

May 24, 1938.

P. G. PEIK

2,118,056

MUFFLER

Filed Sept. 17, 1934

4 Sheets-Sheet 1

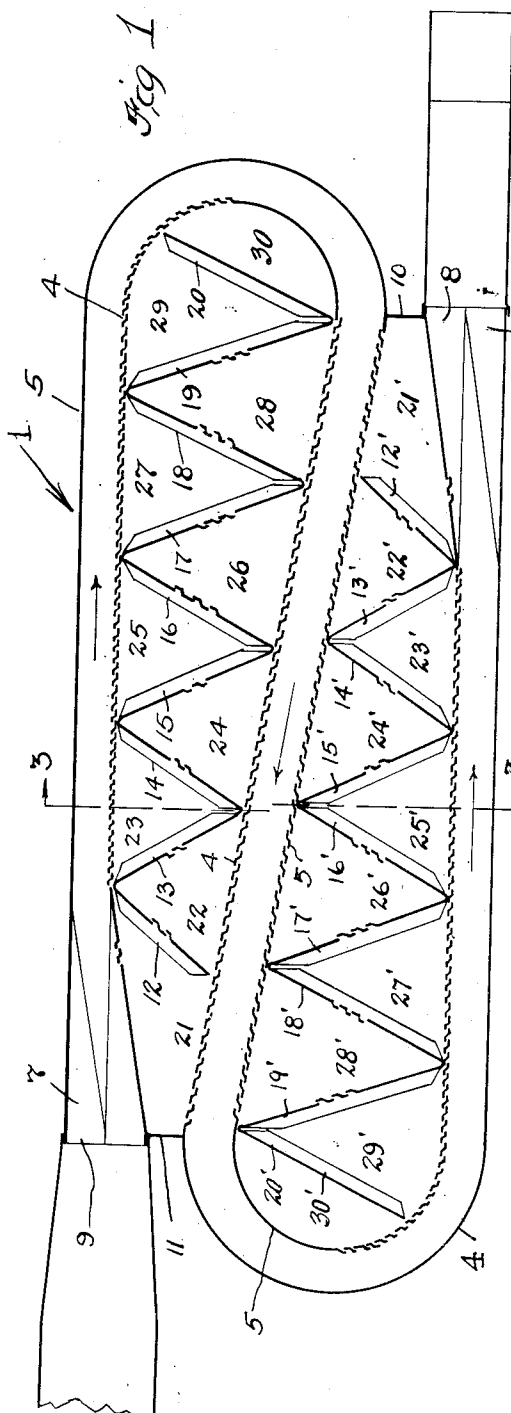
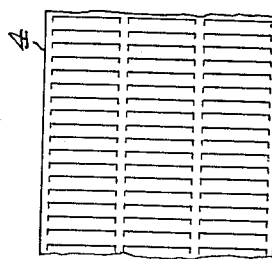


Fig. 4

Fig. 2

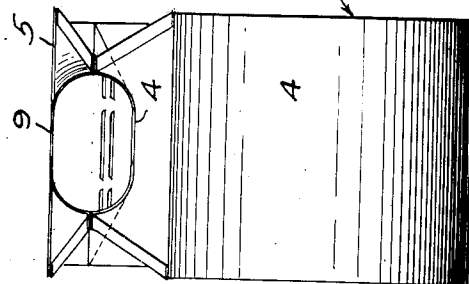
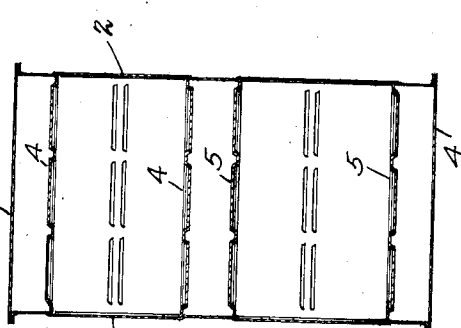


