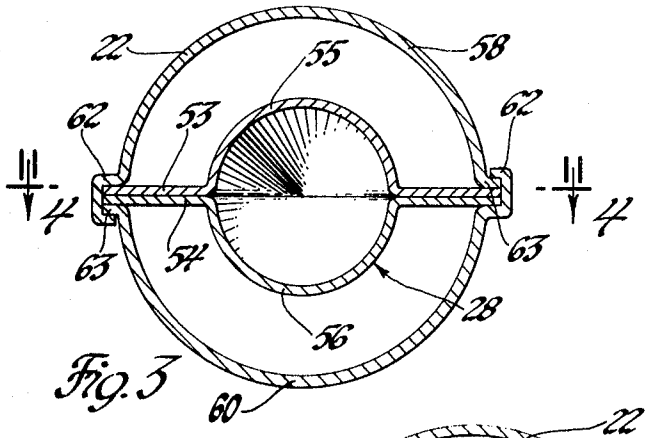


Fig. 3

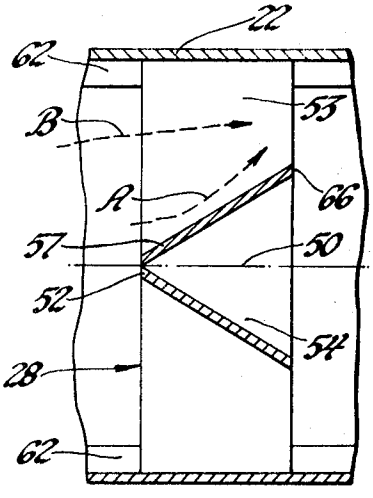


Fig. 4

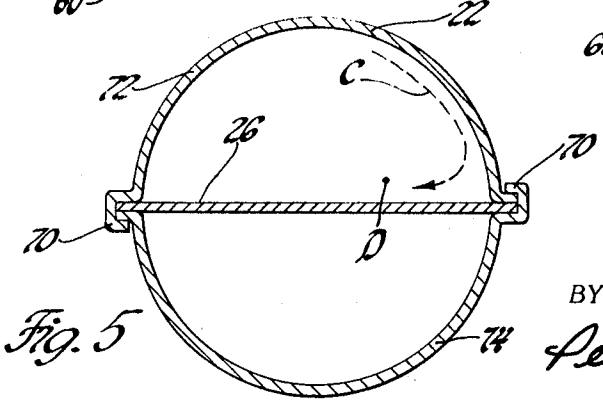


Fig. 5

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GAS FLOW BAFFLE FOR WAVE INTERFERENCE SILENCING SYSTEMS

The present invention relates to silencing systems and, in particular, to wave interference silencing systems for motor vehicles incorporating a plurality of serially connecting attenuating sections separated by acoustical equalization conduits.

To predictably attenuate the periodic noises produced by an operating motor vehicle engine, exhaust systems using destructive wave interference principles have been proposed for silencing throughout the noise spectrum of the engine. Generally such a system employs a plurality of serially connected attenuating sections which are energy and flow compensated to establish actual sound propogational velocities such that the pressure waves transiting the separate acoustical paths exit in phase opposition. In this manner, the pressure waves destructively acoustically interfere in a coupling volume adjacent the transmitted attenuating section. The most prevalent construction for achieving this acoustical attenuation takes the form of a pair of parallel flow paths having differing actual acoustical lengths and most easily obtained by encircling an axial inner conduit with a helically wound outer conduit. The ratio of the acoustical lengths places the pressure waves of the separate paths one-half cycle or 180° out of phase in the adjacent coupling volume thereby producing a pressure stabilization and a band of attenuation of either side of the design frequency for the particular section.

