March 18, 1941. L. L. HAAS ET AL 2,235,705

MUFFLER

Filed Aug. 29, 1939 4 Sheets-Sheet 1

Fig. 1.

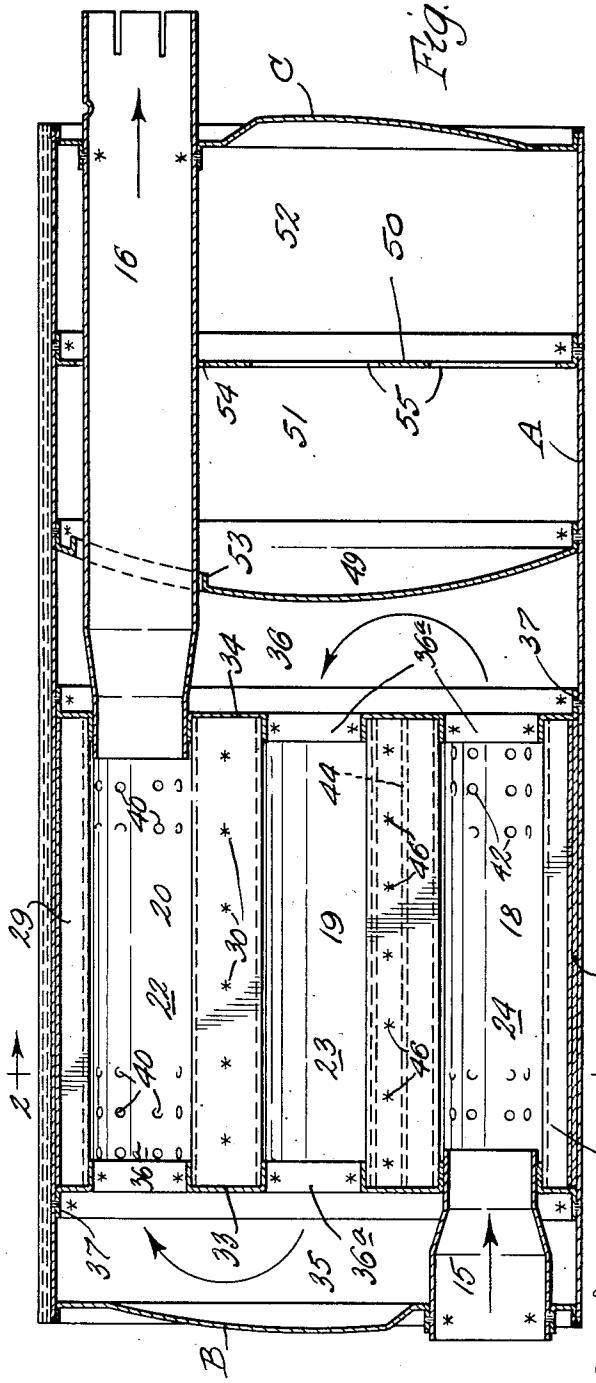
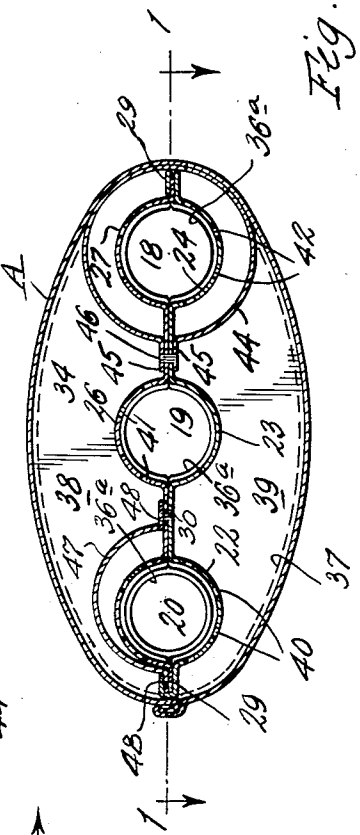


Fig. 2.



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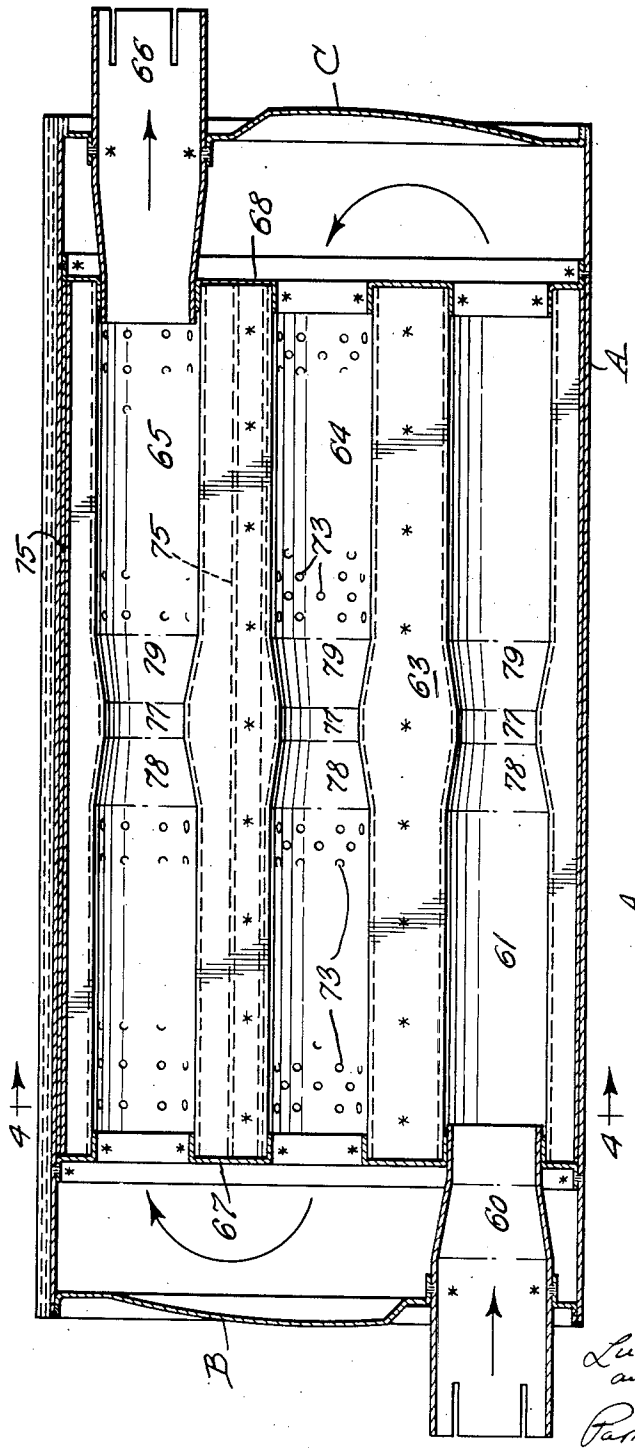