Fig. 3

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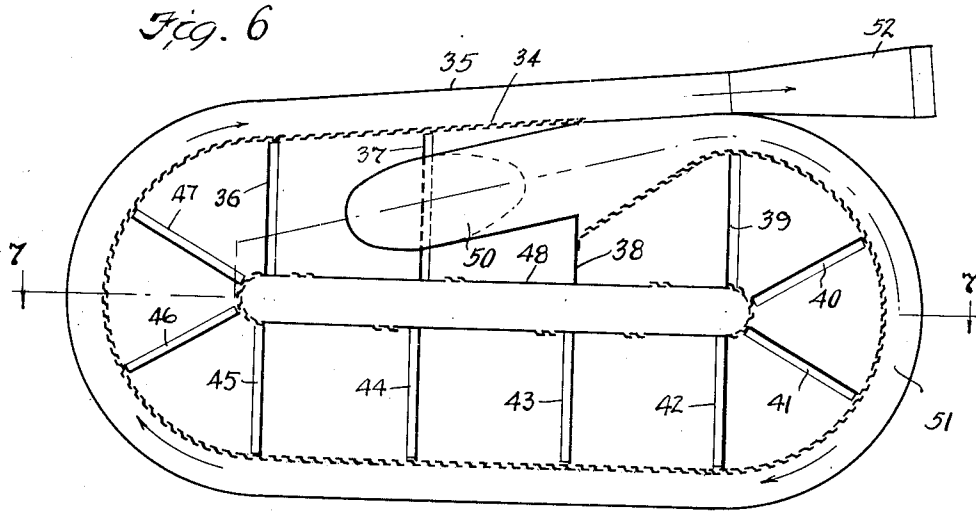
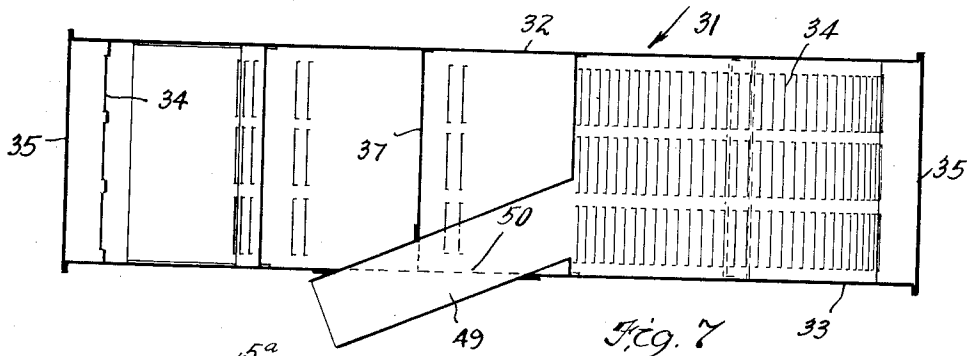
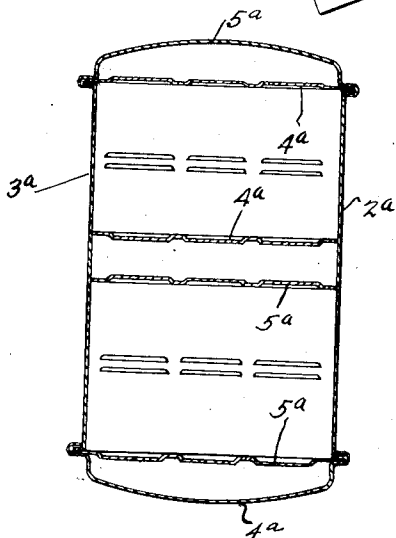
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4 Sheets-Sheet 2



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Filed Sept. 17, 1934

4 Sheets-Sheet 3

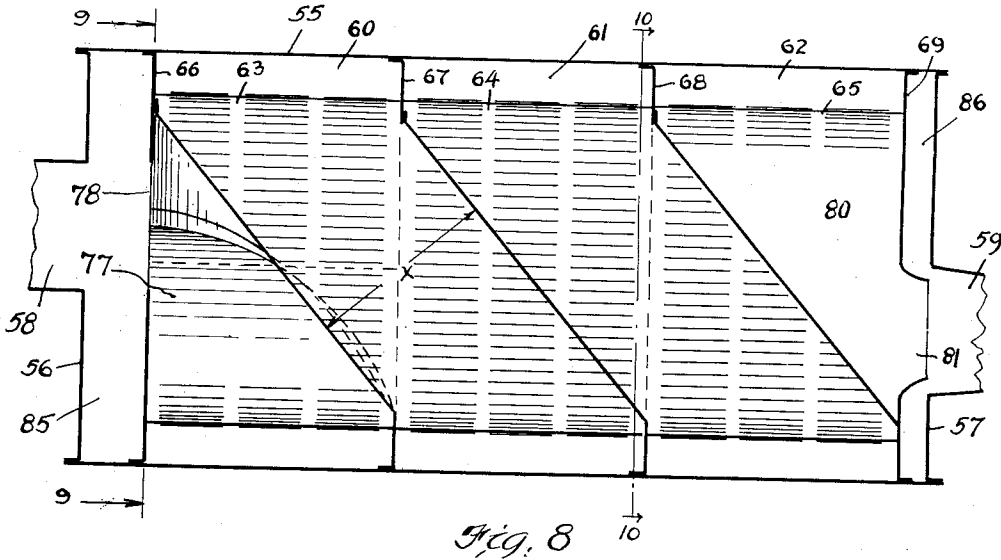
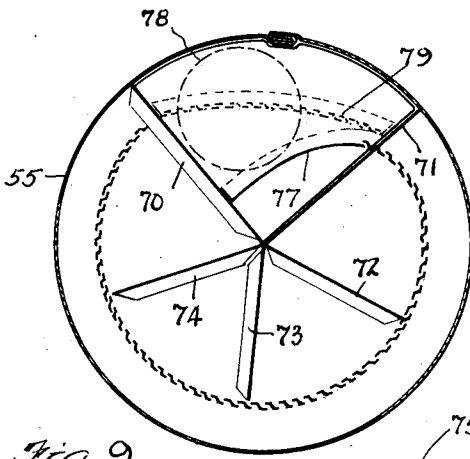
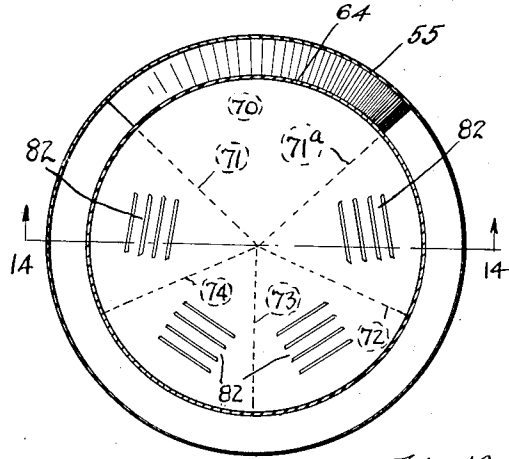
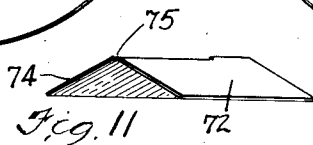
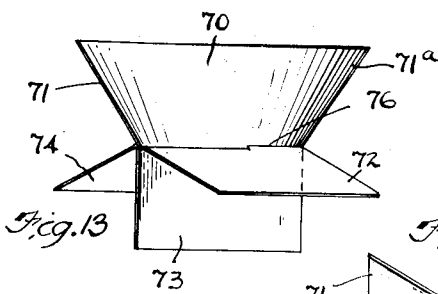
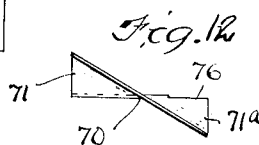
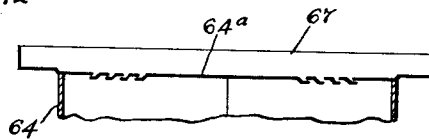


