

Nov. 29, 1938.

C. F. RAUEN

2,138,510

MUFFLER

Original Filed Feb. 10, 1930 2 Sheets-Sheet 1

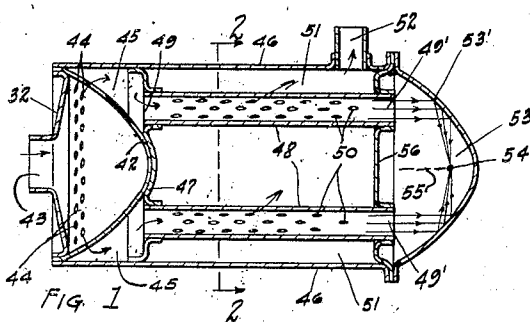
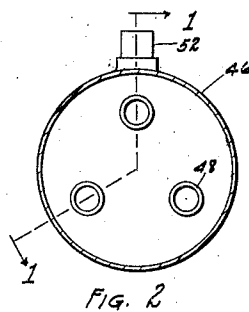
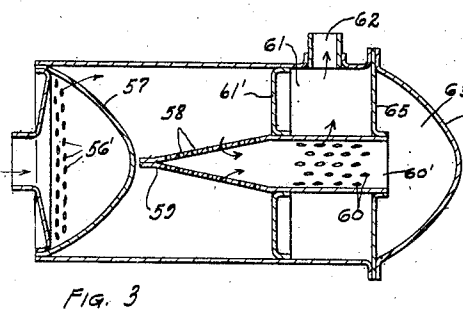
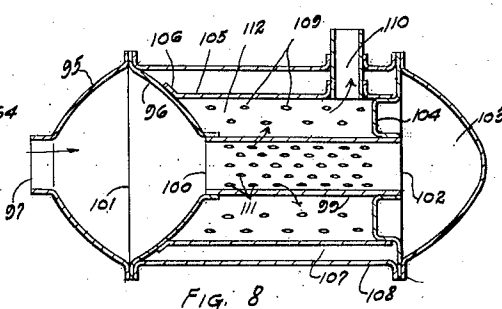
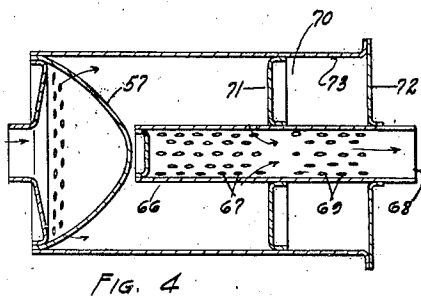
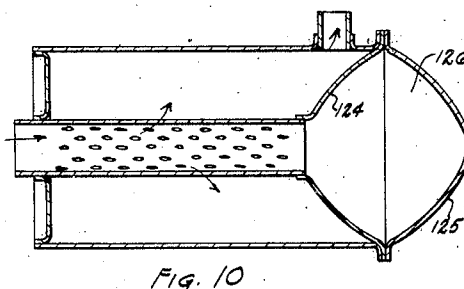
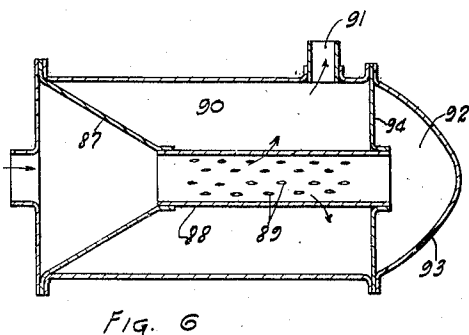
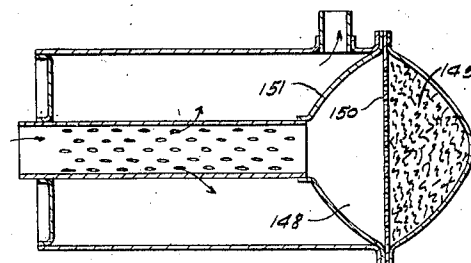


FIG. 12
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Original Filed Feb. 10, 1930 2 Sheets-Sheet 2

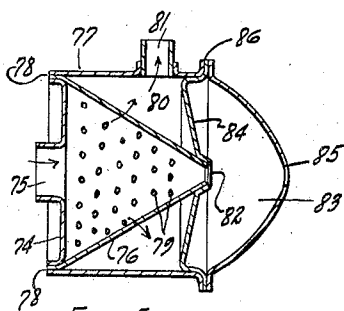


Fig. 5

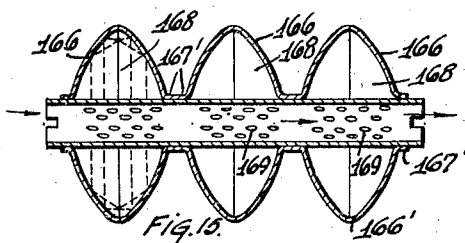


Fig. 15

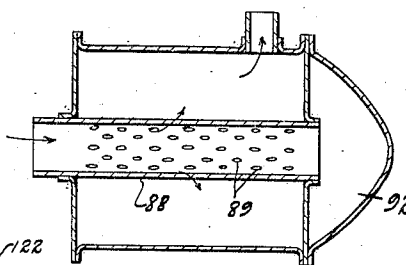


Fig. 7

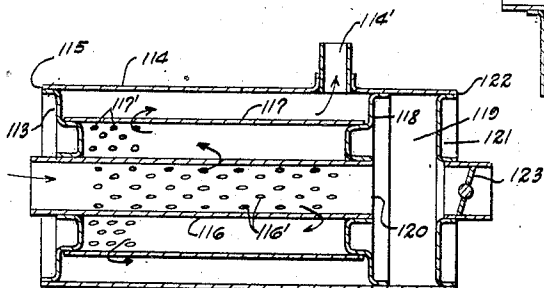


Fig. 9

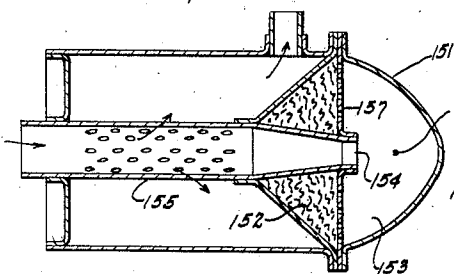


Fig. 13

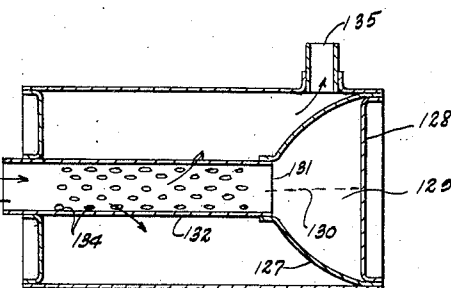


Fig. 11

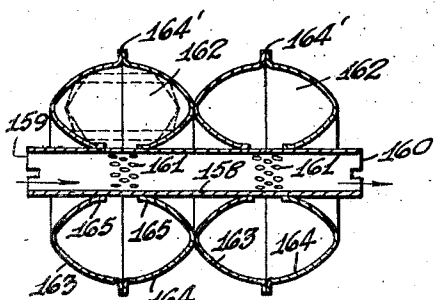


Fig. 14

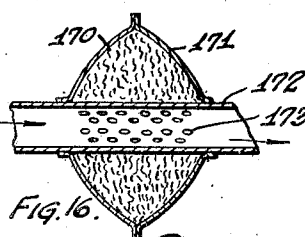


Fig. 16

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UNITED STATES PATENT OFFICE

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MUFFLER

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Application February 10, 1939, Serial No. 427,312
Renewed September 21, 1937