Fig. 3.

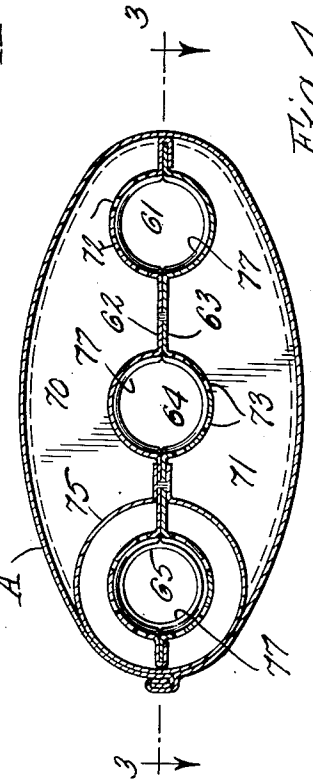


Fig. 4.

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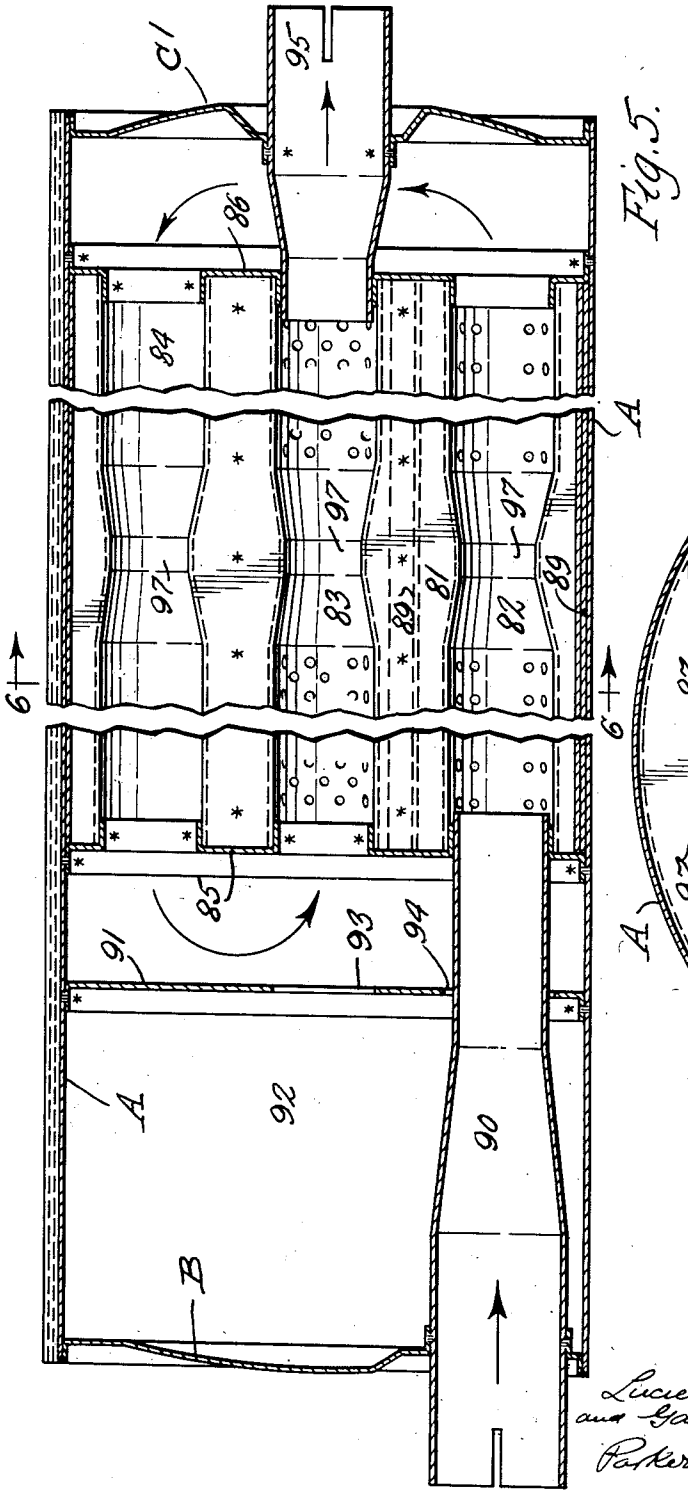


Fig. 5.

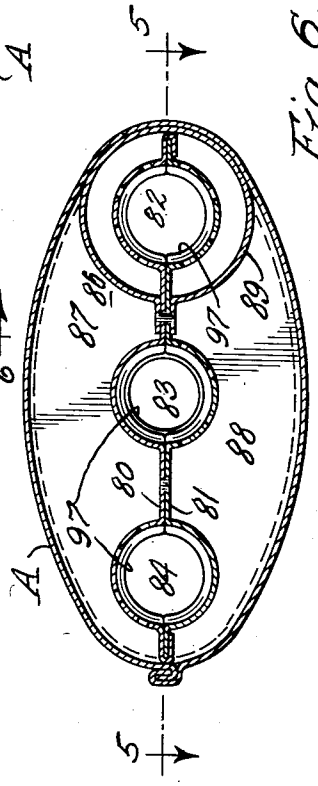


Fig. 6.