Fig. 14.

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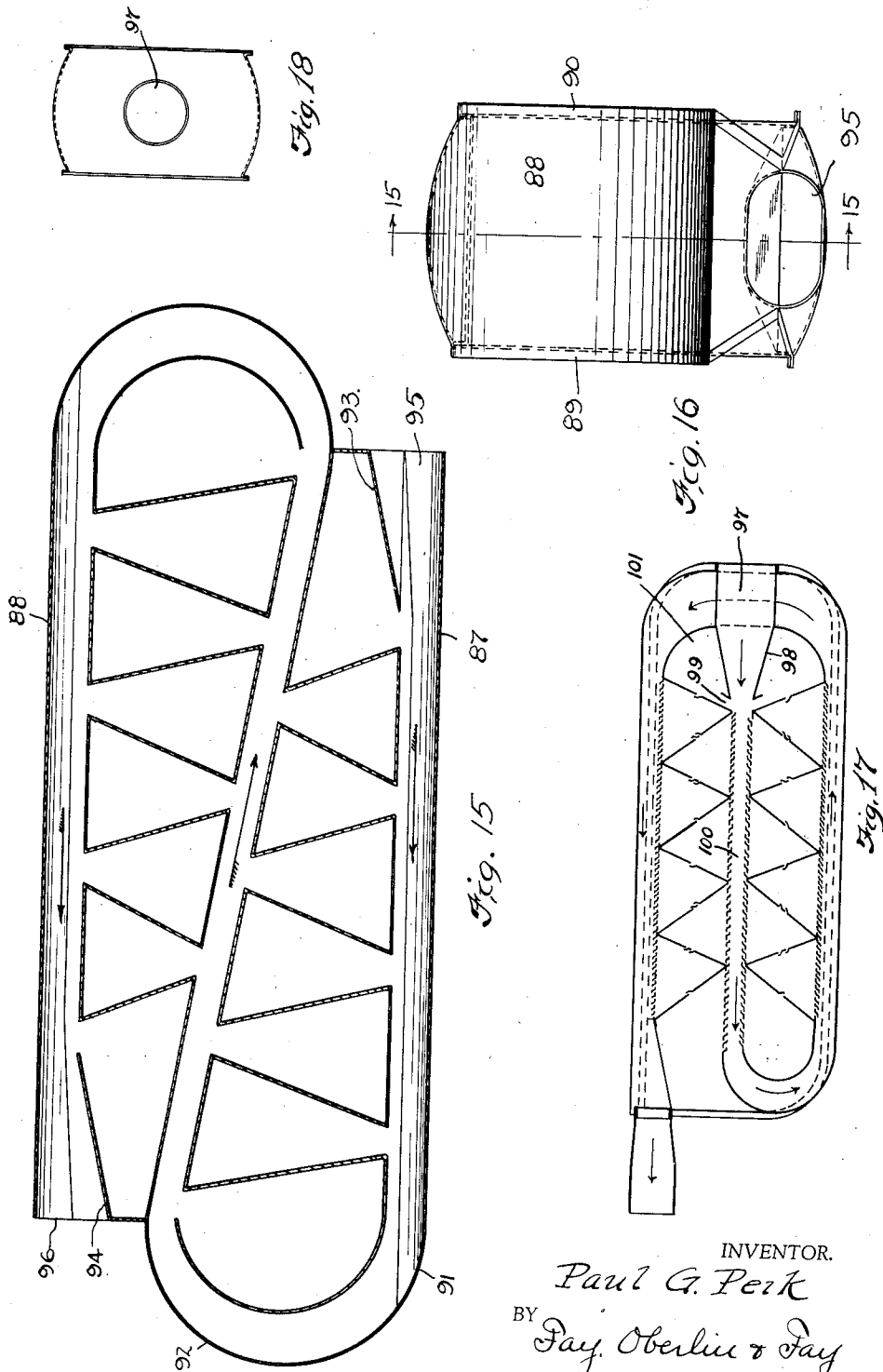
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4 Sheets-Sheet 4