32 Claims. (Cl. 181—59)

This invention relates to mufflers for silencing the exhaust of internal combustion engines, the intake of air compressors and the like.

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 direct 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 materials 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 specification preferably are made of sheet metal stampings, which are fastened together, as by welding. They can, however, be made of castings.

A further object of this invention is to cause the sound wave or impulse of an explosion to neutralize the following explosions and produce silencing by sound interference. This can be done by causing the sound wave to be reflected or

returned over the path it came, but out of phase with oncoming waves.

It is another object of this invention to provide baffles to break up the sound waves and produce silencing without the gas stream flowing through them, and with little effect on the flow of the gas stream, as well as to cause these baffles to act more than once on the sound, that is, to cause their ability to destroy sound to be brought into play at least twice.

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 recombining of the sound wave fronts after being broken up by baffles.

Another object of this invention is to provide in connection with the following designs, a "cut out" or back pressure release valve, which when in operation permits free escape of the exhaust gas with but very little attendant noise.

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

With these 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.

Reference being had to the accompanying drawings which form a part of this specification:

Fig. 1 is a longitudinal, partially developed, sectional view of one form of a muffler embodying my invention and taken along the line 1—1 of Fig. 2;

Fig. 2 is a transverse sectional view of the muffler illustrated in Fig. 1 and taken in a plane along the line 2—2 thereof; and

Figs. 3 to 13, inclusive, are longitudinal sectional views of modified forms of mufflers embodying my invention.

Figs. 14, 15 and 16, are still further modifications of my invention showing a "straight thru" type of muffler.

The muffler illustrated in Fig. 1 is provided with a reflector 42 opposite the exhaust gas stream inlet opening 43. The reflector 42 is preferably of parabolic shape. The gas stream enters the muffler inlet 43, and after impinging upon the reflector 42, passes through the holes 44 to the chamber 45 formed by the body 46, the reflector 42 and the plate 47. It will be noted that the holes 44 are disposed adjacent the periphery of the reflector 42.

Some of the sound waves, after impinging on the reflector 42, are reflected and concentrated at the focus point of the reflector, while the exhaust gas stream flows out the holes 44, which are in a relatively quiet zone. In order to have most of the sound energy concentrated at the focus point of the reflector, it is necessary to prevent as much of it as possible from scattering—that is, expanding in the form of a sphere, as it tends to do as it passes from the end of the exhaust pipe to the reflector—so that the sound energy strikes the reflector in lines parallel to the axis. Therefore, the end of the exhaust pipe should protrude in the muffler through the opening 43 to a point where a maximum of silencing is obtained with a minimum of restriction to the flow of the exhaust gas stream. This location can best be determined experimentally. That part of the sound energy which escapes with the exhaust

gas stream through the holes 44 passes into the tubes 48. The plate 47 supports preferably two or more, preferably equally spaced tubes 48, which are in communication with the chambers 45 and 53 by means of the openings 49 and 49'. The gas, after passing through the holes 44 into the chamber 45, enters the tubes 48 through the openings 49, and then passes through the holes 50 in the tubes 48 to the chamber 51 and thence to atmosphere through the outlet 52. Any sound that escapes out the holes 44 in the reflector 42, enters the tubes 48 and travels down them into the chamber 53 formed by the plate 56 and the reflector 53' and impinges on the parabolic reflector 53'. It is then reflected to the focus point 54 where it meets similar reflected sound from the other tube or tubes 48. All sound not destroyed by the first reflection is reflected back and forth within the chamber 53 until it is destroyed; except what sound may possibly be reflected back into the tubes 48.

Inasmuch as only sound waves parallel to the axis 55, will be reflected to the main focus point 54, and as some of the sound is almost sure to scatter, this scattered sound will be reflected to form a line of foci on the axis 55.

The reflector 53' and the plate 56 form a sort of "sound trap" from which little or no sound escapes after entering, due to the smallness of the holes 49' compared to the cross sectional area of the sound trap chamber 53. I have determined this by actual experiment on automobiles. This sound trap chamber has no openings other than those for the tubes 48. It is possible to even omit the front reflector 42 and get very good results. It will be noted that the exhaust gas stream on its passage to atmosphere does not flow through the sound trap chamber formed by the reflector 53' and the plate 56, and therefore the objectionable sound waves are trapped and destroyed after separation from the exhaust gas stream and without impeding the flow thereof.

There is practically no escape of sound out of the holes 50 in the tubes 48 and whatever does escape is broken up by the holes 50, so as not to be noticeable. The back pressure of these mufflers is very low, due to the absence of a large number of baffles and restrictions to the flow of the exhaust gas stream. Hence, the number of perforations for a given back pressure is materially less than in conventional designs, with the result that there is less possibility for the sound energy to escape with the exhaust gas stream. Furthermore, these perforations can be spaced further apart and thereby prevent the sound waves that do escape with the exhaust gas stream from recombining before passing to atmosphere.

The operation of the reflector 53' is somewhat different than that of the reflector 42, in that the gas does not flow against it or through the chamber 53, and that the sound is brought into it in preferably two or more parallel streams. If the reflector 53' was a cone instead of a parabola, the sound would not be reflected to a focus point as there is none in a cone, but it would obey the ordinary laws of reflection, and the sound energy from one of the tubes 48 would be reflected to impinge on the reflected sound energy from the other tube 48, assuming that the axis of the cone was on the center line of the muffler. If the cone has an included angle of 90 degrees, the sound energy from the tubes 48 will be reflected so as to abut directly against each other, whereas if the angle of the cone is something other than 90

degrees the sound energy from the tubes 48 will meet on an angle. Any sound not destroyed on the first reflection within the chamber 53, or any that scattered, will be reflected back and forth within the chamber 53 until its energy is destroyed; if the tubes 48 make an angle with the centerline of the muffler, the reflected sound will meet on an angle and will be reflected within the chamber 53 until its energy is destroyed much in the same manner as sound is reflected from one wall to another, or to the ceiling and floor of a building until it dies out, but in case of the muffler, the time required for the sound energy to be destroyed is only a very small fraction of a second, instead of several seconds as in the case of an auditorium. The reason for this is that, since, sound loses energy every time it is reflected, it will be reflected many more times per second in the small chamber 53 than it will be in an auditorium and, therefore, die out quicker.