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MUFFLER

Filed Aug. 29, 1939 4 Sheets-Sheet 4

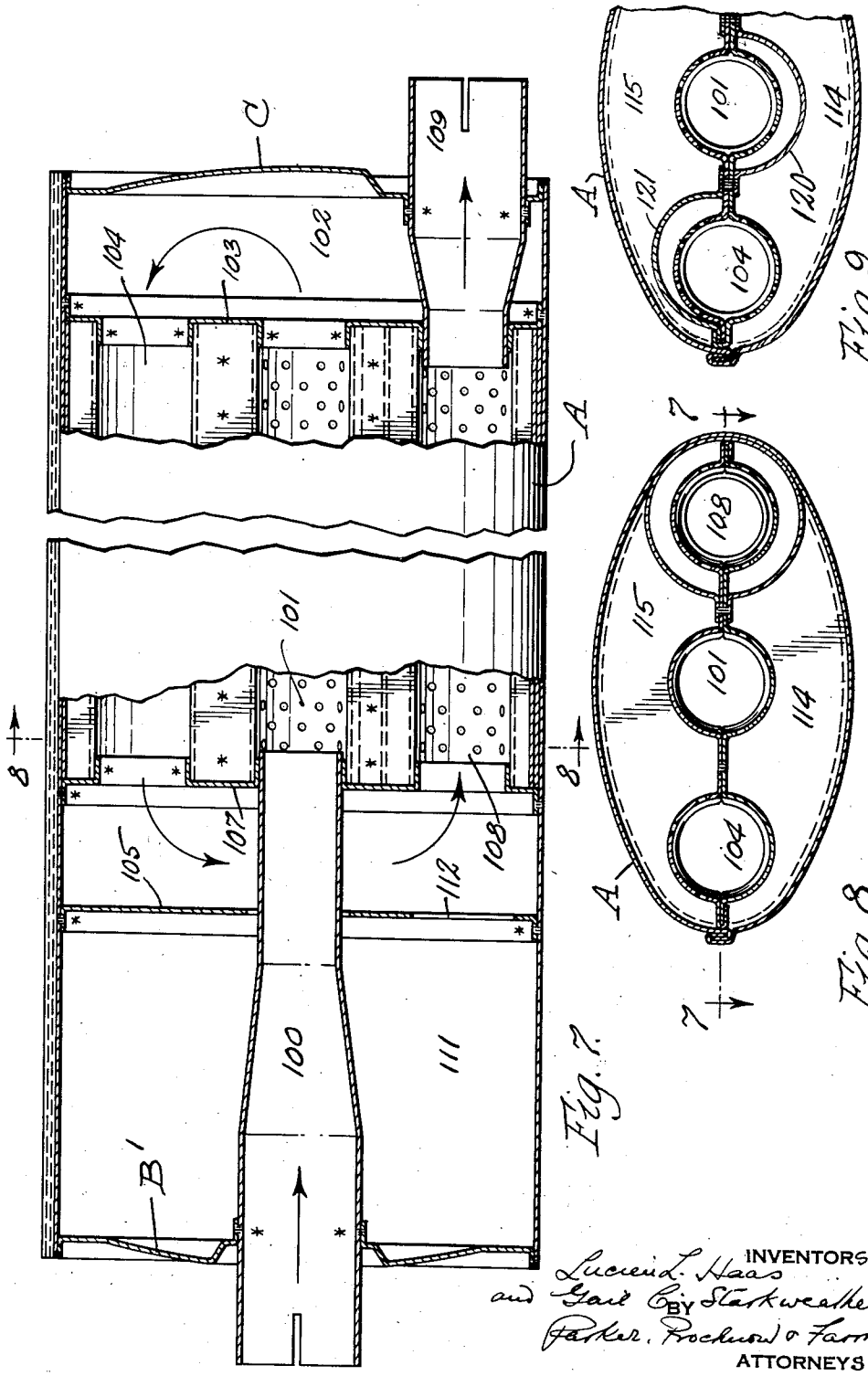


Fig. 7.

Fig. 8.

Fig. 9.

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2,235,705

UNITED STATES PATENT OFFICE

2,235,705

MUFFLER

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Application August 29, 1939, Serial No. 292,460

13 Claims. (Cl. 181—54)

This invention relates to improvements in mufflers or silencers of the type which are commonly employed for silencing the exhaust of internal combustion engines.

One of the objects of this invention is to provide a muffler having a plurality of flow passages of improved construction formed therein. Another object of this invention is to provide a muffler of improved construction for providing in a portion thereof reverse flow passages through which the gases may flow first in one direction and then in another or reverse direction. A further object is to provide an improved reverse flow structure in a muffler which also provides with a shell surrounding the same a silencing chamber. Another object is to provide an improved flow directing member in a muffler which also serves to reinforce against distortion the shell in which the structure is housed.

Another object of this invention is to provide in a muffler a gas flow directing structure which is formed by a pair of sheets having portions thereof secured together and other portions spaced apart to form the flow passages for the gases.

Another object of this invention is to provide a flow directing structure for a muffler formed of a pair of sheets having longitudinal grooved portions formed in each of the sheets, the sheets being secured together so that the grooves of one sheet lie in registration with the grooves of the other sheet to form flow passages for the gases.

Another object is to provide in a flow directing structure of this kind means of improved construction for forming one or more high frequency resonator chambers.

A further object of this invention is to provide a muffler with improved means for forming a bottle neck passage for a resonator chamber.

Other objects of this invention will appear from the following description and claims.