Optimum attenuation for the aforementioned devices is achieved when the gas flow at the entrance of the succeeding attenuating section is acoustically and vibrationally uniform. Otherwise, temperature gradients and unbalanced flow energies result which cause a phase shift of the sound waves and unequal pressure peaks, all of which diminish the destructive acoustical interference outlined above. The prior devices normally require a section length of at least two to three times the diameter of the attenuating section to effect the outlined flow stabilization. At a lesser length, the swirling circumferentially flowing gases in the outer path does not have an adequate volume in which to mix with the axially flowing gases in the inner path. It has been suggested that the large volumes required to achieve this stabilization are due to a vortex created by the swirling gases which creates a transient and gradually axially diminishing barrier to mixing with the inner gases.

The present invention contemplates providing an affirmative means for abruptly mixing the gas flows from the respective flow paths in a minimum coupling volume thereby permitting a decrease in acoustical equalization conduit size and ensuring vibrational and energy stabilization at the entrance of a succeeding attenuating section. More particularly, each equalization conduit incorporates a gas flow baffle suspended within the coupling volume downstream of the transitted attenuating section. The baffle is positioned so as to divert the individual gas streams and cause a turbulent interaction between the circumferentially flowing gas in the outer path and the axially flowing gas in the inner path. By so diverting the gases, the aforementioned vortex is immediately eliminated thereby producing complete flow and energy stabilization prior to the succeeding attenuating section. In one embodiment, the baffle takes the form of a cone-shape segment disposed coaxially with the inner conduit and having its apex facing the transited attenuating section. The gases flowing through the inner path are diverted axially outwardly by the flared conical surface into turbulent interference with the circumferentially swirling gases of the outer path. The impedance to relative circumferential flow thus created effects the desired flow stabilization. In another construction, the baffle extends diametrically across the ends of the outer and inner flow paths. The baffle diverts the circumferential flowing gases into the axially flowing gases causing turbulent mixing and stabilization prior to the next attenuating section.

The above and other features of the present invention will be apparent to one skilled in the art upon reading the following detailed description, reference being made to the accompanying drawings in which:

FIG. 1 is a plan view of a motor vehicle frame incorporating a wave interference silencing system made in accordance of the present invention;

FIG. 2 is an enlarged fragmentary cross sectional view of a portion of the wave interference silencing system;

FIG. 3 is an enlarged view taken along line 3—3 of FIG. 2 showing one form of a gas flow baffle;

FIG. 4 is a view taken along line 4—4 of FIG. 3; and

FIG. 5 is a view taken along line 5—5 of FIG. 2 showing a modified form of gas flow baffle.

Referring to FIG. 1, there is shown a motor vehicle frame **10** on which there is mounted an internal combustion engine **12** having exhaust manifolds **14**. For the V-type engine illustrated, exhaust gases are discharged from the intake manifolds **14** to an exhaust line **16** including a crossover pipe **18**. The exhaust line **16** includes a wave interference silencing system **19** comprising a plurality of serially connected attenuating sections **20** which are axially coupled and separated by acoustical equalization conduits **22**. A tailpipe extension **24** is telescoped over the rearward end of the attenuating section **20** and constitutes the exhaust end of the system.

As will be appreciated, the above components from the exhaust manifolds **14** to the tailpipe extension **24** form an acoustical line through which heated exhaust gases and their resultant pressure waves flow as products of combustion from the engine **12**. During operation, the engine **12** generates pressure pulses and sound waves in the exhaust line **16** having plural frequencies which are a function of engine speed.

The present invention is designed to attenuate the entire noise spectrum by incorporating the principles of wave interference silencing. The design of the several attenuating sections **20** generally provides for parallel acoustical paths which are energy and flow compensated to establish actual sound propogational velocities such that the pressure waves in the respective paths are in phase opposition at exit in the transitted attenuating section so as to destructively interfere in the stabilization conduit adjacent thereto. While the specifics of the attenuating sections form no part of the present invention, the design and operation of the entire system can be ascertained by reference to the pending application of Donald R. Whitney, U.S. Ser. No. 39,705 filed on May 22, 1970 and assigned to the assignee of the present invention.