If only one tube 48 is used, the sound passing into the chamber 53 is reflected back and forth within the chamber until it is destroyed, obeying the well known laws of reflection. The tubes 48 can extend into the chamber 53 varying amounts, depending on the size of the said chamber.

Fig. 3 is a modification of Fig. 1 and differs from it in that the exhaust gas stream, after passing out the holes 56' in the reflector 57, passes through the holes 58 into the wedge-shaped tube 59. Portions of the gas stream entering oppositely disposed holes in tube 59 will abut, as will the sound waves. The gas stream then passes out the holes 60 into the chamber 61 formed by the plates 61' and 65, and thence to atmosphere through the outlet 62, while all or nearly all the sound that escaped from the reflector 57 passes into the sound trap 63 formed by the reflector 64 and the plate 65, where it is destroyed by reflection and focusing within the sound trap, the sound obeying the reflecting and focusing laws of the confining chamber 63. The location of the end 60' of the tube 59 can be varied with respect to the focus point of the reflector 64, for changing the manner in which the sound will be focused and reflected. Some of the sound will be reflected back over the path from whence it came and will tend to neutralize or destroy oncoming sound, and it also will be destroyed.

It has been found by experiment that a sort of "tuning" can be done by changing the size or the characteristics of the sound trap, to prevent resonance and to eliminate drumming in the body of an automobile as well as other objectionable sound due to "harmonics", engine periods and low frequency sound waves. In this design it is sometimes possible to eliminate the reflector 57. In Fig. 4 there is shown a modified form of the muffler shown in Fig. 3. This design discloses a cylindrical sound trap which operates as follows:

The gas, after passing through the reflector 57, enters the perforated tube 66 through the holes 67, and passes out the outlet 68, while any sound that escapes from the reflector 57, and enters the tube 66 would, due to its tendency to expand, pass through the holes 69 into the sound trap 70, formed by the plates 71 and 72, and the body 73. The sound after entering the sound trap expands and is reflected within the sound trap until its energy is destroyed. This action can be readily demonstrated by clapping your hands in a small room and then in a large hall. When

the hands are clapped in a small room, the sound dies out immediately, due to the short path it travels between succeeding reflections from walls, floor, and ceiling; whereas in a large hall, the distance between walls, ceiling, and floor is so much greater that there are much fewer reflections per unit of time and since each reflection takes some of the energy out of the sound, the sound dies out very quickly when reflected between the confines of relatively small rooms or chambers.

It is understood that some of the sound will have a tendency to reenter the tube 66 and any that would so try to enter would be broken up by the holes 69, after which it would tend to neutralize oncoming sound by interference in the tube 66, and thereby lose its energy. One or more of the sound traps 70 can be used.

In Fig. 5 is shown another form of sound trap muffler using a reflector for part of the sound trap. A head 74 is provided with an inlet 75 and is nested in the perforated conical frustum 76, which in turn is nested in the body 77 and welded at 78. The cone is provided with small holes 79, to permit the gas to pass into the chamber 80, from which it passes to atmosphere through the outlet 81; and is also provided with an opening 82 at its small end to permit the sound which has been collected and guided by the cone to pass into the sound trap 83, formed by the plate 84 and the reflector 85. This sound trap acts on the sound in a manner similar to those previously described. Its reflecting action being dependent on the location of the hole 82 and the angle of the cone 76, as well as the shape of its confining walls. The plate 84 also supports the small end of the cone, and it and the reflector are welded to the body at 86.

Fig. 6 differs from Fig. 5 in that the cone 87 is preferably not perforated and is attached to a tube 88 provided with perforations 89 to permit the gas to pass into the chamber 90 and thence to atmosphere through the outlet 91. The sound passes down the tube 88 and into the sound trap 92, formed by the reflector 93, and the plate 94. The plate 94 also serves as a support for the tube 88.

This sound trap functions similar to the one in Fig. 3. Of course, some of the sound passes out the holes 89, but is so broken up by these small holes that it is practically unnoticeable. A feature of all the foregoing mufflers, and those yet to be described, is that there is not more than two obstructions or baffles to the flow of the gases through the muffler except Fig. 3, whereas Figs. 5, 6, 7, 8, 10, 11, 12, and 13 have only one baffle or obstruction (the tube 88 in Fig. 6), and Figs. 14, 15 and 16 have no baffles or obstruction.

Due to the fact that the above mufflers have only one or two baffles, it is possible to permit the gas to pass to atmosphere with only a small percentage of the hole area required in the baffles of mufflers now in use, and consequently, a very small amount of sound passes through these holes with the gas. Since so few holes are required to pass the gas, they can be spaced further apart and thereby prevent the recombining of the broken up sound wave fronts, as previously mentioned. The tendency of such wave fronts to recombine is illustrated by photographs in several books on sound.

Fig. 7 is the same as Fig. 6 except that the cone 87 has been omitted. Fig. 8 is a modification of Fig. 6 and has two opposed reflectors 95 and 96 on the front end. These reflectors can be

parabolical or elliptical. The reflector 95 is provided with an inlet port 97, and the reflector 96 supports the perforated tube 99, which has an opening 100 into the reflector chamber 101, and an opening 102 into the sound trap chamber 103, and which is supported on its rear end by the plate 104. The plate 104 also supports one end of the perforated tube 105, the other end being supported on the reflector 96 at 106. A "sound trap" 107, similar to the sound trap 70 of Fig. 4, is thus formed between the tube 105, the plate 104, the reflector 96, and the body 108. The tube 105 is provided with perforations 109, and with an outlet 110 for the exhaust gases. This outlet has no communication with the "sound trap" 107 that is, no exhaust gas passes thru the sound trap 107 on its way to the outlet 110. The gas and sound after passing through the inlet 97 expand in the reflector chamber 101, where part of the sound is destroyed by the opposed reflectors. The remaining sound and the gas then enters the tube 99. Practically all of this sound passes down to the sound trap 103, where it is trapped and destroyed, as previously described, while the gas passes out the holes 111 in the tube 99 into the chamber 112 formed between the tube 99 and the tube 105 and their sustaining ends 96 and 104. Any sound passing out the holes 111 into the chamber 112, or at least most of it, passes through the holes 109 in the tube 105, and into the "sound trap" 107 where it expands and is trapped and destroyed, by reflection back and forth within the sound trap. Some of the sound energy is destroyed by the fact that the wave fronts are broken up by passing through the small holes 109, into the sound trap and any sound that tends to pass from the sound trap back to the chamber 112 has its wave fronts also broken up by passing back through the holes 109. Thus the holes 109 act twice in destroying the sound waves without any hindrance to the gas flow. This is also true of the holes 69 in Fig. 4. The gas then passes from the chamber 112 to atmosphere through the outlet 110. By providing the second sound trap 107, I can put more holes 111, in the tube 99, thus reducing back pressure, and while this permits more sound to escape out the tube 99, it is trapped and destroyed by the action of the second sound trap, 107.