In the accompanying drawings:

Fig. 1 is a longitudinal central sectional view of a muffler embodying this invention, the section being taken on line 1—1, Fig. 2.

Fig. 2 is a transverse sectional elevation thereof, on line 2—2, Fig. 1.

Fig. 3 is a longitudinal central section of a muffler of modified construction, the section being taken on line 3—3, Fig. 4.

Fig. 4 is a transverse sectional elevation thereof, on line 4—4, Fig. 3.

Fig. 5 is a longitudinal central sectional elevation on line 5—5, Fig. 6, of a muffler of another modified form.

Fig. 6 is a transverse sectional elevation thereof, on line 6—6, Fig. 5.

Fig. 7 is a longitudinal central sectional view, on line 7—7, Fig. 8, of still another modified form of muffler embodying this invention.

Fig. 8 is a transverse sectional elevation thereof, on line 8—8, Fig. 7.

Fig. 9 is a fragmentary transverse sectional elevation similar to that shown in Fig. 8 but having two intermediate shells added thereto.

Our improved flow directing structure may be embodied in any suitable or desired type of muffler, and it is understood that our invention is not limited to the particular mufflers shown in the drawings, which merely exemplify certain embodiments of this invention.

The mufflers shown have suitable housings which may, for example, include an outer shell A, which is provided with transverse walls or heads B and C at the opposite ends thereof. In each of the constructions shown, the outer shell A is of elongated or substantially oval or elliptical cross section, but the cross sectional shape of the outer shell may be of any other suitable or desired form. While the shell A constitutes the outer shell in each of the constructions shown, yet it will be obvious that, if desired, additional shells may be arranged about the shell A, if desired.

Referring to the particular muffler shown in Figs. 1 and 2, the head B is provided with a suitable aperture through which an inlet duct 15 extends for conducting gases and sound waves from the exhaust pipe of an engine into the interior of a muffler, and the other head C also has an aperture through which a discharge duct 16 extends, to the outer end of which the usual tail pipe (not shown) may be secured.

The muffler shown in Figs. 1 and 2 is of the reverse flow type and is provided with a structure for directing the flow of gases, which includes a passage or conduit 18 connected with the inlet duct 15 to receive gases therefrom. The gases discharged from the passage or conduit 18 are reversed, as indicated by the arrow and enter into a second passage or conduit 19, in which they flow toward the inlet head B of the muffler, whereupon they are again reversed and pass into a conduit or passage 20 which connects with the discharge duct 16. The flow directing structure which includes the passages 18, 19 and 20 may, according to this invention, be formed of a pair of sheets or stampings of metal or other suitable

material, or if desired, may be formed of a single piece of sheet material bent over on itself to form two opposed sheets. These sheets are secured together at portions thereof and have other portions thereof spaced apart to form the flow passages 18, 19 and 20. Any suitable grooves or depressions may be formed in the sheets or stampings to produce these flow passages and the grooves or depressions may be formed in one or both of the sheets to provide the spaced apart portions thereof. Preferably the flow passages are of approximately cylindrical form, and for this purpose, the two sheets are provided with a series of semi-cylindrical grooves or depressions therein which, when placed oppositely to each other, form substantially cylindrical passages. For this purpose, one of the sheets is provided with semi-cylindrical grooves or depressions 22, 23 and 24, and the other sheet has similar longitudinal grooves or depressions 25, 26 and 27 formed therein. The two sheets when placed in proper registration with each other, form the passage 20 by means of the grooves 22 and 25, while the passages 19 and 18 are formed respectively by the grooves 23, 26 and 24, 27. At their opposite sides, one sheet may be turned over the end of the other sheet to form seams 29 at opposite sides of the sheet and the sheets may also be secured together between grooved portions, for example, by means of welding, as indicated at 30.

In order to complete the flow directing structure, transverse baffles or walls 33 and 34 may be provided at opposite ends of the sheets or stampings. These baffles form chambers 35 and 36 at opposite ends of the flow directing structure and preferably the baffles are also provided with flanged portions 36a which may be formed to extend to a slight distance into each of the flow passages 18, 19 and 20 for securing the sheets in fixed relation to the baffles. The baffles may also have flanges on their outer peripheries which may be welded or otherwise secured to the shell A, as indicated at 37. The baffles, consequently, not only secure the sheets of the flow directing structure in operative relation within the muffler, but also form walls of the chambers or passages 35 and 36, and furthermore, form between them a chamber within the muffler, which may be used for silencing the noise of the exhaust. In the particular construction illustrated, the two grooved plates forming the flow passages extend substantially diametrically completely across this chamber and from one baffle to the other, thus dividing the chamber between the two baffles into two silencing chambers 38 and 39, see Fig. 2. In order to utilize these chambers for silencing the noise of the exhaust, the groove or depression 22 in one of the sheets or stampings is provided with a series of apertures or perforations 40 which may extend throughout the length of this groove, and which may vary in number and in cross sectional area according to the particular silencing effect desired. These perforations communicate with the chamber 39, so that parts of the gas pulsations and sound waves may pass into and out of this chamber through the perforations 40. Consequently, this chamber acts as a resonator or silencing chamber in a manner well known in connection with the silencing of engine exhausts. A similar series of apertures 41 are provided in the groove 26 of the other sheet and communicate with the chamber 38, thus producing further silencing of the exhaust. Since the groove 23, in the construction shown, is imperforate, gases discharged through the perforations 40 cannot pass into the flow passage 19 and also gases discharged through the perforations 41 cannot pass into the flow passage 20. If desired, however, some apertures may be provided in the groove or depression 23, so that a portion of the gases may flow through the chamber 39 from the passage 19 directly to the passage 20.

