Jan. 28, 1941. C. F. RAUEN 2,229,672

MUFFLER

Original Filed Feb. 10, 1930

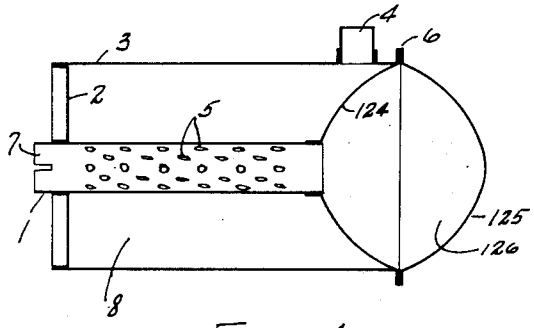

FIG. 1

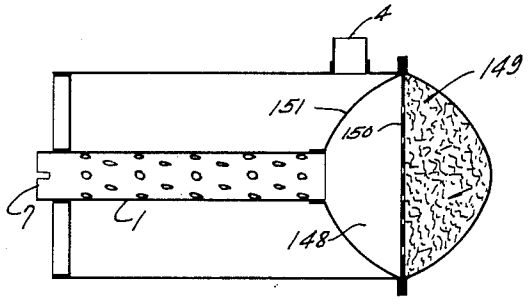

FIG. 3

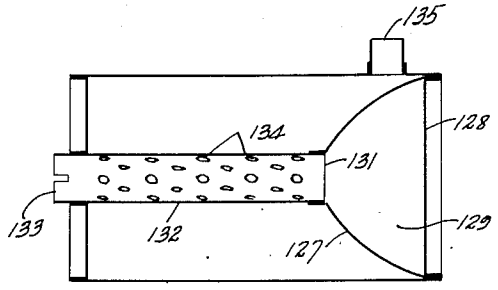

FIG. 2

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Patented Jan. 28, 1941 2,229,672

UNITED STATES PATENT OFFICE

2,229,672

MUFFLER

Carl F. Rauen, Grosse Pointe, Mich.

Original application February 10, 1930, Serial No. 427,312, now Patent No. 2,138,510, dated November 29, 1938. Divided and this application October 14, 1937, Serial No. 168,947

21 Claims. (Cl. 181—48)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention has to do with silencing chambers acoustically coupled to the passageway of sound entrained flowing gases such as the exhaust gas of internal combustion engines, the "intakes" of internal combustion engines, air compressors or the like, and more particularly to the use of a compound silencing chamber comprising two or more portions or compartments acoustically coupled to the gas passageway in series.

Heretofore, exhaust noises have been silenced primarily by restricting the flow of the gases by means of several baffles. These baffles are usually either in series so that the gas passes directly from one to the other, or so arranged that the gases reverse their flow after passing through each baffle. These methods of silencing cause a high degree of back pressure. Since back pressure is detrimental to the operation of an internal combustion engine, it is desirable to eliminate it or reduce it to a very low degree.

With my designs I can muffle the exhaust gases from internal combustion engines, with little or no back pressure, and with mufflers relatively smaller than those now in use.

A primary object, therefore, of this invention is to separate the sound energy from the exhaust gas stream, with little or no restriction on the flow of the gas stream; that is, to separate the sound from the gas stream by directing it to one place until its energy is destroyed, while the gas stream is allowed to escape at another place.

To obtain this control of the sound and gas, I make use of what I term sound trap chambers, which will be hereinafter more fully explained, and the reflecting and focusing properties of the conic sections, and other shapes, to reflect, focus, concentrate and destroy sound; I also make use of the sound absorbing and destroying properties of such materials as steel wool, mineral wool, asbestos, etc., which are so arranged in the muffler that the sound is absorbed or destroyed by entering the interstices of the material, where it travels devious and tortuous paths, while the exhaust gas stream is led through the muffler with little or none of it passing through this absorbing material. A further property of the above material is its comparative softness; that is, it does not reflect sound like hard material.

It is a well known fact that sound can be reflected and focused substantially in the same manner as light, by means of reflectors, and hence I make use of the reflecting and focusing properties of reflectors shaped to the conic sections; that is, the parabolic, hyperbolic, elliptical, or spherical reflectors, or any combination of the above, to control the sound energy and produce silencing by reflecting, focusing, or concentrating the sound at one place by means of the foregoing methods, either separately or in any combination, until its energy is destroyed, while the gas stream is allowed to escape from another place.