The sound trap 107 can be filled with steel wool or other sound absorbing material. This wool not only prevents ringing of the body due to the sound impulses, but also absorbs the sound energy that passes through the holes 109, like drapes absorb excess sound in an auditorium, due to the fact that the sound passes into the interstices of the wool where its energy is destroyed; and, also due to the softness of the wool, it reflects very little sound.

A further modification of this design would be to eliminate one or both of the reflectors 95 and 96 and put a flat plate in front, as 74 of Fig. 5. This can be done in some cases without affecting the silencing effects of the muffler when used on some engines, as some engines are easier to silence than others due to differences in compression ratios, volumetric efficiencies, valve timing, manifold and other variables.

Fig. 9 is a modification of Fig. 7 and has a front plate 113 nested in the body 114 and welded at 115, and which supports the inlet tube 116 at one end, and also supports the intermediate tube 117, at one end. The plate 118 is also welded in the body 114, and forms one end of a modified form of sound trap chamber 119. It also supports the

rear end of the tubes 116 and 117. The tube 116 has communication with the sound trap 119 by means of the opening 120. The plate 121 forms the rear end of the sound trap and is welded in the body 114 at 122. It is provided with a back pressure release valve 123 of the butterfly type which when open permits the gas to pass direct to the atmosphere without going through the holes in the tubes 116 and 117. A valve of this nature can be also used with the sound traps of Figs. 1, 3, 5, 6, 7, 8, 10, 11, and 13. The gas normally flows through the holes 116' in the tube 116, and then through the holes 117' in the tube 117 which serves as an additional baffle and thence to atmosphere through the outlet 114', while the sound passes into the sound trap 119.

As previously mentioned the sound trap 119 is of a different shape than those previously described; however, it works equally as well. In the previous designs, Fig. 4 excepted, a reflector was used to form part of the sound trap and the resultant silencing was due to the reflecting and focusing properties of the reflector, whereas in this design the silencing is due to reflection between the confining walls of the sound trap. Since the sound loses energy by reflection, as previously mentioned, it is desirable to make the muffler and the sound trap as small as possible so that the sound dies out quickly. Inasmuch as these sound traps may act as resonators, and since the exhaust noise is composed of a great many frequencies, it is possible that said sound traps will "tune in" on some of these frequencies and cause a slight hum. In this case an alteration in the size or shape of the sound trap can be made to attenuate this hum.

It is well known that any hard plate or wall will act as a reflector of sound regardless of its shape, the shape only affecting the direction of the reflected sound waves, which obey the well known laws of reflection. Therefore, when the sound enters the sound trap 119, it immediately expands until it comes in contact with the body 114 and the confining walls 118 and 121, whereupon it is reflected back and forth until its energy is dissipated, and as the sound trap is comparatively small, and as each reflection takes some of the energy out of the sound, it takes but a small fraction of a second for it to lose its energy, as previously described.

Inasmuch as the opening 120 is small compared to the size of the sound trap, very little sound will be reflected back through the opening 120, and whatever does pass through will be neutralized by oncoming sound. The tube 117 is optional, depending on the results desired. The end of the tube 116 can protrude in the sound trap any desired amount.

Fig. 10 is a further modification of Fig. 7 in which two opposed reflectors 124 and 125 are used to form the sound trap 126 wherein the sound is focused and reflected until its energy is destroyed. Instead of two opposed parabolas, an elliptical reflector could be used.

Fig. 11 is still another modification of Fig. 7 wherein the reflector 127 and the plate 128 which form the sound trap 129 are reversed in position.

In this design, the sound after entering the sound trap will have part of its energy reflected by the reflector 127 against the rear plate 128, while the remainder will impinge directly on the plate 128, whereupon it is reflected back again to the reflector which causes all the waves parallel to the axis 130 to converge at the focus point, while non-parallel waves are reflected to a line of

foci on the axis, some before and some after the main focus point, depending on the angle they strike the reflector. This focusing has a tendency to destroy incoming sound. The end 131 of the tube 132 is located approximately at the focus point of the reflector. The plate 128 can be "dished" in toward the reflector if desired. This, however, will cause the sound to be reflected somewhat differently. The gas enters at 133, passes through the holes 134, and then out the outlet 135.

As previously mentioned, hard surfaces reflect sound and as soft surfaces absorb sound and reflect very little of it, I make use of these absorbing properties of some materials as shown in Fig. 12 which is a modification of Fig. 10 and differs only in the fact that the sound trap 148 is partially filled with steel wool 149 (coated to prevent rusting) or other sound absorbing material, as mineral wool, asbestos, brass or copper wool, and held in place by a perforated plate 150.

In this design the sound after entering the sound trap 148 is reflected against the steel wool by the reflector 151. Of course, it is understood that some of the sound will impinge directly on the steel wool without being reflected. The steel wool absorbs the sound energy much as drapes in an auditorium—that is, when there are a great many echoes (reflections) in an auditorium due to the reflecting properties of the walls, it is customary to hang drapes, as they, being soft material, compared to the walls, absorb the excess sound waves and prevent echoes (reflections)—so the steel wool being soft and containing a large number of tortuous passages breaks up and absorbs the sound energy.

The gas flow is the same as in Fig. 10.

Fig. 13 is a modification of Fig. 12 wherein the location of the steel wool is reversed and the sound after impinging on the reflector 151 is reflected against the steel wool 152, and absorbed by it. The action of the sound after entering the sound trap 153 can be changed by varying the location of the opening 154 in the tube 155 in relation to the focus point 156 of the reflector 151. If the opening 154 is on the focus point 156, practically all of the sound will be reflected against the steel wool in parallel lines, provided a parabolic reflector is used. If the opening 154 is to the right of the focus point, the sound will be reflected against the steel wool in diverging lines. If it is to the left of the focus point, any appreciable amount the expanding of the sound wave which expands in the shape of a sphere will cause part of the wave to be absorbed directly by the steel wool, while the remainder of the wave will impinge on the reflector and be reflected against the steel wool and absorbed by it. The perforated plate 157 holds the steel wool in place.