A resonator chamber may also be provided in connection with the flow passage 18, and for this purpose, in the construction illustrated, an intermediate shell 44 is arranged about the grooves 24 and 27 forming the flow passage 18. In the particular construction shown for this purpose, the shell 44 may, for example, be formed by means of a sheet of metal bent into tubular or cylindrical form with flanges 45 extending outwardly therefrom which may be welded to the two sheets, as indicated at 46, thereby securing these two sheets together, as well as securing the flanges 45 of the intermediate shell to the sheets. The grooves 24 and 27 forming the passage 18 are also perforated so that gases and sound waves may pass through the perforations into the resonator chamber formed by the intermediate shell 44. This resonator chamber, as will be seen in Fig. 2, is divided by the sheets or stampings into two separate semi-cylindrical parts. A shell of this kind also serves the purpose of preventing exhaust gases and sound waves passing through the perforations from the passage 18 from impinging directly against the outer shell A, which in some cases, causes shell noises.

Another type of intermediate shell may be employed in connection with any of the flow passages, to provide a high frequency resonator chamber within either of the chambers 38 and 39 and we have by way of example shown such shell 47 in connection with the flow passage 20. This intermediate shell 47 is of approximately semi-cylindrical form and has flanges 48 along opposite edges thereof, which may be secured to one of the sheets or stampings forming the flow passages 18, 19 and 20. For example, one of the flanges 48 of the intermediate shell 47 may be secured to one of these sheets by means of the same welded connections 30 which also connect the two sheets. The other flange 48 of the intermediate shell 47 may be secured in place by the seam 29 connecting a side of each of the two sheets or stampings. When used in connection with an intermediate shell of this type, the groove 25 is perforated to establish communication between the passage 20 and the high frequency resonator chamber within the shell 47. It will be obvious that a semi-cylindrical shell of this kind may also be employed in connection with the groove 23 to form another resonator chamber, and if desired, the intermediate shell 44 may be replaced by two semi-cylindrical shells similar to the shell 47.

In the particular muffler shown in Fig. 1, a pair of transverse baffles 49 and 50 are provided in the space between the baffle 34 and the end head C. The baffle 49 forms one of the walls of the chamber or passage 36 which serves the purpose of conducting gases from the passage 18 into the passage 19, as indicated by the arrow, and this baffle also forms with the baffle 50 a low frequency resonator chamber 51. Similarly the baffle 50 forms with the head C a resonator or silencing chamber 52. The baffle 49 may have any suitable or desired aperture connecting the

same with the resonator chamber 51, and in the construction shown, the baffle 49 is provided with an aperture of sufficient size so that the discharge duct 16 may pass through the aperture, and this aperture preferably is of sufficient size to provide a space about the duct 16 through which gases and sound waves may enter the chamber 51 from the chamber or passage 36. This construction also has the advantage that the duct 16 and the baffle 49 are spaced apart so that no rattling can occur because of contact between these parts and this enlarged opening also facilitates the assembly of the muffler. This aperture in the baffle 49 may also, if desired, be provided with an annular flange 53 about the discharge duct 16 and spaced therefrom, thus forming an annular passage or bottle neck connecting the reverse flow chamber 36 with the resonator chamber 51. The baffle 50 may also be provided with an enlarged aperture 54 through which the discharge duct 16 extends, and if desired, additional apertures 55 may be provided for establishing communication between the chambers 51 and 52.

It is well known that the action of a resonator chamber may be materially modified by the proportions of a bottle neck communicating with the same, and in order to tune the compound resonator chambers 51 and 52 to cancel the desired sound waves, the flange 53 may be made longer or shorter and the aperture enclosed by the flange 53 may also be varied in diameter so that both the cross sectional area and the length of the bottle neck passage formed by the flange 53 in cooperation with the outer surface of the discharge duct 16 may be varied for the proper tuning of the low frequency resonator chambers 51 and 52. The tubular flange 53 is preferably formed integral with the baffle 49 by bending outwardly a portion of the metal which would otherwise be removed to form the hole in the baffle.

In the operation of this muffler, gas pulsations and sound waves entering the muffler through the inlet duct 15 pass into and through the passage 18, some of the gases and sound waves passing through the apertures in the grooves forming the passage 18 into the chamber formed by the intermediate shell 44 and upon returning from this chamber through the apertures into the passage 18, the returning gas pressure pulsations and sound waves will be out of phase with those in the passage 18, thus producing a silencing and pressure equalizing effect. From the passage 18, the gases enter the chamber 36 and some of the gas pulsations and sound waves entering this chamber will pass through the bottle neck formed by the flange 53 and the low frequency sound waves returning through the bottle neck to the chamber 36 will in part cancel the pressure pulsations and similar sound waves in the chamber 36, thus further reducing noises and equalizing the flow of gas through the passage 19. In this passage, some of the gas pulsations and sound waves will pass through the apertures or perforations 41 into the chamber 38 and then back into the passage 19. This passage discharges into the flow reversing chamber 35 from which the gases pass into the passage 20. Some of these gases and the sound waves carried thereby will pass out of the perforations 40 into the chamber 39 with a flow equalizing and sound reducing effect similar to that already described in connection with the chamber 38. Some gases and sound waves will pass through the apertures in the groove 25 into the high frequency resonator chamber formed by the shell 47 for further silencing of the exhaust. The gases finally pass from the passage 20 to the discharge duct 16.

It will be noted that this muffler provides a relatively large number of silencing chambers by the use of comparatively few parts, and consequently, a very effective silencing of exhaust gases results from the use of the minimum of material.

In the construction shown in Figs. 3 and 4, the gases enter the muffler through an inlet duct 60 extending through the head B and pass into a passage 61 formed between a pair of plates 62 and 63, which are grooved, as described in connection with Figs. 1 and 2 to provide the passage 61 and additional passages 64 and 65, the passage 65 being connected with a discharge duct 66. The two grooved sheets 62 and 63 are provided with transverse baffles 67 and 68 at the opposite ends thereof, which form with the heads B and C chambers or passages for reversing the flow of gases.

