

March 26, 1940.

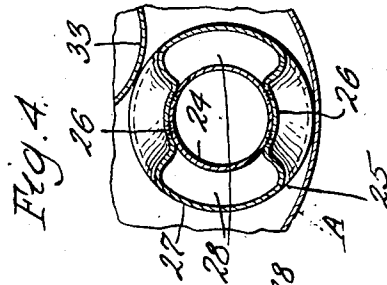
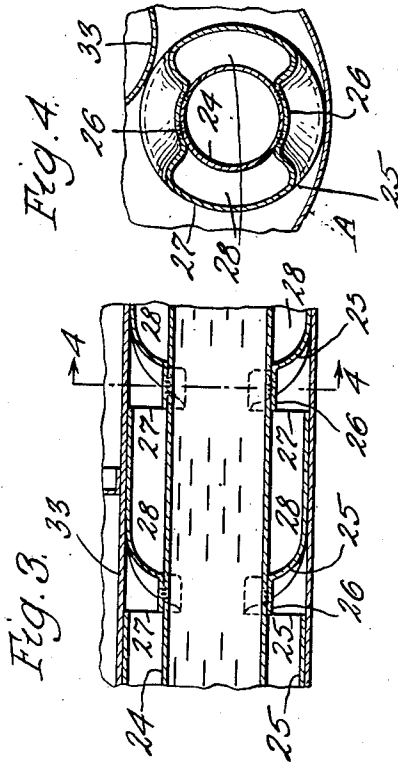
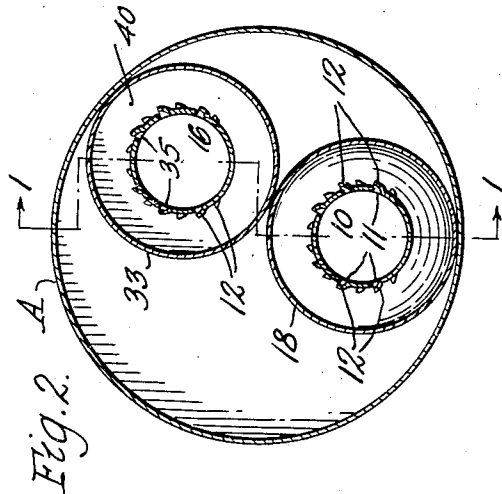
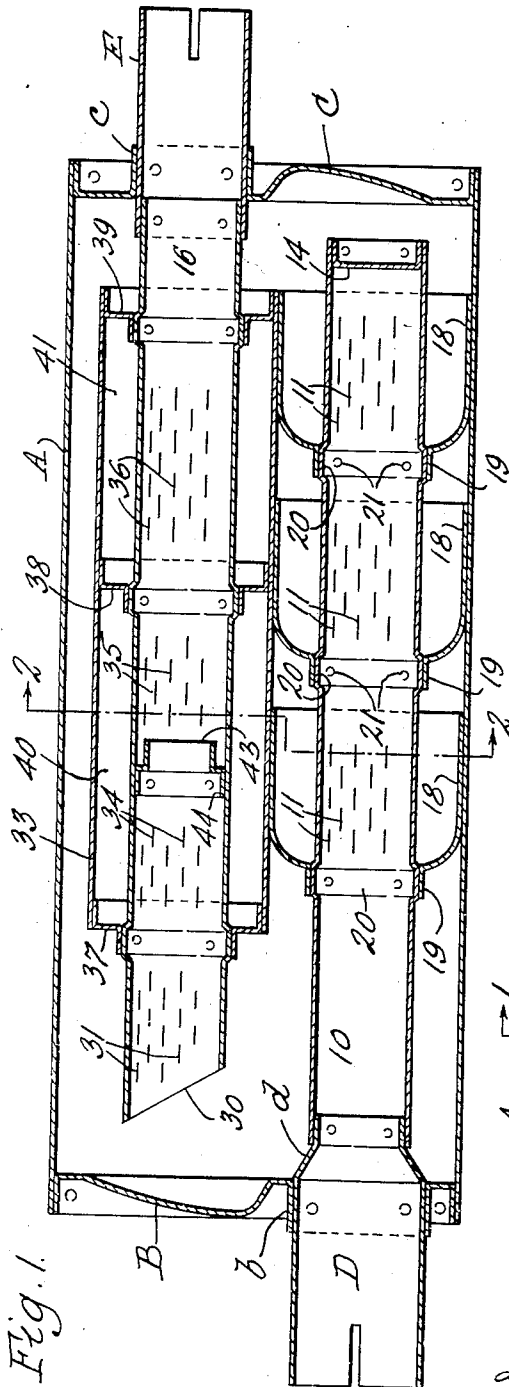
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2,194,550