The sound traps, when used as illustrated in Fig. 4, are not as efficient as those disposed at the end of the muffler (as illustrated in the other figures), due to the fact that, since the sound energy has direction down the pipe, it is headed into the sound trap chamber at the end of the tube, whereas in the construction illustrated in Fig. 4, the tendency of the sound energy to pass into the sound trap 70 is not nearly as great. In some instances, several sound traps 70, used as illustrated in Fig. 4, are required to obtain results equivalent to that construction in which the sound trap is disposed at the end of the tube, such as is illustrated in Fig. 7.

In Fig. 14 is shown another form of muffler using "sound traps" to produce silencing.

In this design a center tube 158 is provided with groups of small holes 161. Surrounding these groups of holes and having communication with them are the sound traps 162 formed by the opposed annular parabolas 163 and 164, which are fastened together by welding or otherwise so as to form a substantially airtight joint at 164'. The inner diameters of the parabolas are pressed on or otherwise secured to the tube 158 at 165 and located in respect to the holes 161 as shown.

The end 159 of the tube 158 is attached to the exhaust pipe of the engine, and the end 160 can be attached if desired to a pipe to conduct the gases from the muffler. The number of sound traps 162 required depends on the results desired and the characteristics of the exhaust noise to be silenced.

The gas from the engine enters the muffler at 159 and passes down the tube 158 while the sound energy passes into the sound traps 162 where, after expansion, it is dissipated or destroyed by reflection and focusing within said sound traps so that the gas emerges from the outlet port 160 with little or no attendant noise.

It can readily be seen that in this design of muffler, there are no baffles to offer restrictions to the flow of the gas, and that the gas has a direct passage through the center of the muffler. The dot and dash lines show how some of the sound may be focused and reflected. The manner in which the sound is reflected is dependent on the angle it strikes the walls of the sound trap.

Fig. 15 is a modification of Fig. 14. The center exhaust conduit 167 is provided with groups of holes 169 which are surrounded by the sound traps 168, formed by another kind of annular parabola 166. The parabola 166 can be in halves and welded together at 166' and also be welded to the tube 167 at 167'.

Parabolas similar to 127 of Fig. 11 can be used if desired; in which case two such reflectors would be used face to face, and the focus point would be on the axis of the tube 167.

The operation of this muffler is similar to Fig. 14, that is, the gas passes through the tube 167 while the sound energy passes into the sound traps 168 where it is destroyed by reflection and focusing.

I have found by experiment that the sound traps 162 and 168 of Figs. 14 and 15 respectively, as well as any of the preceding sound traps, can be of various shapes without effecting the silencing characteristics. The sound after entering the traps destroys itself by reflection within said traps with little or none escaping after entering. The effect of different shaped sound traps is only to change the manner in which the sound is reflected within said trap after entering it.

My sound traps, as used in Figs. 4, 14 and 15 are not as efficient as when used as shown in Figs. 6, 7, 8 and 9, that is, at the end of the muffler, due to the fact that, since the sound has direction down the pipe, it will readily pass into, or rather, it is headed into the sound trap at its end, whereas in Figs. 14 and 15, the tendency of the sound to pass into the sound traps 162 and 168 is not near as great. A practical proof of this is that, say in Fig. 6 or any of the other similar figures, very little sound passes through the holes 89, Fig. 6 into the chamber 90, even though the gas flow would tend to carry it through. Therefore, in Figs. 14 and 15, several

sound traps are needed to give results equivalent to that where the sound trap is at the end of the tube, but offsetting this need of more than one sound trap is the fact that the mufflers in Figs. 14 and 15 have comparatively no back pressure, as the gas passes straight through without being hindered by baffles.

The holes 161 and 169 of Figs. 14 and 15 respectively, break up the sound energy somewhat as it enters the sound traps, after which still more energy is taken from the sound by reflections within the sound traps. However, some of this sound energy which has been greatly reduced by the aforesaid reflections, may be reflected in this weakened condition back through the holes 161 and 169 in which case, it would be further weakened, and would mingle with the sound energy in the pipe and be acted on again by the following sound traps. It will be seen that the holes 161 and 169 act twice on breaking up the sound energy without offering resistance to the flow of the gases. The holes 161 and 169 are preferably few in number and comparatively small to prevent most of the sound which passes into the sound traps from being reflected back through the holes. It will be understood that there is more tendency for the sound to pass into the sound traps through the holes 161 and 169 than there is for it to come back from the sound trap through these holes as the energy of the sound is greatly reduced by this time.

In Fig. 16 is shown a modification of the sound traps 162 and 168. This sound trap, formed by the parts 170 and 171, surrounding the perforated tube 172 is filled with steel wool or other sound absorbing material to absorb the sound energy from the gas as it passes down the tube 172. This steel wool acts similar to the steel wool in Figs. 12 and 13, that is, the sound passes through the holes 173 and into the interstices of the steel wool where its energy is absorbed or destroyed.

I have previously mentioned that soft material will absorb sound, therefore the soot that will accumulate in the sound trap chamber of the foregoing designs after the mufflers have been in operation will have a sound absorbing effect and reduce the number of reflections necessary to dissipate the sound energy, and also increase the silencing.

In the mufflers illustrated, the idea is to cause the destruction of the sound energy by providing closed chambers or sound traps, through which there is substantially no gas flow, but into which the sound energy can pass and be trapped, where it is dissipated.

In any of the foregoing sound traps, the sound can be permitted to expand as it naturally tends to do when passing into a larger chamber from a smaller one, and said expanded sound will dissipate itself by reflection within the sound traps and practically none of said sound energy will escape from said sound trap after entering it.

The methods of silencing set forth in this specification can be applied also to ventilators.

While various modifications of my invention have been described in considerable detail, it is not my intention to limit its scope to those particular embodiments, or otherwise, than by the terms of the appended claims.

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

1. A silencer for exhaust gases comprising a muffling unit through which the exhaust gas stream flows on its way to atmosphere and hav-

ing provision at one end thereof for connection to the exhaust pipe of an engine, said muffling unit having in combination a tube of substantially uniform cross sectional area and through which sound entrained gas flows, said tube being provided with an exhaust gas inlet opening at one end thereof, an outlet opening in the walls thereof, said outlet opening comprising a series of relatively small openings extending axially and circumferentially of said tube, and a further outlet opening at the other end thereof, one of said outlet openings constituting an exhaust gas outlet having communication with atmosphere, the other outlet opening constituting a sound energy outlet, means providing a sound trap chamber, said chamber being acoustically coupled to said sound energy outlet in such a way as not to form part of the path traversed by the major portion of said gas on its flow through said unit, and having a cross sectional area substantially greater than that of said sound energy outlet immediately adjacent said outlet.