Referring to FIG. 2, a representative attenuating section **20** is preceded and succeeded by acoustical equalization conduits **22** that is provided with a gas diverting flow stabilization baffles **26** and **28**, respectively. Both forms of baffles function, as hereinafter described, in a manner which rapidly promotes complete mixing of the exhaust gases flow through the immediately preceding attenuating section.

Each attenuating section **20** comprises an inner conduit **30** and an outer sleeve **32** which are structurally connected by a helical baffle **34**. More particularly, the inner conduit is a cylindrical tube and establishes an axial flow path **36**. The outer wall of the inner conduit **30**, the helical baffle **34**, and the inner wall of the sleeve **32** establish a helically wrapped circumferential flow path **38**. The inner cylindrical edge of the helical baffle **34** is seam welded at **40** to the outer surface of the inner conduit **30**. The outer sleeve **32** is in the form of a helically wrapped metallic sheet and is seam welded at mating edges **42** to the outer surface of the helical baffle **34**.

Each acoustical equalization conduit **22** generally comprises a sectioned cylinder joined at mating longitudinal seams and having diametrically enlarged ends **46** which are telescopically received over the end sections **48** of adjacent attenuating sections **20**. The inner surface of the equalization conduits **22** constitutes a flow stabilization and energy equalization chamber or coupling volume **49** for handling and uniformly mixing the gas streams from the separate flow paths **36, 38**.

The attenuating sections **20** thus far described will produce separate circumferentially and axially flowing gas paths which must be mixed in the succeeding coupling volume **49**. In conventional wave interference systems, the circumferentially swirling gases from the outer path **38** effects only a gradual mixing with the axially flowing gases from the inner path **36**.

The vortex created by the swirling gases prevents the equalization and stabilization necessary to achieve the contemplated attenuation from the prior transitted section and thereby present equal and uniform vibrational energy to the succeeding attenuated section. This condition is obviated herein by the gas flow baffles **26** and **28** which are positioned in the left hand and right hand equalization conduits, respectively, and configured so as to provide a rapid dissipation of the vortex and a turbulent mixing of the gases thereby promoting complete energy and pressure uniformity.

More particularly and referring to FIGS. **3** and **4**, the right hand gas flow baffle **28** takes the form of a cone having its axis **50** coaxial with and its apex **52** facing the inner conduit **30**. The gas flow baffle **28** comprises a pair of juxtaposed plates **53, 54** extending diametrically across the inner surface of the equalization conduit **22**. The plates **53** and **54** are provided with conical segment **55** and **56**, respectively, which together constitute and establish a conical surface **57** for the baffle **28** as assembled. Each conduit **22** is in the form of identical half sleeves **58** and **60** having crimped longitudinal seams **62** retaining the outer edge of the plates **53, 54** and the mating lip **63** of the opposing sleeve **58** or **60**.

Operationally, and as shown in FIG. **4**, exhaust gases flowing axially from the inner path **36** as indicated by the arrow A will be diverted radially outwardly into dynamic turbulent interference with the exhaust gases flowing circumferentially from the outer path **38** as indicated by arrow B. The turbulent interaction between the gas streams thus created by the baffle **28** will dissipate the circumferential flow variance between the paths **36** and **38** and effect a flow stabilization at a point beyond the base **66** prior to entry into a succeeding attenuating section.

In the alternate form as shown in FIG. **5**, the gas flow baffle **26** extends diametrically across the interior of the equalization conduit **22** and is retained at crimped longitudinal seams **70** between the opposed section sleeves **72** and **74**. The leading or upstream edge of the gas flow baffle **26** is positioned immediately adjacent the end of the preceding attenuating section and the downstream or trailing edge **75** is spaced sufficiently therebeyond to effect complete mixture of the gas streams prior to the following attenuating device. In operation, the circumferentially flowing exhaust gases C from the outer flow path **38** are diverted radially inwardly by the gas flow baffle **26** in the turbulent interaction with the axially flowing exhaust gases D from the inner flow path **36**. This effects a dissipation of the relative circumferential motion between the separate gas streams and promotes rapid and complete mixing to present a homogenous gas flow at the following attenuating section.