MUFFLER

Filed June 23, 1937

3 Sheets-Sheet 1



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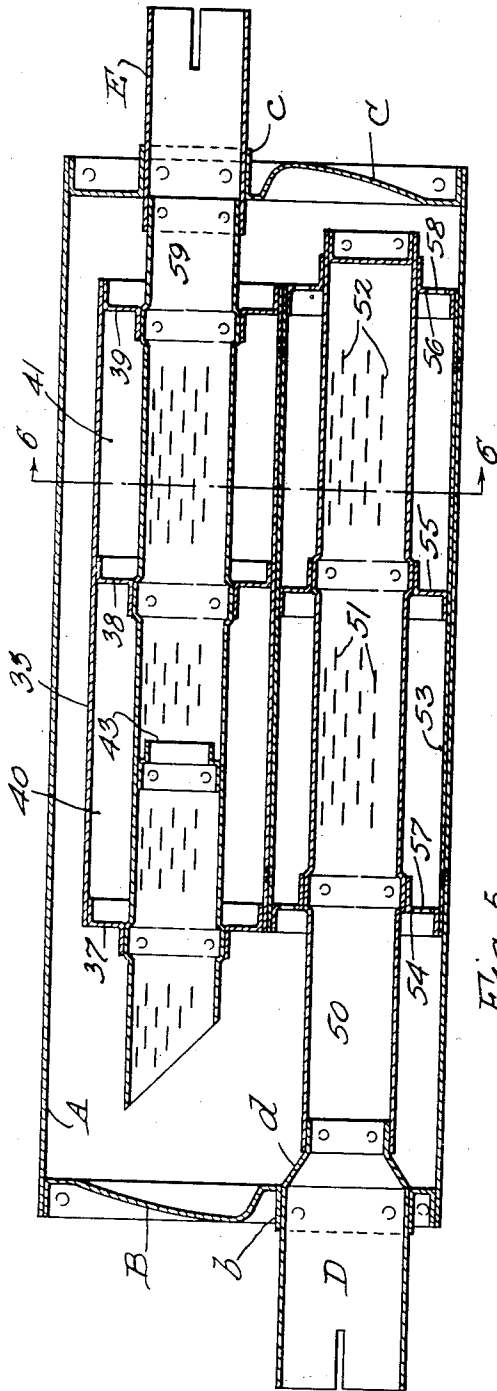


Fig. 5.

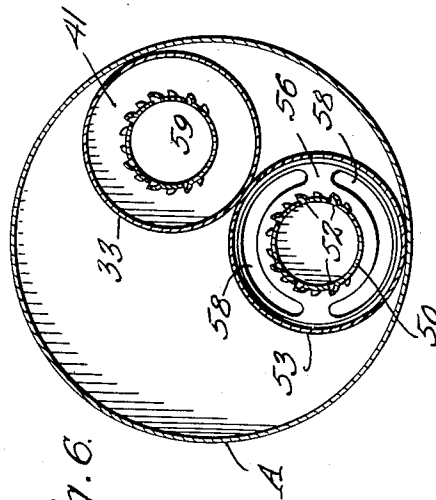


Fig. 6.

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Fig. 7.