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2,118,056

MUFFLER

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Application September 17, 1934, Serial No. 744,380

16 Claims. (Cl. 181—54)

This invention relates, as indicated, to mufflers, and more particularly, to mufflers for silencing the exhaust of internal combustion engines, particularly automotive engines.

It is one of the objects of my invention to provide a muffler which combines a high degree of silencing efficiency with extreme compactness, yet has low back pressure and is relatively simple and cheap to manufacture.

It is a further object of my invention to provide a muffler of the character described in which the gas stream in passing therethrough is, for a major portion of the extent of such travel, in contact with the outer closure shell of the muffler so that the temperature of the exhaust gases may be appreciably reduced during the passage thereof through the muffler with the advantages hereinafter more fully explained.

It is a further object of my invention to provide a muffler of the character described in which there is provided an unbaffled passage for the gas through the muffler, which passage is so arranged that a minimum of back pressure is generated, so that it is in contact with the outer closure shell of the muffler, as above explained, and further, so that it is bordered by sound attenuating chambers throughout the major portion of its travel through the muffler.

Other objects of my invention will appear as the description proceeds. To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims.

The annexed drawings and the following description set forth in detail certain mechanism embodying the invention, such disclosed means constituting, however, but several of the various mechanical forms in which the principle of the invention may be used.

In said annexed drawings:—

Fig. 1 is a somewhat diagrammatic representation of the construction of one form of muffler according to my invention; Fig. 2 is an end elevational view of the structure illustrated in Fig. 1; Fig. 3 is a transverse sectional view of the structure illustrated in Fig. 1 taken on a plane substantially indicated by the line 3—3; Fig. 4 is a fragmentary elevational view of one of the elements of the construction illustrated in the previous figures showing the arrangement of the louvers therein; Fig. 5 is a transverse sectional view similar to Fig. 3 showing, however, a slight modification in the arrangement of the several parts forming the structure illustrated in

Fig. 1; Fig. 6 is a somewhat diagrammatic representation of a slightly different form of muffler construction embodying the principles of my invention; Fig. 7 is a longitudinal, transverse, sectional view of the structure illustrated in Fig. 6 taken on a plane substantially indicated by the line 7—7; Fig. 8 is a somewhat diagrammatic representation of yet another form of muffler embodying the principles of my invention; Figs. 9 and 10 are, respectively, transverse sectional views of the structure illustrated in Fig. 8 taken on a plane substantially indicated by the lines 9—9 and 10—10; Figs. 11, 12, 13 and 14 are views showing details of construction of the assembly illustrated in Figs. 8 to 10; Figs. 15 and 16 are respectively transverse sectional and end elevational views of another form of muffler constructed in accordance with the principles of my invention, Fig. 15 being a sectional view taken on a plane substantially indicated by the line 15—15 in Fig. 16; Fig. 17 is a view similar to Fig. 15 but showing a further modified form of construction; and Fig. 18 is an end elevational view of the structure disclosed in Fig. 17.

Referring now more specifically to the drawings and more especially to Figs. 1 to 3, the muffler herein illustrated comprises a substantially rectangular body generally indicated at 1, which is formed by means of substantially flat side members 2 and 3 between which are disposed and secured two substantially identical looped strips 4 and 5 formed of flat stock and arranged in substantially parallel relation to each other. At their terminals 6 and 7 the strips 4 and 5 are brought together so as to provide substantially elliptical extensions 8 and 9 to which exhaust conduits may be secured. Closure members 10 and 11 are employed to close the spaces between the extensions 8 and 9 and the rebent strips 4 and 5 so that a closed shell is provided.

Extending between the side walls 2 and 3 in the spaces within the casing 1 defined between rebent strips 4 and 5, are a plurality of partitions respectively indicated by the ordinals 12 to 20 and 12' to 20'. These partitions define a plurality of sound attenuating chambers respectively designated by the ordinals 21 to 30 and 21' to 30'.

The strips 4 and 5 are provided with louvers, as indicated in Fig. 1, and the partition members 12 et seq. are likewise provided with louvers, whereby sound waves from the stream of gas passing through the muffler may pass into the various sound attenuating chambers.