The grooved sheets 62 and 63 extend diametrically across the space within the shell A and form therewith chambers 70 and 71, the passage 61 being provided at one side thereof with perforations 72 communicating with the chamber 70, and the passage 64 being provided at the other side thereof with perforations 73, communicating with the chamber 71. The silencing action of these chambers upon the gases passing through the passages 61 and 64 is similar to that explained in connection with Figs. 1 and 2. 75 represents an intermediate shell similar to the shell 44 shown in Figs. 1 and 2, except that the intermediate shell 75 is arranged about the passage 65 which communicates with the discharge duct 66.

The flow directing structure embodying this invention comprising the grooved sheets or stampings secured to each other lends itself particularly to the formation of restrictions in the passages formed by the grooves of the sheets. These restrictions cooperate with surrounding resonator chambers to produce an improved silencing of the exhaust. It is, of course, easily possible to form the grooves in the sheets 62 and 63 so as to provide any desired shape of the passages formed by these grooves. Consequently, we have provided in each of the three passages 61, 64 and 65 restricted portions 77, those shown preferably having tapering or substantially frusto-conical parts 78 and 79 leading to the restrictions 77. These restrictions operate in the same manner as the restrictions disclosed in our Patents Nos. 2,047,442 and 2,047,443. The diameters of the restricted parts 77 may be reduced to any desired extent relatively to the diameters of the passages 61, 64 and 65 and the restrictions serve to cause a larger flow of gases out of the perforations located ahead of the restrictions, and these gases will flow lengthwise of the resonator chambers 70 and 71 or the resonator chamber formed within the intermediate shell 75, and then back into the conduit or passage through perforations located rearwardly or down stream relatively to the restrictions 77. By causing portions of the gas pulsations and sound waves to travel in the chambers through greater distances than the main flow of gases through the passages 61, 64, and 65, the gas pulsations and sound waves returning from the resonator chambers into the flow passages will be out of phase with those portions of the gases and sound waves which flow

straight through these passages, thus resulting in very effective silencing of noises of the exhaust. Restrictions similar to those illustrated in Figs. 2 and 3 may, of course, be used in connection with the muffler shown in Fig. 1, if desired.

In Figs. 5 and 6 is shown another modified form of muffler provided with a reverse flow unit similar to that described in connection with Figs. 3 and 4, this unit comprising a pair of grooved sheets or stampings 80 and 81 forming passages 82, 83 and 84, the two sheets being arranged between transverse baffles 85 and 86. This arrangement of the reverse flow structure, consequently, provides silencing chambers 87 and 88 at opposite sides of the two sheets. The silencing chamber 87 receives a portion of the gas pulsations and sound waves from the reverse flow passage 84 due to perforations in one wall of this passage, and the chamber 88 similarly receives gas pulsations and sound waves from the middle passage 83. In this construction, an intermediate shell 89 is provided about the passage 82 which receives gases entering the muffler through a duct 90 extending throgh the head B.

In this construction, an additional baffle 91 is employed which forms with the baffle 85 a passage or chamber through which gases may flow from one of the longitudinal passages 84 of the reverse flow structure to the passage 83 thereof. The baffle 91 also forms with the head B a low frequency resonator chamber 92, the baffle being provided with an opening or hole 93 through which gas pulsations and sound waves may enter the resonator chamber 92. Preferably the baffle 91 is also provided with an aperture or hole 94 through which the inlet duct 90 extends, and this hole may be made somewhat larger than the external diameter of the inlet duct to provide an an additional opening through which gas pulsations and sound waves may enter the chamber 92 and also to provide ample clearance about the duct 90 to prevent rattling and facilitate assembly of the muffler.

In the particular construction shown in Figs. 5 and 6, the muffler is provided at the discharge end thereof with a head C' provided with a central aperture through which a discharge duct 95 extends and to which it is secured. The inner end of this duct, consequently, communicates with the middle discharge passage 83 of the reverse flow structure.

In the muffler shown in Figs. 5 and 6, the passages 82, 83 and 84 are provided with restrictions 97 similar to the restrictions 77 described in connection with Fig. 3, but if desired, these restrictions may be omitted from the reverse flow structure.

In the operation of this muffler, gases entering the muffler through the duct 90 pass through the passage 82, some of the gases and sound waves passing through the perforated walls thereof into and out of the resonator chamber formed by the intermediate shell 89. The gases and sound waves discharged from the passage 82 enter the space between the baffle 86 and the end head C' and pass into the passage 84 of the reverse flow structure, some of them passing through the perforations of a wall of this passage into and out of the chamber 87, and in passing out of the chamber 84, they enter the space between the baffles 85 and 91. Some of the gas pulsations and sound waves will enter the chamber 92, while another portion of the gas pulsations and sound waves enter directly into the passage 83. The gases and sound waves from the chamber 92 upon discharging through the aperture 93 entering into the passage 83 will, consequently, be out of phase with gases and sound waves which pass directly into the passage 83, thus producing additional silencing of low frequency sound waves and materially reducing the amplitude of the pressure pulsations in the passage 83. From this passage, the gases and sound waves pass through the discharge duct 95 out of the muffler, some of the gases first passing through the perforations in a wall of the passage 83 into and out of the chamber 88.

In the construction shown in Figs. 7 and 8, the muffler is provided with an inlet head B' having a central aperture through which an inlet duct 100 passes. This duct discharges the gases and sound waves into a central passage 101 formed by means of a pair of grooved sheets or stampings as described in connection with the other figures. The gases and sound waves discharged from the passage 101 enter into a transverse chamber or passage 102 formed between a baffle 103 of the reverse flow structure and the end head C of the muffler, and then enter the passage 104 in which the gases flow in the reverse direction. From the passage 104, the gases enter into a transverse passage or chamber formed between baffles 105 and 107. From this chamber or passage, the gases enter the discharge passage 108 of the reverse flow structure, and then to the discharge duct 109 of the muffler. The passages 101, 104 and 108 may be either of approximately cylindrical form, as shown in Fig. 1, or they may be provided with restrictions, as shown in Figs. 3 and 5.