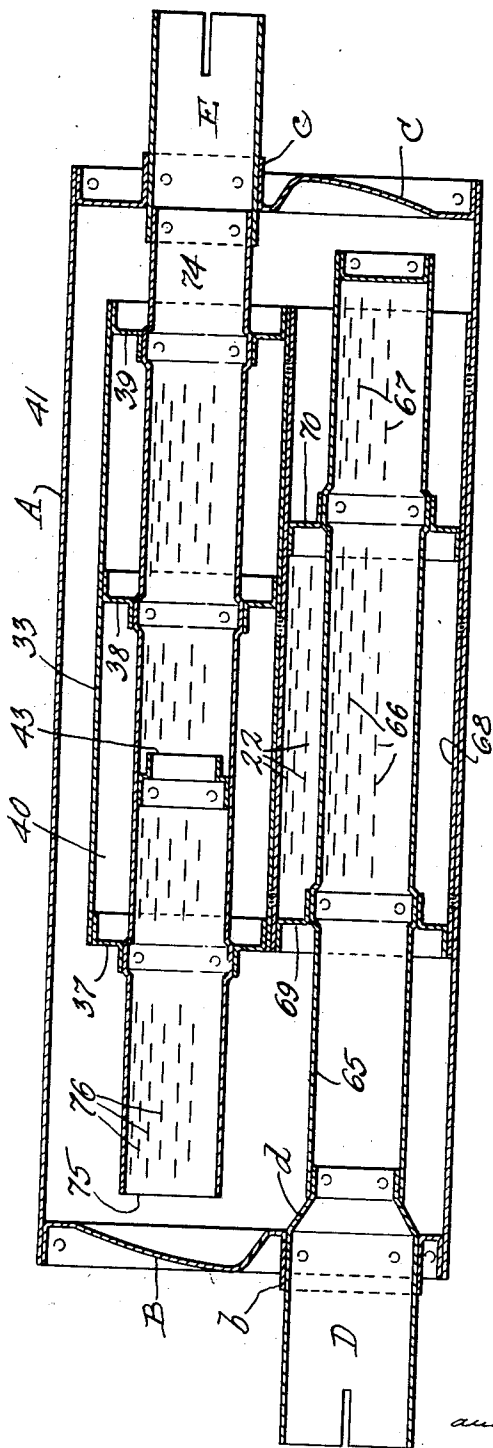
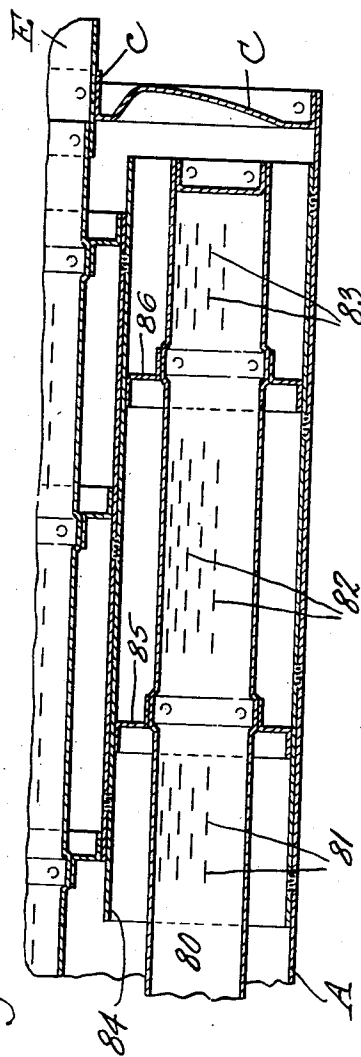


Fig. 8.



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UNITED STATES PATENT OFFICE

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MUFFLER

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Application June 23, 1937, Serial No. 149,900

17 Claims. (Cl. 181—54)

This invention relates to improvements in mufflers or silencers of the kind commonly used in connection with the silencing of the exhaust of internal combustion engines.

5 One of the objects of this invention is to provide a muffler of the reverse flow type of improved construction in which gas pressure pulses are broken up into a plurality of parts out of phase with each other for the purpose of equalizing the flow of gas through the muffler. It is also
10 an object of this invention to provide a muffler of this kind in which the gases are discharged into the muffler housing at different portions of the housing so that gas pressure pulses entering the housing are broken up into a plurality of parts
15 which travel through different distances in the housing to a discharge conduit.

Another object of this invention is to provide a muffler with a housing having inlet and discharge conduits extending into the same and having the inlet conduit provided with discharge openings located at intervals lengthwise thereof and also having the discharge conduit provided with a receiving opening for gases from the chamber which is located at different distances from the openings in the inlet conduit. It is also
20 an object of this invention to provide a muffler in which the inlet duct is provided with openings at intervals lengthwise thereof and in which a discharge conduit is provided having a high frequency acoustic chamber associated therewith. Another object of the invention is to provide a
25 muffler with a relatively large expansion and equalizing chamber into which gases are discharged at different points lengthwise thereof and from which gases are discharged at a point located at different distances from the points of entrance to the chamber, to even out the rate of fluctuation of pressure as rapidly as possible with
30 the minimum of turbulence.

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

In the accompanying drawings:

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

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

50 Fig. 3 is a fragmentary longitudinal sectional view of a muffler of slightly modified construction, the section being taken through the inlet conduit of the muffler.

Fig. 4 is a fragmentary transverse section
55 thereof, on line 4—4, Fig. 3.

Fig. 5 is a longitudinal sectional view of a muffler of modified construction.

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

Fig. 7 is a longitudinal sectional view of the
5 muffler of still another modified form.

Fig. 8 is a fragmentary longitudinal sectional view of a muffler of still another modified form, the section being taken mainly through the inlet unit of the muffler.

The muffler is provided with a housing which may be of any suitable or desired form, that shown as employed on all of the mufflers illustrated, including an outer shell A and inlet and discharge heads B and C, the inlet head being
10 provided with a flanged inlet opening b and the discharge head being provided with a similar discharge opening c. In all of the mufflers shown, D represents a duct suitably secured to the flange surrounding the inlet opening and to which an
15 exhaust pipe (not shown) of an engine may be connected and E represents a duct suitably secured to the flange surrounding the discharge opening of the housing and to which the usual
20 tail pipe (not shown) may be connected. In all of the forms shown, the inlet duct D extends into the interior of the housing and is contracted or reduced in diameter, as shown at d for connection with an inlet conduit within the muffler. All of these parts are commonly used in mufflers
25 and of themselves constitute no part of this invention and may obviously be of any other suitable construction.