2. A silencer for exhaust gases comprising a muffling unit through which the exhaust gas stream flows on its way to atmosphere and having provision at one end thereof for connection to the exhaust pipe of an engine, said muffling unit having in combination a tube through which exhaust gas and sound energy pass, said tube being provided with an exhaust gas inlet opening at one end thereof, an outlet opening in the walls and a further outlet opening at the other end thereof, one of said outlet openings constituting an exhaust gas outlet having communication with atmosphere, the other outlet opening constituting a sound energy outlet, means providing a sound trap chamber, one of said openings comprising a series of relatively small openings extending axially and circumferentially of said tube, said sound trap chamber being acoustically coupled to said sound energy outlet in such a manner as not to form part of the path traversed by the major portion of said gas on its flow through said unit and being of substantially larger cross sectional area than said sound energy outlet, immediately adjacent said outlet, the axis of said tube being disposed within the outer peripheral boundary of said sound trap chamber.

3. A silencer for exhaust gases comprising a muffling unit through which the exhaust gas stream flows on its way to atmosphere and having provision at one end thereof for connection to the exhaust pipe of an engine and provision at the other end thereof for connection to a tail pipe leading to atmosphere, said muffling unit having in combination a tube through which sound entrained gas flows, said tube being provided with an exhaust gas inlet opening at one end thereof, an outlet opening at the other end thereof, and a further outlet opening in the walls thereof, said outlet opening in the walls thereof comprising a series of relatively small openings extending axially and circumferentially of said tube, one of said outlet openings constituting an exhaust outlet having communication with atmosphere, the other outlet opening constituting a sound energy outlet having communication with means providing a sound trap chamber, said chamber being abruptly enlarged adjacent said communication and being of substantially greater cross sectional area than said sound energy outlet, said chamber being disposed adjacent the end of said tube and constructed and arranged in such a manner as not to form part

of the path traversed by the major portion of the exhaust gas stream on its flow through said unit, and an expansion chamber through which the exhaust gas flows, in communication with

5 said tube through one of said openings.

4. A silencer for exhaust gas comprising a muffling unit through which the exhaust gas stream flows on its way to atmosphere and having provision at one end thereof for connection
10 to the exhaust pipe of an engine, said muffling unit having in combination a tubular member through which exhaust gas and sound energy pass, a casing around said member, said member being provided with an exhaust gas inlet opening
15 and separate outlet open areas, one of said open areas being formed in a wall of said member by a plurality of relatively small openings of sufficient relative effective area to provide a substantially unrestricted exhaust gas opening to
20 atmosphere, the other of said open areas constituting a sound energy opening, and a sound trap chamber formed in part by said casing and being in communication with the latter mentioned open area, said sound trap chamber
25 being abruptly enlarged adjacent said opening so as to restrict the return flow of sound from said sound trap chamber to said tubular member and being constructed and arranged in such a manner as not to form part of the path traversed by the
30 major portion of the gas in its flow through said unit.

5. A silencer for exhaust gases comprising a muffling unit through which the exhaust gas stream flows on its way to atmosphere and having
35 provision at one end thereof for connection to the exhaust pipe of an engine, said muffling unit having in combination a tube having a series of relatively small openings extending axially and circumferentially thereof, said tube being
40 provided with an exhaust gas inlet opening and separate outlet open areas, one of which open areas being provided by said series of openings, one of said open areas being formed in the walls of said tube and of sufficient relative effective
45 area to provide a substantially unrestricted exhaust gas opening to atmosphere, the other of said open areas being formed at one end of said tube and constituting a sound energy opening, and means providing a sound trap chamber in
50 communication with the latter mentioned tube open area, the opening between said tube and said chamber being of substantially less cross sectional area than that of the main portion of said chamber, said chamber being constructed and arranged in such a manner as not to form
55 part of the path traversed by the major portion of said gas on its flow through said unit.

6. A silencer for exhaust gases comprising a muffling unit through which the exhaust gas
60 stream flows on its way to atmosphere and having provision at one end thereof for connection to the exhaust pipe of an engine, said muffling unit having in combination a tube through which gas and sound energy pass, said tube being provided
65 with an exhaust gas inlet opening and separate outlet open areas, one of said open areas being formed in the walls of said tube by a plurality of relatively small openings extending circumferentially and axially of said tube, one of said open
70 areas being of sufficient relative effective area to provide a substantially unrestricted exhaust gas opening to atmosphere, the other of said open areas being formed at the end of said tube and constituting a sound energy opening, and means
75 providing a sound trap chamber closed on all

sides except for an opening that is in communication with the latter mentioned tube open area, said sound trap chamber having a cross sectional area substantially greater than that of said sound energy opening, said sound trap
5 chamber being abruptly enlarged adjacent said opening.

7. A silencer for exhaust gases comprising a muffling unit through which the exhaust gas stream flows on its way to atmosphere and having
10 provision for connection to the exhaust pipe of an engine and to a tail pipe leading to atmosphere, said muffling unit having in combination a tube of substantially uniform cross-sectional area, said tube being provided with an exhaust gas inlet opening at one end thereof, an
15 outlet opening in the walls formed by a series of relatively small openings extending circumferentially and axially thereof and a further outlet opening at the other end of said tube, one of said outlet openings constituting an exhaust gas
20 outlet leading to atmosphere through said tail pipe and having an effective area sufficient to permit a substantially unrestricted flow of exhaust gas to atmosphere, the other of said outlet openings constituting a sound energy outlet, and means
25 constituting a sound trap chamber having communication with said sound energy outlet opening, at least a portion of said chamber having a cross sectional area substantially greater than that of said sound energy outlet opening, said
30 sound trap chamber being constructed and arranged so as not to form part of the path traversed by the major portion of said gas stream on its flow through said unit.

8. A silencer for exhaust gases comprising a muffling unit through which the exhaust gas stream flows on its way to atmosphere and having
40 provision at one end thereof for connection to the exhaust pipe of an engine and provision at the other end thereof for connection to a tail pipe leading to atmosphere, said muffling unit comprising a tube of substantially uniform cross-sectional area, said tube being provided with an exhaust gas inlet opening at one
45 end thereof, an outlet opening at the other end thereof, and a further outlet opening in the walls, said outlet opening in the walls comprising a series of relatively small openings extending axially and circumferentially of said tube, one of said outlet openings constituting an exhaust gas
50 outlet leading through said tail pipe to atmosphere and having an effective area sufficient to permit a substantially unrestricted flow of exhaust gas to atmosphere, the other outlet opening constituting a sound energy outlet and leading to means providing a dead chamber for trapping said sound energy, the communication between said tube and said chamber being of substantially less cross sectional area than that of the main portion of said chamber, said chamber being abruptly enlarged adjacent said communication.