Those skilled in the art will appreciate that in both of the above arrangements the baffle surfaces are used to divert one of the gas flow paths into turbulent interaction with the other flow path so as to set up dynamic conditions which equalize relative motion between the two paths so as to promote complete mixing of the gas streams. Whatever the form of the baffle, its position and surfaces should contribute to achieving rapid dissipation of relative movement between the separate flow paths so as to achieve complete mixing within a minimum volume and in this manner volume permit reduction in the size of the acoustical equalization sections.

Although only one form of this invention has been shown and described, other forms will be readily apparent to those skilled in the art. Therefore, it is not intended to limit the scope of this invention by the embodiment selected for the purpose of this disclosure but only by the claims which follow.

What is claimed is:

1. A wave interference silencing system for the exhaust gases of an internal combustion engine, said silencing system comprising: a cylindrical acoustical equalization conduit; a pair of attenuating members connected to and located upstream and downstream of said equalization conduit, each of said attenuating members having an outer conduit helically wrapped around an inner conduit wherein said inner conduit provides a substantially axial flow path for gases flowing therethrough from said engine and said outer conduit provides a substantially circumferential flow path for such gases; a planar gas flow baffle member positioned across said equalization conduit for creating a physical barrier to relative circumferential movement of said gases exiting the upstream attenuating member so as to promote complete mixing and stabilization of the gases prior to entering the downstream attenuating member.

2. In a wave interference silencing system having an acoustical equalization chamber through which exhaust gases flow between serially connected attenuating sections, each of said attenuating sections having an inner conduit and an outer conduit helically wrapped with respect to the inner conduit so as to establish a circumferential vortex flow pattern at the exit end of the attenuating section, the improvement comprising: a gas diverting member disposed within the acoustical equalization chamber, said gas diverting member having a surface positioned adjacent the exit end of one of said attenuating sections so as to cause turbulent interaction between gases exiting from the inner and outer conduits by establishing a barrier to said circumferential vortex flow pattern thereby promoting flow and energy stabilization prior to the gases entering a succeeding attenuating section.

3. In a wave interference silencing system having an acoustical equalization conduit serially connected between wave interference attenuating sections, each of said attenuating sections having an inner axial flow path and an outer helical flow path which causes gases flowing therethrough to establish a circumferential vortex flow pattern at the exit end of the attenuating section, a gas diverting baffle for stabilizing the gas stream so as to present uniform vibrational energy at the succeeding attenuating section comprising: a conical member housed within the equalization conduit with its apex facing the exit end of the attenuating section and its outer surface flaring outwardly therefrom sufficiently to divert the gases flowing in the inner axial flow path into turbulent interference with the gases flowing in the outer helical flow path thereby creating an impedance to said circumferential vortex flow pattern and accelerating mixing and stabilizing of the gas stream.

4. A wave interference silencing system for the exhaust gases of an internal combustion engine, said silencing system comprising: a cylindrical acoustical equalization conduit; a pair of attenuating members connected to and located upstream and downstream of said equalization conduit, each of said attenuating members including an outer conduit helically wrapped around an inner conduit wherein said inner conduit provides a substantially axial flow path for gases flowing therethrough from said engine and said outer conduit provides a substantially circumferential flow path for said gases; a planar gas flow baffle member positioned diametrically across said equalization conduit for creating a physical barrier to relative circumferential movement of said gases exiting the upstream attenuating member so as to accelerate the mixing of the separate flow paths and promote complete mixing and stabilization of the gases prior to the gases entering the downstream attenuating member.

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