The baffle 105 forms with the inlet head B', a resonator chamber 111 into which gases may enter through an aperture 112 in the baffle 105. The two sheets or stampings forming the passages 101, 104 and 108 also divide the space between the two baffles 103 and 107 into two silencing or resonator chambers 114 and 115, Fig. 8, which cooperate with the passages 101 and 108 respectively in a manner similar to that described in connection with the other figures. The operation of this muffler is similar to that described in Figs. 5 and 6, and differs therefrom mainly in providing for a centrally arranged inlet duct and a discharge duct at one side of the muffler. These various arrangements are necessary to enable the mufflers to be applied to automobiles of different makes, in which the exhaust pipes and tail pipes are so arranged as to require different arrangements of the inlet and discharge ducts of the mufflers.

In Fig. 9, we have shown in section a modification of the construction shown in Figs. 7 and 8. In this modification, a pair of substantially semi-cylindrical intermediate shells 120 and 121 are provided, these shells being similar in construction to the shell 47 shown in Fig. 2. Each of the passages 101 and 104 is provided with perforations in both of the grooves forming these passages, so that gases and sound waves from the passage 101 may enter into the intermediate chamber formed by the shell 120 as well as into the larger chamber 115. Gases and sound waves from the reverse flow passage 104 enter into the chamber formed by the shell 121, as well as into the larger chamber 114.

While we have shown in each of the figures, an arrangement according to which the two sheets or stampings of the reverse flow structure extend completely across the chamber in which they are contained, so as to divide the chamber

into two separate parts, it will be obvious that, if desired, the enclosing shell A may be made larger, or the sheets, or stampings may be made of smaller dimensions transversely of the muffler so that they do not extend completely across the space between the transverse baffles of the reverse flow structure, so that only a single chamber is formed about the sheets or stampings. Such construction may be desired under certain conditions. While we have shown in each of the drawings, a reverse flow structure having three separate passages for the gases, it will be obvious that these sheets may be formed to provide only two passages or more than three passages for the gases and sound waves. It will also be obvious that our improved construction lends itself readily to producing passages of tapering form between the two sheets, it being merely necessary to provide grooves in the two sheets corresponding to the form of passage desired.

The reverse flow construction described in connection with the mufflers shown in the drawings has the advantage that the three passages of the reverse flow structure can be simply and inexpensively formed by means of two sheets or stampings suitably shaped to form the passages and secured together. Furthermore, these two sheets in addition to forming the three passages also divide the space between the two transverse baffles of the reverse flow structure into two separate silencing chambers. Consequently, by the use of only four parts, two sheets and two baffles, the three passages for the exhaust gases and two silencing chambers therefor can be formed. Since any or all of the passages of the reverse flow structure can readily be formed so as to receive at either end the inlet and discharge ducts, it will be obvious that the reverse flow structure may be readily adapted to cooperate with any arrangements of these ducts that may be desired. The reverse flow structure may readily be positioned in any portion of the muffler, so that any desired arrangement of additional silencing chambers may be used in connection with a reverse flow structure.

By means of intermediate shells which form smaller chambers within the larger chambers of the reverse flow structure, a large variety of silencing effects can be obtained. The intermediate shells, whether the same are of cylindrical or semi-cylindrical form can be easily applied to the grooved sheets forming the flow passages by means of the same welding or seaming operations employed in forming this flow structure, and consequently, add very little to the cost of the muffler.

Our reverse flow structure, while it may be used in connection with an outer or enclosing shell of any suitable or desired form, has an added advantage when used with a non-circular type of shell such, for example, as shown in the accompanying drawings, in that the reverse flow structure reinforces this shell against distortion. It is well known that, in the event of explosions of gases in the muffler, a shell of elliptical cross section will tend to assume a circular cross section. The reverse flow structure herein disclosed materially reinforces the enclosing shell against such distortion by forming a relatively rigid brace across the major diameter of the elliptical or oval cross section. The muffler described is also economical to manufacture for the reason that the end heads or transverse partitions B and C in all of the various figures may be identical, but merely differently positioned in the respective ends of the muffler, so that by different arrangements of the end walls relatively to each other, and by the provision of an end wall or head having a central aperture, various types of mufflers can be constructed to suit different conditions encountered with various makes of automobiles with reference to the positions of the exhaust and tail pipes.

We claim as our invention:

1. A muffler having a reverse flow structure formed by a shell, a pair of transverse baffles forming with said shell a chamber, and a pair of metal sheets arranged in said chamber and secured together and provided with longitudinal grooves forming between said sheets passages for the gases, said sheets having their opposite sides extending to said shell to divide said chamber into two separated parts, said sheets being provided with perforations in grooved portions thereof establishing communication between said passages and said chamber, said baffles having openings communicating with said passages.

2. A muffler having a reverse flow structure formed by a shell, a pair of transverse baffles forming with said shell a chamber, and a pair of metal sheets arranged in said chamber and secured together and provided with longitudinal grooves forming between said sheets passages for the gases, said sheets being secured at their ends to said baffles and having their opposite sides extending to said shell to divide said chamber into two parts, said sheets being provided with perforations in grooved portions thereof establishing communication between said passages and said chamber, said baffles having openings communicating with said passages.

3. A muffler having a reverse flow structure formed by a shell, a pair of transverse baffles forming with said shell a chamber, a pair of metal sheets arranged in said chamber and secured together and provided with longitudinal grooves forming between said sheets passages for the gases, said sheets being secured at their ends to said baffles and having their opposite sides extending to said shell to divide said chamber into two parts, said sheets being provided with perforations in grooved portions thereof establishing communication between said passages and said chamber, said baffles having openings communicating with said passages, and means arranged beyond said baffles for conducting gases from one passage to another.