Use is also made of the reflecting properties of flat plates and inclined surfaces or, for that matter, any shape of inclosure wherein the sound can be trapped and caused to lose its energy by rapid reflection between the walls of said enclosure, into which it has been introduced, while the gas stream is led to atmosphere by a separate path, minus the greater part of the sound energy.

Since sound can be focused or concentrated by various types of reflectors, I have designed and built mufflers wherein the exhaust sound is concentrated or trapped by one or more reflectors, or sound traps, while the gas is permitted to escape at a place where the least amount of sound can escape with it.

The chamber referred to herein as a "sound trap chamber" is a substantially closed chamber, having communication with the gas passageway of a muffler and so arranged that little or none of the exhaust gas passes through said chamber on its way to atmosphere, said communication forming an acoustic coupling between said gas passageway and said chamber and opening abruptly into said sound trap chamber, the area of said communication being substantially less than the cross sectional area of said chamber, whereby the sound, after passing through said communication into said chamber, expands, as is its natural tendency, and is destroyed by reflection or otherwise, and little or none of said sound returns to said passageway, due to the restriction offered by said communication.

Due to the high efficiency of the methods of silencing used in my invention, very little restriction need be put on the flow of the gas stream, in order to confine the sound to the muffler until it is destroyed, and in consequence of this high silencing efficiency, a much smaller and cheaper muffler can be made to do the work of the larger ones now in use.

It is understood that any hard surface will reflect sound, regardless of its shape, in a manner complying with the well known laws of reflection,

and that soft surfaces absorb sound. It is further understood that every time sound is reflected, it loses some of its energy. The muffler designs shown in this application preferably are made of sheet metal stampings which are fastened together as by welding. They can, however, be made of castings.

A still further object is to provide a muffler that is highly efficient, simple in construction and cheap to manufacture.

A further object of this invention is to provide a muffler with relatively small chambers, so that the sound energy will be destroyed in a very short time within said chambers.

A still further object of this invention is to prevent the re-combining of the sound wave fronts after being broken up by baffles.

This application is a division of my copending application Serial No. 427,312, filed February 10, 1930, for Muffler on which Patent No. 2,138,510 issued Nov. 29, 1938.

With the foregoing and other objects in view, as will hereinafter appear, my invention consists of certain novel features of construction, combinations, and arrangements of parts, as will be hereinafter described in detail and particularly set forth in the appended claims.

For a better understanding of the invention, reference may be had to the accompanying drawing, in which:

Fig. 1 is a longitudinal sectional view of one embodiment of my invention;

Fig. 2 is a longitudinal cross-sectional view of another form of my invention; and

Fig. 3 is a longitudinal sectional view of a still further form of my invention.

Referring to Fig. 1, the muffler consists of a tube 1, which may be of any desired cross-sectional shape, and is mounted in a plate 2 at one end thereof. The plate 2 is nested in the body 3, which is preferably of cylindrical shape and is provided with an outlet 4 to conduct the gas from the muffler.

The tube 1 is provided with a plurality of openings 5 in the walls thereof and is mounted in the cup-shaped plate 124 and welded thereto. Another plate 125 is mounted opposite the plate 124 and both plates 124 and 125 are welded to the muffler body 3 at 6.

The plates 124 and 125 form a sound trap or acoustic chamber 126 for trapping and destroying by reflection therein exhaust noise from the engine, and may be formed to one of the conic sections.

The open end 7 of the tube 1 is adapted to be connected to the exhaust pipe of the engine, and the operation of this muffler is as follows: The exhaust gas enters the tube 1 at 7 and passes through the openings 5 into the chamber 8, from whence it passes to atmosphere through the outlet 4, while the exhaust noise being headed in the direction of the sound trap chamber 126 enters therein and expands, whereupon it is subsequently destroyed by reflection between the plates 124 and 125, and due to the relative smallness of the tube diameter compared with the diameter of the sound trap chamber 126, very little of the sound re-enters the tube 1 from said chamber 126. As the sound has direction along the tube there is very little tendency for it to pass out of the openings 5 and whatever sound does pass out of these openings is broken up and destroyed by the baffling effect of the openings 5.