As above indicated the members 4 and 5 may

be respectively formed from identical flat strips coiled to the contour illustrated in Fig. 1 and positioned between the side members 2 and 3 as the muffler is assembled. In order to facilitate assembly the side plates 2 and 3 may be provided with struck out portions conforming to the configuration to be taken by the members 4 and 5 so that as the side members 2 and 3 are brought together, the members 4 and 5 will be automatically located and secured in the desired position. Attention is also directed to the fact that the partition members numbered 12 to 20 may be formed of accordion folded flat stock, which, along its longitudinal edges is provided with lateral flanges by which the partition members may be secured to the side plates 2 and 3. At this point, it should also be noted that the accordion folded strip forming the partition members 12 to 20 is identical with the similarly formed strip which provides the partitions 12' to 20'. In order to facilitate assembly of the two accordion folded strips providing the intermediate partitions, the side plates 2 and 3 may be provided with triangular shaped indentations arranged to conform to the desired location of the accordion folded strips so that the intermediate partition members are held in proper position during and until they are secured to the side walls as by welding.

As most clearly illustrated in Fig. 3, the strips 4 and 5 are substantially flat and arranged normal to the plates 2 and 3 to which they are secured in spaced relation along their longitudinal edges. It may be desirable to transversely dish the strips 4 and 5 in the manner illustrated in Fig. 5, wherein ordinals bearing the subscript "a" have been employed to designate parts similar to those shown in Fig. 3. In Fig. 5 the strips 4a and 5a are, in their areas which form a part of the outer shell, dished sufficiently so that they may have their longitudinal edges brought into abutting relation and joined to the side members 2a and 3a in one line instead of two spaced lines as indicated in Fig. 3.

From the above description, it is believed that the action of the muffler in silencing the exhaust of internal combustion engines will be apparent to anyone versed in the art. However, the following brief explanation is offered of the function of the muffler described to accomplish this end.

While the main body of the gas flows around the S-shaped passage and is acted upon by the sound wave attenuating functions of the adjacent chambers, a portion of the gas short circuits from the incoming passage through the reverse passage direct into the outgoing passage by virtue of the openings in the partition 12 et seq. and 12' et seq. Restricted communication is thus afforded between various parts of the main gas stream in which the sound waves are out of phase with resultant increase in sound attenuation, as well as reduction in back pressure. In this particular modification of the invention it has been found that a greater volume of gas can be permitted to thus short circuit without suffering undue amplitude in the sound waves, which likewise cross over, due to the relative position of the sound attenuating chambers with respect to each other and the gas stream. For example, the sound waves short circuiting from any one chamber facing the incoming stream are distributed or spread out into the two adjacent chambers facing the reverse stream and after being acted upon by the out of phase sound waves in the reverse

passage over an area equal to the "face" of these two chambers, cross over and in the same manner are spread out further by the time they enter the outgoing passage. In this connection it should be borne in mind that the energy potential across a wave front after it has left its source is inversely proportional to the area or spread of the wave front; also that both the back pressure and amplitude of the sound waves are decidedly greater at the incoming end of the muffler than at the outgoing.

There is a very substantial cooling effect secured due to the fact that the main gas stream is in direct contact with the outer shell of the muffler during the major portion of its passage therethrough with resultant beneficial effect upon back pressure and sound wave attenuation.

The substantially flat or rectangular stream employed can be reversed, as shown, in a very short radius without any appreciable increase in back pressure.

The construction illustrated in Figs. 6 and 7 is based upon the same fundamental principles underlying the construction of the muffler illustrated in Fig. 1. The muffler illustrated in Figs. 6 and 7 comprises a substantially rectangular body generally indicated at 31 formed by means of two substantially flat side plates 32 and 33, immediately of which there are positioned two coiled flat plates generally indicated at 34 and 35. The latter plate is so formed and secured to the side plates 32 and 33 as to form a completely closed chamber within which the plate 34, perforated throughout the major portion of its length, is in spaced relation to the plate 35.

Mounted within the casing 31 and separating the inner space defined by the coiled plate 34 and the side plates 31 and 32 into a plurality of sound attenuating chambers, are partitions respectively indicated by 36 to 47, both inclusive.

Another strip 48 coiled into oblong form and positioned between the side plates and partition members, as shown in Fig. 6, provides a central chamber making possible restricted communication between the various sound attenuating chambers in which the said waves are out of phase, resulting in a reduction in back pressure and an increase in the silencing effect of the muffler.

As most clearly illustrated in Fig. 7, the side plate 33 is provided with an opening, into which there extends a conduit generally indicated at 49 for the incoming gases. It will be noted that the conduit 49 extends through partition 37 and terminates in an opening provided therefor in partition 38. The strips 34 and 35 are at one end brought together and formed into a substantially tubular extension 52 to which the usual outgoing pipe is secured.