9. A muffler for exhaust gases comprising a muffling unit through which the exhaust gas
65 stream flows on its way to atmosphere and having provision for connection to the exhaust pipe of an engine and to a tail pipe leading to atmosphere, said muffling unit having in combination a substantially unrestricted chamber through which exhaust gas and sound energy pass and having an inlet for an exhaust gas stream, a plurality of openings in the walls of said chamber, one of which comprises a series of relatively small apertures extending axially and circum-
75

ferentially of said chamber, one of said openings constituting an outlet for the exhaust gas stream leading to atmosphere through said tail pipe, and the other of said openings constituting an outlet for the sound energy, and means providing a dead chamber in communication with said sound energy outlet opening, said dead chamber constituting a sound trap and being abruptly enlarged adjacent said opening.

- 10 10. A silencer for exhaust gases comprising a muffling unit through which the exhaust gas stream flows on its way to atmosphere and having provision at one end thereof for connection to the exhaust pipe of an engine, said muffling unit having in combination a tubular member of substantially uniform cross-sectional area through which the exhaust gas stream having sound energy entrained therein flows on its way to atmosphere, the walls of said member being provided with a series of relatively small openings extending axially and circumferentially thereof, and means providing an enlarged chamber having a communication with said member, said chamber constituting a sound trap into which the sound energy from said gas stream escapes and wherein said sound energy expands and is confined, said chamber being abruptly enlarged adjacent said communication so as to restrict the return flow of sound from said chamber to said member.

11. A silencer for exhaust gases comprising a muffling unit through which the exhaust gas stream flows on its way to atmosphere and having provision for connection to the exhaust pipe of an engine and to a tail pipe leading to atmosphere, said muffling unit having in combination a tubular member of substantially uniform cross-sectional area through which the exhaust gas stream having sound energy entrained therein flows on its way to atmosphere, and an opening from said member leading to atmosphere and permitting a substantially unrestricted flow of said gas stream, a second opening in said tubular member constituting a sound energy outlet, one of said openings comprising a plurality of relatively small openings extending axially and circumferentially of said tubular member, and means providing an enlarged dead chamber in communication with said sound energy outlet, said dead chamber being abruptly enlarged to permit the rapid expansion therein of sound energy, and constituting a sound trap.

12. In a silencer for exhaust gases, a muffling unit through which the exhaust gas stream flows on its way to atmosphere and having provisions for connection to the exhaust pipe of an engine and to a tail pipe leading to atmosphere, said muffling unit having in combination a tube forming part of a path through which the exhaust gas stream flows on its way to atmosphere, a plurality of relatively small openings extending axially and circumferentially of said tube and providing an outlet opening for the gas stream in the side walls of said tube, and means providing a dead chamber at one end of said tube acoustically coupled to said path and having a cross-sectional area substantially greater than that of said tube, said dead chamber constituting a sound trap wherein the sound energy of said exhaust gases is destroyed, the axis of said tube being disposed within the outer peripheral boundary of the sound trap chamber.

13. In a unitary device for trapping the sound energy out of a gas stream during its passage therethrough, means affording a passageway

through which the gas stream flows through said device, an inlet opening and an outlet opening in said device connected by said passageway, and means providing an enlarged dead chamber adjacent one end of said passageway, said chamber being separate from said passageway and having a communication therewith, said communication opening abruptly into said chamber, said chamber having a cross-sectional area substantially greater than that of said communication and being adapted to permit the rapid expansion of sound energy within said chamber after passing through said communication, said communication being such as to restrict the return flow of sound energy from said chamber to said passageway so as to trap the major portion of said sound energy within said chamber, and a series of relatively small openings extending axially and circumferentially of said passageway and operatively disposed between said chamber and the outlet from said device.

14. A muffler for exhaust gases comprising a muffling unit through which the exhaust gas stream flows on its way to atmosphere and having provisions for connection to the exhaust pipe of an engine and to a tail pipe leading to atmosphere, said muffling unit having in combination a chamber of substantially uniform cross-sectional area having an inlet for an exhaust gas stream, a plurality of outlets in the walls of said chamber, one of said outlets comprising a plurality of relatively small openings extending annularly and axially of said chamber, one of said outlets constituting an outlet for the exhaust gas stream leading to atmosphere through said tail pipe, and the other of said outlets constituting an outlet for the sound energy, and means providing a dead chamber out of the path of flow of the gas stream and in communication with said sound energy outlet, said dead chamber constituting a sound trap and being abruptly enlarged adjacent said sound energy outlet.

15. In a muffling unit through which the exhaust gas stream flows on its way to atmosphere having provisions for connection to the exhaust pipe of an engine and to a tail pipe leading to atmosphere, said muffling unit having in combination a passageway through which the gas stream flows through said unit and including an expansion chamber, an outlet from said unit leading to atmosphere through said tail pipe, means providing an enlarged dead chamber separate from said passageway and having a communication therewith, said dead chamber being abruptly enlarged adjacent said communication and having a cross-sectional area substantially greater than that of said communication and being adapted to permit the rapid expansion of sound energy within said dead chamber after passing through said communication, said communication being restricted to the return flow of sound energy from said chamber to said passageway so as to trap the major portion of said sound energy within said dead chamber, said unit being constructed so as to provide an annular and axially extending series of relatively small openings operatively disposed between said dead chamber and the outlet from said unit.

16. An acoustic silencer for sound entrained flowing gases of internal combustion engines comprising a casing having an inlet port and an outlet port for said gases, means providing a gas passageway within said casing between said ports, a sound trap chamber, formed in part by the walls of said casing, in direct communica-

tion with said passageway and disposed and arranged relative thereto so as not to form part of the path traversed by the major portion of the gas on its flow through said silencer, said communication being of substantially less cross-sectional area than said sound trap chamber, said sound trap chamber being abruptly enlarged adjacent said communication so as to trap and attenuate the sound entrained in said gases, and having a length less than its width, the maximum effective cross-sectional area of the passageway being less than the maximum cross-sectional area of said sound trap chamber.

17. An acoustic silencer for sound entrained flowing gases comprising a casing having an inlet port and an outlet port for said gases, means providing a gas passageway within said casing, a sound trap chamber, formed in part by the walls of said casing, acoustically coupled to said gas passageway and disposed and arranged so that said gases do not have to pass through said chamber on their way to said outlet, said acoustically coupled chamber being adapted to attenuate the sound entrained in said gases, the cross-sectional area of said coupling being at least as great as the effective cross-sectional area of said passageway, and the maximum effective cross-sectional area of the passageway being less than the maximum cross-sectional area of said sound trap chamber.