Fig. 2 is similar to Fig. 1 and differs therefrom in that the sound trap chamber 129 is composed of a cup-shaped plate 127 and the relatively flat plate 128. The operation of this muffler is similar to that of Fig. 1, that is, the gas enters the tube 132 at 133 and passes out through the holes 134, from whence it goes to atmosphere through the outlet 135, while the sound passes through the opening 131 in the tube 132 into the sound trap chamber 129.

If the plate 127 is made in the form of a parabola, then the sound entering the chamber 129 impinges on the plate 128 and will be reflected in parallel lines against the parabolic reflector and thence it will be reflected so as to focus on the axis of the reflector.

Fig. 3 is a modification of Fig. 1 and differs therefrom in that the rear portion of the compound sound trap chamber 148 is filled with sound absorbing material 149 such as copper wool, asbestos, blast furnace slag, etc. This sound absorbing material is held in place by means of a perforated plate 150, which divides the rear portion of the compound chamber from the portion thereof communicating directly with the end of the tube 1. The perforations in the plate 150 afford communication between the portions of the chamber 148.

In this design the exhaust gas enters the perforated tube 1 at 7 and passes through the holes therein and out the outlet 4, whereas the sound travels into the sound trap chamber 148 and is absorbed by the interstices formed by the sound absorbing material 149 against which it impinges directly or after reflection from the cup-shaped plate 151.

All the joints in the foregoing designs are preferably welded together to prevent gas leakage. It will also be noted that the cross-sectional area of the sound trap chambers in the foregoing designs increases progressively from the opening to said chambers.

I have found by experiment that the sound traps illustrated can be of various shapes without affecting the silencing characteristics thereof. The sound energy, after entering the sound traps, destroys itself within the sound traps, and very little, if any, of said sound energy which passes into the sound traps escapes therefrom, due to the fact that the sound energy, after passing into the sound traps, expands, and the communication between the sound trap and the tube through which the exhaust gas stream flows is relatively restricted.

The idea in the foregoing designs is to cause a destruction of sound energy by providing a closed chamber or sound trap through which there is substantially no gas flow but into which the sound energy can pass and be trapped until it is dissipated, while the gas stream passes to atmosphere substantially free of all or a major portion of the sound energy.

While several modifications of the invention have been described with some detail, it is to be understood that the description is for the purpose of illustration only and is not definitive of the inventive idea, but is to be limited only by the scope of the appended claims.

What I claim and desire to secure by Letters Patent is:

1. An acoustic silencer for sound entrained flowing gases of internal combustion engines comprising a casing having an inlet port and an outlet port, a tube forming at least part of the path through which the gas passes on its way from the inlet to the outlet port, means defining a sound attenuating chamber acoustically coupled

to said tube, said chamber increasing in cross-sectional area progressively with the distance from its coupling to the path to its maximum area.

2. An acoustic silencer for sound entrained flowing gases of internal combustion engines comprising a casing having an inlet port and an outlet port, means defining a main channel through which the gas passes on its way from the inlet to the outlet port, means defining a sound attenuating chamber acoustically coupled to said gas channel, said chamber having a wall in the form of a conic section of revolution.

3. An acoustic silencer for sound entrained flowing gases of internal combustion engines comprising a casing having an inlet port and an outlet port, means defining a main channel through which the gas passes on its way from the inlet to the outlet port, means defining a sound attenuating chamber acoustically coupled to said gas channel, said chamber having a wall in the form of a parabola of revolution.

4. An acoustic silencer for sound entrained flowing gases of internal combustion engines comprising a casing having an inlet port and an outlet port, means defining a main channel through which the gas passes on its way from the inlet to the outlet port, means defining a sound attenuating chamber acoustically coupled to said gas channel, said chamber increasing in cross-sectional area rapidly and progressively with the distance from its coupling to the main channel to its maximum area and then progressively decreasing to substantially zero area at the closed end of said chamber.