The modification illustrated in Figs. 8 to 14 comprises a substantially cylindrical shell, generally indicated at 55, to which there is secured, at its opposite ends, headers 56 and 57 respectively, provided with inlet and outlet orifices 58 and 59. The space defined by the shell 56 is divided into a plurality of sections, generally indicated at 60, 61 and 62. Each of these sections includes a substantially cylindrical inner shell 63, 64 and 65, respectively. These inner shells positioned between transversely extending partition members 66, 67, 68 and 69 are provided with louvers, as most clearly illustrated in Fig. 9. The louvers may, in certain sections, such as 63 and 64, be faced towards the gas stream and in certain other sections such as 66 faced away

from the gas stream; or the louvers in certain portions of each section may be faced towards the gas stream and in other portions of the same sections faced away from or trailing the gas stream. The spaces defined by the inner shells 63, 64 and 65 are divided into a plurality of sound attenuating chambers by means of radially extending partition members such as 70, 72, 73 and 74. In order to facilitate the manufacture, the partition members 72 and 74 may be made from one piece bent angularly in the manner illustrated in Fig. 11. At this point, it might be well to note that the opposite radially extending edges of the element 70 are respectively denoted by the ordinals 71 and 71a. The angularly bent section illustrated in Fig. 11 is at the line of such bend provided with a slot as indicated at 75, so that the partition members 70 and 73, likewise formed of one piece and bent angularly in the manner illustrated in Fig. 13, may be conveniently assembled therewith in the manner illustrated in said last-named figure; such assembly is made possible by the provision of a slot in the plate forming the members 70 and 73 and arranged at the line of juncture of such elements.

As previously indicated the elements 72, 73 and 74 extend axially and radially of the inner shell in flat planes. The elements 70 are, however, twisted into substantially helical shape and extend through the inner shells 63, 64 and 65 into engagement with the outer shell. These elements 70, therefore, provide helically arranged streamlined turns between the inner and outer shells whereby the gas progressing from one end of a muffler to another in the space defined by the inner and outer shells flows in a circumferential path for a major portion of its travel through each section and then moves helically into the next section.

The inner shell in the area 77 at the gas-receiving end of the muffler is bent inwardly on the left-hand side of the member 70, so that the gas entering the section 60 through the opening 78 in the partition member 66 may have an unrestricted and unobstructed path into and through said section.

Since the width of the gas passage between adjacent members 70 on the line indicated at X is less than the axial distance between partitions 66, 67, etc., the inner shell in these areas may likewise be depressed inwardly as indicated at 79 in order to compensate for this reduction in width of the gas stream. The inner shell 65 at 80 may likewise be depressed inwardly as at 77 in Fig. 9 in order to afford an unobstructed passage for the gas through the outlet orifice 81 in the partition member 69. The partition members 66, 67, et seq. may, as most clearly illustrated in Fig. 10, be provided with spaced groups of louvers indicated generally at 82, which louvers are so arranged as to be positioned between the sound attenuating chambers of adjacent sections of the muffler. These louvers are designed primarily to reduce the back pressure of the muffler and also to assist in the sound attenuating function of the central chambers of the muffler.

In assembling the muffler as illustrated in Fig. 8, it may be expeditious to build up as separate units each of the sections 63, 64 and 65 with their internal partition members 70 etc. After these separate units have been thus individually constructed, they may then be nested and assembled within the main outer shell 55. In order to facilitate this nesting and assembly of the muffler sections, each section is assembled complete to one

of the partition members such as 67 to which the various parts are secured as by welding, as shown most clearly in Fig. 9. It will be apparent that if the various parts of the inner structure are assembled on the raised portions of the partition members as illustrated at 64a in Fig. 14, after such assembly is in place it will present a "dished in" area into which the open end of the next adjacent section may nest and be held in place. At this point it may be noted that the partition members 70, 72, 73 and 74 are preferably provided with securing and supporting flanges along their edges, as indicated in Fig. 9.

The modification illustrated in Figs. 15 and 16 is fundamentally similar to the construction illustrated in Fig. 1. Instead, however, of providing the gas passage through the muffler by means of two looped or rebent plates such as 4 and 5 which are, as illustrated in Fig. 1, perforated in certain areas to provide sound attenuating chambers between the partition members disposed intermediately of such plates, I may prefer to construct the muffler from two principal plates such as 87 and 88 which, of course, are disposed between side plates 89 and 90. The plate 87 is maintained substantially straight until it reaches the point, generally indicated at 91, where it is curved through the sections denoted by 92 and thence continues straight again until it reaches the area within the upper righthand portion of the muffler where it is bent to the form shown so as to provide a plurality of oppositely directed sound attenuating chambers between the side walls of the outer shell.

In a similar fashion, the plate 88 is formed to provide the top closure for the muffler and at its lower end to provide a plurality of oppositely directed sound attenuating chambers in the lower and lefthand side of the muffler, as viewed in Fig. 15. The plates 87 and 88, at their ends, have auxiliary plates 93 and 94 associated therewith, which last-named plates are so formed as to cooperate with the formed ends of the plates 87 and 88 to respectively provide substantially elliptical extensions 95 and 96 to which inlet and outlet conduits may be respectively connected.

It will be understood, of course, that the rebent portions of the strips 87 and 88 which provide the sound attenuating chambers may be provided, along their opposite edges, with laterally extending flanges (not shown), which will facilitate the securing of these portions of the strips to the side plates 89 and 90 and thus generally facilitate assembly.