4. A muffler having a reverse flow structure formed by a shell, a pair of transverse baffles forming with said shell a chamber, a pair of metal sheets arranged in said chamber and secured together and provided with longitudinal grooves forming between said sheets passages for the gases, said sheets being secured at their ends to said baffles and having their opposite sides extending to said shell to divide said chamber into two parts, said sheets being provided with perforations in grooved portions thereof establishing communication between said passages and said chamber, said baffles having openings communicating with said passages, means arranged beyond said baffles for conducting gases from one passage to another, means for conducting gases to one of said passages, and means for conducting gases out of said reverse flow structure from another of said passages.

5. In a muffler, the combination of a shell and a pair of transverse walls forming therewith a chamber, and a gas conducting structure formed in said chamber and comprising a pair of metal

sheets arranged lengthwise in said chamber, at least one of said sheets having longitudinal depressions formed therein which form passages between said sheets, portions of at least one of said sheets forming a wall of a passage having perforations through which gases may pass into and out of said chamber, said transverse walls having openings connecting with some of said passages, some of said longitudinal depressions having transversely extending portions of less depth than the main portions thereof to increase the quantity of gas flowing through said perforations.

6. A muffler having a shell and a pair of walls extending transversely of and connected with said shell and forming therewith a chamber, and means for conducting gases through said chamber including a pair of metal sheets having portions thereof secured together and other portions thereof grooved to form flow passages between said sheets, said last mentioned portions of said sheets being provided with perforations through which gases may pass into and out of said chamber, a portion of at least one of said grooves between perforations being of less depth than the main portion thereof to produce a portion of smaller cross sectional area in the passage formed by such groove to cause a larger quantity of gas to flow into and out of said perforations, said transverse walls having openings therein connecting with said flow passages.

7. A muffler having a shell and a pair of walls extending transversely of and connected with said shell and forming therewith a chamber, and means for conducting gases through said chamber including a pair of sheets having portions thereof secured together and other portions thereof grooved lengthwise thereof to form flow passages, said transverse walls having openings therein connecting with said flow passages, at least one of said sheets having perforations in the portions thereof spaced from the other sheet through which gases may flow into and out of said passages into the space in said chamber, some of said grooved portions having transverse zones thereof of less depth than the main grooved portions to provide a restriction in a passage to increase the flow of gas through said perforations.

8. A flow directing structure for a muffler comprising a shell, a pair of transverse walls secured to said shell, and a pair of sheets extending from one of said walls to the other end having its sides terminating at said shell and having portions thereof spaced from said shell to form with said shell a pair of chambers, parts of said sheets being secured together and other portions thereof being spaced apart to form flow passages between said sheets, said walls having apertures communicating with said passages, a portion of one of said sheets forming a wall of one of said passages having perforations communicating with one of said chambers for permitting gases to flow therethrough into and out of said chamber, and a portion of said other shell forming a wall of another passage having perforations communicating with the other of said chambers for permiting gases from said last mentioned passage to flow into and out of said last mentioned chamber.

9. A muffler having a flow structure formed by a shell, a pair of transverse walls forming a chamber with said shell, a pair of metal sheets arranged between said walls and secured together, at least one of said sheets having grooves formed lengthwise therein which form between said sheets passages for the gases, means for conducting gases to and from said structure into said passages, and an intermediate half shell arranged in said chamber about a part of a passage and having its longitudinal edges secured to one of said sheets, a wall of said passage having perforations through which gases may pass into and out of the space within said intermediate shell.

10. A flow directing structure for a muffler comprising a shell, a pair of transverse walls secured to said shell, and a pair of metal sheets extending from one of said walls to the other end having its sides terminating at said shell and having portions thereof spaced from said shell to form with said shell a pair of chambers, parts of said sheets being secured together and other portions thereof being spaced apart to form flow passages between said sheets, said walls having apertures communicating with said passages, a portion of one of said sheets forming a wall of one of said passages having perforations communicating with one of said chambers for permitting gases to flow therethrough into and out of said chamber, a portion of said other sheet forming a wall of another passage having perforations communicating with the other of said chambers for permitting gases from said last mentioned passage to flow into and out of said last mentioned chamber, and an intermediate shell arranged within said first mentioned shell about a third passage formed by said sheets and forming therewith a silencing chamber, portions of said sheets forming said third passage being perforated to permit gases to pass into and out of the space within said intermediate shell.

11. A muffler having a flow structure formed by a shell, a pair of transverse walls forming a chamber with said shell, a pair of sheets arranged between said walls and secured together, at least one of said sheets having grooves formed lengthwise therein which form between said sheets passages for the gases, means for conducting gases to and from said structure into said passages, and a substantially semi-cylindrical shell secured to one of said sheets about a portion thereof forming a wall of a passage and forming with said sheet a silencing chamber, said portion of a sheet having perforations communicating with said chamber.

12. A muffler having a reverse flow structure formed by a shell, a pair of transverse baffles forming with said shell a chamber, and a pair of sheets arranged in said chamber and secured together and provided with longitudinal grooves forming between said sheets passages for the gases, said sheets having their opposite sides extending to said shell to divide said chamber into two separated parts, said sheets being provided with perforations in grooved portions thereof establishing communication between said passages and said chamber, the perforations of one passage communicating with one part of said chamber and the perforations of another passage communicating with the other part of said chamber, and means for conducting gases to flow in succession from one of said passages to another.

13. A muffler having a flow structure formed by a shell, a pair of transverse walls forming a chamber with said shell, a pair of metal sheets arranged between said walls and secured together, at least one of said sheets having grooves formed lengthwise therein which form between said sheets passages for the gases, means for conduct-

ing gases to and from said structure into said passages, and a substantially cylindrical longitudinally split intermediate shell extending about a longitudinal edge of said sheets and about a groove adjacent to said edge and having its longitudinal edges at said split secured to said sheets, at least one of said sheets at said groove having perforations through which gases may pass into and out of the space between said intermediate shell and said sheets.

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