5. A silencer for exhaust gases comprising a tube, said tube being provided with an exhaust gas inlet opening and separate outlet open areas, one of said open areas being formed in the walls of said tube, and of sufficient relative effective area to provide a substantially unrestricted exhaust gas opening to atmosphere, the other being formed at the end of said tube, and constituting a sound energy opening and a sound trap chamber closed on all sides except for an opening that is in communication with the latter-mentioned tube open area, having one of its walls of parabolic form with its focus disposed within said chamber, said parabolic form presenting outwardly away from said sound energy open area.

6. An acoustic silencer for sound entrained gases of internal combustion engines, comprising a casing having an inlet port and an outlet port, means including a tube providing a main channel through which the gas passes on its way from said inlet to said outlet port, a sound attenuating chamber acoustically coupled to said channel, said chamber increasing in cross-sectional area rapidly and progressively with the distance from its coupling to the main channel to its maximum area, the maximum cross-sectional area of said chamber being appreciably greater than that of said tube.

7. An acoustic silencer for sound entrained gases of internal combustion engines, comprising a casing having an inlet port and an outlet port, means including a tube providing a main channel through which the gas passes on its way from said inlet to said outlet port, a sound attenuating chamber acoustically coupled to said gas channel, said chamber increasing in cross-sectional area rapidly and progressively with the distance from its coupling to the main channel to its maximum area, the maximum cross-sectional area of said chamber being appreciably greater than that of said tube, a series of relatively small openings formed in said tube being operatively arranged between said chamber and said outlet port.

8. An acoustic silencer for sound entrained gases of internal combustion engines, comprising a casing having an inlet port and an outlet port, means including a tube of substantially uniform cross-sectional area providing part of a main channel through which the gas passes on its way from the inlet to the outlet port, means providing a sound attenuating chamber which is acoustically coupled to one end of said tube, said chamber increasing in cross-sectional area rapidly and progressively with the distance from its coupling to its maximum area.

9. An acoustic sound attenuating device comprising a casing having a gas inlet opening and an outlet opening, means providing a sound trap chamber disposed within the confines of said casing, an opening acoustically coupling directly the interior of said casing and said chamber, the maximum cross-sectional area of said chamber being appreciably greater than the cross-sectional area of said opening, said sound trap chamber being constructed and arranged so that little or none of said gas passes through said chamber on its way from said inlet to said outlet opening, said chamber increasing in cross-sectional area rapidly and progressively with the distance from said coupling to its maximum area.

10. An acoustic sound attenuating device comprising a casing having a gas inlet opening and an outlet opening, means providing a sound trap chamber disposed within the confines of said casing, an opening acoustically coupling directly the interior of said casing and one portion of said chamber, said sound trap chamber being constructed and arranged so that little or none of said gas passes through said chamber on its way from said inlet to said outlet opening, and said sound trap chamber including another portion having an acoustic coupling only with said first-mentioned portion of said chamber.

11. An acoustic sound attenuating device comprising a casing having a gas inlet opening and an outlet opening, means providing a sound trap chamber disposed within the confines of said casing, perforated means dividing said chamber into two portions, an opening acoustically coupling directly the interior of said casing and one portion of said chamber, said sound trap chamber being constructed and arranged so that little or none of said gas passes through said chamber on its way from said inlet to said outlet opening, and the other portion of said sound trap chamber having an acoustic coupling with said first-mentioned chamber, one of said chambers containing sound absorbing material.

12. An acoustic sound attenuating device comprising a casing having a gas inlet opening and an outlet opening, means providing a sound attenuating compound chamber closed on all sides and disposed within the confines of said casing, said chamber comprising a plurality of compartments, at least one of which is acoustically coupled to the other, an opening in a wall of said chamber acoustically coupling directly the interior of said casing and one of the compartments of said chamber, the cross-sectional area of said one of said compartments being appreciably greater than the cross-sectional area of said

opening, said sound trap chamber being so disposed and arranged that little or none of said gas passes through said chamber on its way from said inlet to said outlet opening.

13. A silencer for sound entrained flowing gases comprising a muffling unit through which the gas stream flows, said muffling unit having in combination a casing having an inlet opening and an outlet opening, means including a tube of uniform cross-sectional area provided with an open area in the walls thereof forming at least part of the passageway within said casing for the flow of gas between said inlet and outlet openings, means in addition to said tube cooperating with said casing to define a sound trap chamber, a portion of said chamber being acoustically coupled to said passageway in such a manner as not to form part of the path traversed by the gas on its flow through said casing, and said sound trap chamber having a chamber which is acoustically coupled directly only to said first-mentioned portion of said chamber.