The strips 87 and 88 are provided with openings or louvers through which limited cross flow between the several gas streams may take place. These openings or louvers may be formed in the strips before the same are bent into shape and if formed in the lines along which it is desired to bend the strips, the forming of such strips will be greatly facilitated.

The construction illustrated in Figs. 15 and 16 provides a continuous unbaffled passage for the gas through the muffler in the directions denoted by the arrows, which stream of gas is bordered on one side throughout the major portion of its travel through the muffler by the outer shell and on its other side by a plurality of sound attenuating chambers. It is believed that in the light of the previous description of the muffler illustrated in Fig. 1, the construction and operation of the muffler illustrated in Figs. 15 and 16 may be understood without a further detailed description.

In connection with the description of Fig. 5, it will be noted that the outer portions of the strips 4 and 5 have been indicated as dished. It is to be understood that this same modification may be applied to all other forms and that such expedient is present in the modification illustrated in Figs. 15 and 16.

In the foregoing description the openings whereby communication is afforded between the gas stream and the sound attenuating chambers and between the several sound attenuating chambers have been referred to as louvers. It is to be understood, however, that such openings may be merely plain openings and not louvers as disclosed and provided with adjacent lips.

In the foregoing description it will be noted several parts, such as strips 4 and 5, have been shown in certain respects continuous and in certain respects discontinuous. It is to be understood, of course, that the principles of my invention are applicable to all forms of constructions regardless of the particular manner in which the muffler is fabricated. In other words, where the several elements have been shown as continuous, they may be made discontinuous from different strips and where they have been shown discontinuous, they may, if desired and expedient, be made continuous.

The modification illustrated in Fig. 17 is characterized by the fact that the inlet opening 97 for the gas is arranged centrally of one end of the muffler, as most clearly illustrated in Fig. 18. The gas entering the muffler through the conduit 98 passes across a gap 99 before entering the central passage 100. The chamber 101 serves as a means for dampening out pressure impulses due to the opening of different exhaust valves in the engine and such impulses are further ironed out due to the fact that the central passage 100 is in communication with sound attenuating chambers on both sides thereof. The construction of the muffler illustrated in Figs. 17 and 18 has a further advantage in that the permissible cross-over of gas from the incoming central stream to the other streams in the muffler is substantially greater than the permissible cross-over of gas flow in constructions such as illustrated in the previous figures. In all principal respects, the construction illustrated in these last-named figures is fundamentally the same as that illustrated in the previous figures, so that a further description of its construction and function is believed unnecessary.

It may be desired to fill the spaces between the main gas passages in the several illustrated forms of my invention with some material such as steel wool or the like, thus combining in one structure the advantages of an absorption-type muffler with my reverse stream muffler. When such material is employed, it is obvious that the partition members such as 12, 35, 74 etc. may be omitted.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the mechanism herein disclosed, provided the means stated by any of the following claims or the equivalent of such stated means be employed.

I therefore particularly point out and distinctly claim as my invention:

1. An exhaust silencer for internal combustion engines and the like comprising a casing including an outer closure shell and inner partitions, at least some of which partitions are perforated, said partitions so arranged relatively to each other and to said shell as to provide a circuitous

passage unobstructed throughout its length for the exhaust gases through said casing, portions of said passage being oppositely extending, said passage throughout the major portion of its extent bordered on one side by said closure shell and on another side by a perforated partition defining a sound attenuating chamber lying between oppositely extending portions of said passage.

2. An exhaust silencer for internal combustion engines and the like comprising a casing including an outer closure shell and inner partitions dividing a portion of the space enclosed by said shell into a plurality of sound attenuating chambers, said partitions so arranged relatively to each other and said shell as to provide a circuitous passage unobstructed throughout its length through said casing, portions of said passage being oppositely extending with the major extent of such passage bordered on one side by said closure shell and on another side by a partition having openings into sound attenuating chambers lying between oppositely extending portions of said passage.

3. An exhaust silencer for internal combustion engines and the like comprising a casing including an outer closure shell and inner perforated partitions dividing a portion of the space enclosed by said shell into a plurality of sound attenuating chambers, said partitions so arranged relatively to each other and said shell as to provide a circuitous passage of substantially uniform cross-sectional area through said casing, portions of said passage being oppositely extending, and said passage throughout the major portion of its extent bordered on one side by said closure shell and on another side by a partition having openings into said sound attenuating chambers lying between oppositely extending portions of said passage.

4. An exhaust silencer for internal combustion engines and the like comprising a casing including an outer closure shell and inner partitions dividing a portion of the space enclosed by said shell into a plurality of sound attenuating chambers, said partitions so arranged relatively to each other and said shell as to provide a continuous circuitous passage unobstructed throughout its length for the exhaust gases through said casing, portions of said passage being oppositely extending, said passage throughout the major portion of its extent bordered on at least one side by a partition having openings into different successively arranged sound attenuating chambers lying between oppositely extending portions of said passage.