18. A sound attenuating device for sound entrained flowing gases of internal combustion engines comprising a casing having an inlet and outlet for said gases, means providing a gas passageway within said casing and including a tube of substantially uniform cross-sectional area through which said sound entrained gases pass, said tube being provided with a gas inlet opening at one end thereof, an outlet opening in the body of said tube and a further outlet opening at the other end thereof, one of said outlet openings constituting a gas outlet, the other outlet opening constituting a sound energy outlet opening having communication with means providing a sound trap chamber, said sound trap chamber being substantially closed on all sides except for said communication and being of substantially larger cross-sectional area than said other outlet opening, the axis of said tube being disposed within the outer peripheral boundary of said sound trap chamber, said sound trap chamber being abruptly enlarged adjacent said other outlet opening so as to trap and attenuate the sound entrained in said gases.

19. An acoustic sound attenuating device comprising a casing having an inlet opening and an outlet opening, means providing in part a gas passageway of substantially uniform cross-sectional area disposed within said casing, means defining a sound trap chamber in communication with and acoustically coupled to said passageway, said sound trap chamber being substantially closed on all sides except for said communication, and being of substantially larger cross-sectional area than said communication, said communication opening abruptly into said sound trap chamber so that there is a restriction to the return flow of sound energy from said chamber to said passageway, said sound trap chamber being disposed and arranged so that the gas does not have to pass through said chamber on its way from said inlet to said outlet opening, said inlet and outlet being out of alignment.

20. An acoustic sound attenuating device comprising a casing having a gas inlet opening and

an outlet opening, means providing a sound trap chamber substantially closed on all sides and disposed within the confines of said casing, a tube acoustically coupling directly the interior of said casing and said chamber, the cross-sectional area of said chamber being appreciably greater than the cross-sectional area of said tube, 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.

21. An acoustic silencer for silencing the intake or exhaust noise of an internal combustion engine comprising a body, a header at one end thereof provided with a gas inlet opening, a header at the other end thereof, means providing a gas outlet opening, a partition within said body spaced apart from said second mentioned header and cooperating with one of said headers to form an acoustic sound attenuating chamber through which little or none of said gas flows on its way from said inlet to said outlet, and a tube having a direct communication with the interior of said body and opening abruptly into said chamber, the area of said communication being substantially less than the cross-sectional area of said chamber.

22. An acoustic silencer for silencing the intake or exhaust noise of an internal combustion engine comprising a body, a header at one end thereof provided with a gas inlet opening, a header at the other end thereof, means providing a gas outlet opening, a partition within said body spaced apart from said second mentioned header and forming therewith an acoustic side branch chamber through which little or none of said gas flows on its way from said inlet to said outlet, and a tube having a direct communication with and opening abruptly into said chamber, the area of said communication being substantially less than the cross-sectional area of said chamber, said tube being fastened to said partition, the axis of said tube being substantially parallel to the axis of said casing.

23. An acoustic silencer for sound entrained flowing gases of internal combustion engines 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 a part of a path for exhaust 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 means in communication with said casing outlet port, means providing a chamber for extracting sound from said gases, 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.

24. In a silencer for exhaust gases, a muffling unit through which the exhaust gas stream flows on its way to atmosphere and having provisions for connection to the exhaust pipe of an engine and to a tail pipe leading to atmosphere, said muffling unit having in combination a tube forming at least part of a path through which the exhaust gas stream flows on its way to atmosphere, a plurality of relatively small openings extending axially and circumferentially of said tube and providing an outlet opening for the gas stream in the side walls of said tube, a perforated baffle member disposed between said tube and said tail pipe connection, and means defin-

ing a dead chamber which is acoustically coupled to said path and having a cross-sectional area substantially greater than that of said tube, said dead chamber constituting a sound trap wherein the sound energy of said exhaust gases is destroyed, the axis of said tube being disposed within the outer peripheral boundary of the sound trap chamber, said chamber being coupled to said path in such a manner as not to form part thereof.

25. An acoustic silencer for silencing the intake or exhaust noise of internal combustion engines 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 sound entrained flowing gas and having one end operatively connected to said inlet port, said tube having an outlet opening at the other end thereof constituting a gas outlet opening in communication with said casing outlet port, and means providing a chamber within said casing for attenuating said noise, said chamber being substantially closed except for only an acoustic coupling to said path, the maximum cross-sectional area of said chamber being greater than the maximum effective cross-sectional area of said path.

26. An acoustic silencer for silencing the intake or exhaust noise of internal combustion engines 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, means providing a chamber within the confines of said casing for attenuating said noise, said chamber being acoustically coupled to the other of said outlet openings and arranged so as not to form part of the path traversed by the major portion of said gases, and being abruptly enlarged immediately adjacent said coupling.

27. A silencer for silencing the intake or exhaust noise of an internal combustion engine comprising a body, a header at one end thereof provided with a gas inlet opening, a header at the other end thereof, means providing a gas outlet opening, a partition within said body cooperating with at least one of said headers and with said body to form an acoustic sound attenuating side branch chamber, and a tube of small cross-sectional area, compared to the cross-sectional area of said chamber, disposed within said body and opening abruptly into said chamber, said tube forming at least part of a gas conducting channel between said inlet and outlet openings, said chamber being constructed and arranged in such a manner as not to form part of the path traversed by the major portion of the gas in its flow through said silencer.

28. An acoustic silencer for sound entrained flowing gases of internal combustion engines comprising a casing having means providing a main gas conducting channel therein, means providing a sound attenuating chamber coupled

only acoustically to said channel, the maximum effective cross-sectional area of the channel being 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, and said chamber being abruptly enlarged immediately adjacent its zone of coupling to said channel.

29. An acoustic silencer for sound entrained flowing gases comprising a casing having a gas inlet port and a gas outlet port, means providing an acoustic chamber for attenuating said sound, a tube of substantially uniform cross-sectional area within said casing having an inlet opening, operatively connected to said inlet port, and two outlet openings, one of said outlet openings constituting a gas outlet opening in communication with said outlet port, the other of said outlets constituting a sound energy outlet in communication with said acoustic chamber, said chamber being constructed and arranged in such a way as not to form part of the path traversed by the major portion of the gas on its flow through the silencer, and being abruptly enlarged adjacent said communication so as to restrict the return flow of sound energy from said chamber to said tube.

30. 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 perforations in the walls thereof, forming a passageway within said casing for the flow of gas between said inlet and outlet openings, and means cooperating with said casing to define a sound trap chamber, said chamber being acoustically coupled to said passageway in such a manner as not to form part of the path traversed by the major portion of the gas on its flow through said casing.

31. 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 a passageway within said casing for the flow of gas between said inlet and outlet openings, and means cooperating with said casing to define a sound trap chamber, 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.

32. An acoustic sound attenuating device comprising a casing having a gas inlet opening and an outlet opening, means providing a sound trap chamber substantially closed on all sides and disposed within the confines of said casing, an opening acoustically coupling directly the interior of said casing and said chamber, the cross-sectional area of said chamber 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.

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