14. An acoustic silencer for sound entrained flowing gases of internal combustion engines comprising a casing having means providing a main gas conducting channel therein, a transverse partition providing a sound attenuating compound chamber having a portion thereof coupled only acoustically to said channel, the maximum effective cross-sectional area of the channel being appreciably less than the maximum cross-sectional area of said chamber, said casing being provided with an inlet opening and an outlet opening associated with said channel, said chamber being abruptly enlarged immediately adjacent its zone of coupling to said channel, and a second portion of said sound attenuating chamber acoustically coupled by perforated means directly to said first-mentioned chamber.

15. An acoustic silencer for use in connection with the intake or exhaust of an internal combustion engine for silencing noise associated therewith and comprising a casing having a gas inlet port and a gas outlet port, a tube of substantially uniform cross-sectional area within said casing forming at least part of a path for conducting said gas and having one end in communication with said inlet port, said tube having an outlet opening in the walls thereof and a further outlet opening at the other end thereof, one of said openings constituting a gas outlet opening in communication with said casing outlet port, partition means other than said tube providing a compound chamber within the confines of said casing for attenuating said noise, said chamber having a portion thereof acoustically coupled to the other of said outlet openings and arranged in such a way as not to form part of the path traversed by the major portion of said gas, said chamber being abruptly enlarged immediately adjacent said coupling and including a second portion acoustically coupled directly to said first portion.

16. An acoustic silencer for use in connection with the intake or exhaust of an internal combustion engine for silencing noise associated therewith and comprising a casing having a gas inlet port and an outlet port, a tube of substantially uniform cross-sectional area within said casing forming at least part of a path for gas and sound energy and operatively connected to said inlet port, said tube having outlet means in the walls thereof and further outlet means at the other end thereof, one of said means constituting a gas outlet in communication with said casing outlet port, means providing a compound chamber for extracting sound energy from said gas, one part of said chamber being acoustically coupled to the other of said outlet means and being arranged so as not to form a part of the path traversed by the major portion of the gas, and a second part of said chamber acoustically coupled to said other outlet means through said first-mentioned part of said chamber.

17. An acoustic silencer for sound entrained flowing gases of internal combustion engines, comprising means affording a gas passageway, and means defining a sound attenuating chamber having a plurality of portions acoustically coupled in series to said passageway.

18. An acoustic silencer for sound entrained flowing gases of internal combustion engines, comprising means affording a gas passageway, means defining a chamber forming a sound trap and having one portion thereof acoustically coupled to said passageway, and another portion of said sound trap chamber, acoustically coupled to said first mentioned portion of said chamber.

19. An acoustic silencer for sound entrained flowing gases of internal combustion engines, comprising means affording a gas passageway, means defining a compound chamber forming a sound trap and having one portion thereof acoustically coupled to said passageway, and perforated means cooperating with a part of said last-mentioned means to provide another portion of said sound trap chamber, which is acoustically coupled by said perforated means to said first mentioned portion of said chamber, the acoustic coupling between said first mentioned portion of said chamber and said passageway comprising an opening, small in area compared to the cross sectional area of said first mentioned portion of said chamber, and communicating with said passageway.

20. An acoustic silencer for sound entrained flowing gases of internal combustion engines and the like comprising means affording a passageway for the flow of gas through said silencer, and means defining a sound attenuating chamber adjacent one end of said silencer, said chamber having a plurality of portions acoustically coupled in series to said passageway.

21. An acoustic silencer for sound entrained flowing gases of internal combustion engines and the like comprising means affording a passageway for the flow of gas through said silencer, means defining a sound attenuating chamber within the confines of said silencer, said chamber having a plurality of portions acoustically coupled in series to said passageway.

CARL F. RAUEN.

CERTIFICATE OF CORRECTION.

Patent No. 2,229,672. January 28, 1941.

CARL F. RAUEN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 13, after "and" insert --from--; page 4, first column, line 20, claim 13, for the word "chamber" second occurrence, read --portion--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 21st day of October, A. D. 1941.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.

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