5. An exhaust silencer for internal combustion engines and the like comprising a casing including an outer closure shell and inner partitions dividing a portion of the space enclosed by said shell into a plurality of sound attenuating chambers, said partitions so arranged relatively to each other and said shell as to provide a circuitous passage unobstructed throughout its length for the exhaust gases through said casing, portions of said passage being oppositely extending, said passage throughout the major portion of its extent bordered on one side by said closure shell and on another side by a partition having openings into different successively arranged sound attenuating chambers lying between oppositely extending portions of said passage.

6. An exhaust silencer for internal combustion engines and the like comprising a casing includ-

ing an outer closure shell and inner partitions dividing a portion of the space enclosed by said shell into a plurality of sound attenuating chambers, said partitions so arranged relatively to each other and said shell as to provide a continuous circuitous passage unobstructed throughout its length for the exhaust gases through said casing, portions of said passage being oppositely extending, said passage throughout the major portion of its extent bordered on at least one side by a partition having openings into different successively arranged sound attenuating chambers and most of such successive chambers being sequentially different in size lying between oppositely extending portions of said passage.

7. An exhaust silencer for internal combustion engines and the like comprising a casing including an outer closure shell and inner partitions dividing a portion of the space enclosed by said shell into a plurality of sound attenuating chambers, said partitions so arranged relatively to each other and said shell as to provide a circuitous passage unobstructed throughout its length for the exhaust gases through said casing, portions of said passage being oppositely extending, said passage throughout the major portion of its extent bordered on one side by said closure shell and on another side by a partition having openings into different successively arranged sound attenuating chambers and most of such successive chambers being sequentially different in size lying between oppositely extending portions of said passage.

8. An exhaust silencer for internal combustion engines and the like comprising a casing including an outer closure shell and inner partition members dividing a portion of the space enclosed by said shell into a plurality of sound attenuating chambers, said partitions so arranged relatively to each other and said shell as to provide a substantially S-shaped passage for the exhaust gases through said casing, said passage bordered on one side throughout the major portion of its extent by a partition having openings into said attenuating chambers.

9. An exhaust silencer for internal combustion engines and the like comprising a casing including an outer closure shell and inner partition members dividing a portion of the space enclosed by said shell into a plurality of sound attenuating chambers, said partitions so arranged relatively to each other and said shell as to provide a substantially S-shaped passage for the exhaust gases through said casing, said passage bordered on one side throughout the major portion of its extent by said shell.

10. An exhaust silencer for internal combustion engines and the like comprising a casing including an outer closure shell and inner partition members dividing a portion of the space enclosed by said shell into a plurality of sound attenuating chambers, said partitions so arranged relatively to each other and said shell as to provide a substantially S-shaped passage for the exhaust gases through said casing, said passage bordered on one side throughout the major portion of its extent by said shell and on another side by said sound attenuating chambers.

11. An exhaust silencer for internal combustion engines and the like comprising a substantially rectangular casing having flat sides, reversely bent substantially flat strips arranged in substantially parallel relation with respect to each other and normal to said sides whereby a substantially closed chamber is formed provided with an S-shaped continuous unobstructed passage therethrough for the exhaust gases.

12. An exhaust silencer for internal combustion engines comprising a casing including an outer closure shell and inner partition members dividing a portion of the space enclosed by said shell into a plurality of sound attenuating chambers, said partitions and closure shell so arranged as to provide a substantially S-shaped passage for gas flow through the silencer, such passage reversing the direction of gas flow in clockwise and counter-clockwise directions.

13. An exhaust silencer for internal combustion engines and the like comprising a substantially rectangular casing, a plurality of partitions in said casing defining a circuitous passage unobstructed throughout its length for the exhaust gases through said casing, said passage throughout the major portion of its extent being substantially rectangular in cross-section with reversals in direction thereof on smooth curves, and certain of said partitions perforated to permit cross flow between streams of gas flowing in opposite directions.

14. An exhaust silencer for internal combustion engines and the like, comprising a substantially rectangular casing, a plurality of partitions in said casing defining a passage for the exhaust gases through said casing, said passage unobstructed throughout its length, substantially rectangular in cross-section for the major portion of its extent and reversing a plurality of times by means of smooth curves, and certain of said partitions perforated so as to permit limited cross flow between streams of gas flowing in opposite directions.

15. An exhaust silencer for internal combustion engines and the like comprising two substantially parallel sheet members and partitions normally placed therebetween, forming therewith a continuous passage of substantially uniform rectangular cross-section turned and returned upon itself to approximate an S-form, and forming a plurality of chambers positioned laterally of said passage between the turns thereof, and apertures through the walls of said passage whereby compressed gases passing through said passage expand into said chambers.

16. An exhaust silencer for internal combustion engines and the like comprising two substantially parallel sheet members and partitions normally placed therebetween, forming therewith a continuous passage of substantially uniform rectangular cross-section turned and returned upon itself to approximate an S-form, and forming a plurality of chambers positioned laterally of said passage between the turns thereof, and apertures through the walls of said passage whereby compressed gases passing through said passage expand into said chambers, and pass therethrough.

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