Referring to Figs. 1 and 2, 10 represents an inlet conduit which is provided with perforations
35 11 extending throughout a substantial part of the length of the inlet conduit. These perforations may be of any suitable or desired form, for example, in the form of longitudinal slits formed in the conduit 10 and having a portion of the
40 metal at one side of each slit forced away from the surface of the conduit, for example, outwardly as clearly shown in Fig. 2, to form a louver 12 for each opening or perforation. One end of the conduit 10 is connected with the inlet of the
45 muffler housing, for example, by securing the same about the reduced part d of the duct D, and the other end of the conduit is preferably closed by means of a suitable cap or flanged disk 14, or any other means for closing or partly closing the
50 end of the inlet conduit may be employed.

16 represents a discharge conduit which is connected at one end with the discharge duct E of the muffler and which extends into the housing of the muffler preferably substantially parallel to 55

the inlet duct 10. The other end of the discharge conduit is open to receive gases from the interior of the housing of the muffler and preferably this open end of the discharge conduit is arranged near the front or inlet end of the muffler housing.

We have found that by discharging a gas pressure pulse entering the inlet conduit 10 at different distances lengthwise of the conduit, and consequently, at different distances from the open end of the discharge conduit 16, a decided equalizing of the flow of gases through the discharge conduit and tail pipe of the muffler results. Consequently, by arranging the perforations 11 in groups at different distances lengthwise of the inlet conduit, the gases discharged from the group of perforations nearest to the open end of the discharge conduit 16 will obviously reach the receiving end of the discharge conduit sooner than those parts of the pressure pulse which are discharged through another group of perforations farther removed from the receiving end of the discharge conduit 16. Consequently, by means of this arrangement, a gas pressure pulse entering the inlet conduit 10 may be divided into as many different parts as there are discharge openings or perforations disposed at different distances from the inlet end of the discharge duct 16 and these several parts of each pressure pulse will, consequently, pass through the discharge conduit 16 out of phase with each other. This results in a decided equalizing of the flow of gas through the discharge conduit, which in turn results in less resistance to the flow of gas through the discharge conduit, and consequently, in less back pressure in the muffler. By providing the housing of the muffler with a volume materially greater than the combined volume of the inlet and discharge ducts, a further equalizing of the flow of gas in the discharge conduit 16 results and also this chamber serves to reduce the intensity of sound waves, particularly those of low frequency.

While a muffler as thus far described has features of superiority over mufflers heretofore constructed, yet certain refinements of this construction may be incorporated in the muffler, if desired. For example, it has been found that if the gases discharged through the openings or apertures in the inlet conduit impinge directly against the muffler housing, certain shell noises result which, however, can be readily avoided by arranging about the openings or apertures in the inlet conduit suitable sheet metal members or parts in such a manner that the gases discharged through the openings or apertures will impinge against these sheet metal members. Intermediate shells of various types may be provided for this purpose, and in the construction shown in Figs. 1 and 2, the intermediate shell surrounding the apertures or openings in the inlet conduit 10 is in the form of a plurality of short cylindrical members or shell parts 18, each of which has a contracted portion or sleeve 19. When outwardly extending louvers 12 are used on the inlet conduit, the conduit is preferably also provided with annular outwardly extending beads or portions 20 to which the contracted portions 19 of the intermediate shell members 18 may be secured so that the portions 19 may, during the assembly of the muffler, be slid lengthwise of the conduit 10 over the outer edges of the louvers 12. The shell parts 18 may be secured to the conduit 10 in any suitable manner, for example, by means of welding, as indicated at 21.

It will be noted that by means of the construction described, one end of each of the shell parts 18 opens into the interior of the muffler housing, and consequently, gases and sound waves discharged through a group of openings or perforations in the inlet conduit 10 will be discharged into the interior of the housing through an open end of the corresponding shell part 18 and similar gases discharged through other groups of openings or perforations in the conduit 10 will be discharged through the open ends of the other shell parts 18 at intervals lengthwise of the conduit 10. Consequently, a pressure pulse entering the muffler will, by means of the construction shown in Fig. 1, be broken up into three separate pulses which are discharged into the interior of the housing of the muffler at different distances from the open end of the discharge conduit 16 and will, consequently, enter this conduit in the form of three separate and reduced pressure pulsations, all out of phase with each other. Furthermore, because of the relatively large volume of the interior of the muffler housing, which causes this housing to act as an expansion and equalizing chamber, the parts of the pressure pulsations entering the discharge conduit 16 will be very much reduced in intensity as compared with the parts of such pressure pulsations which pass through the open ends of the shell parts 18.

In Figs. 3 and 4, we have shown a modified construction of the inlet unit of the muffler in which the perforate portions of the inner conduit 24 are enclosed by an intermediate shell 25 of single piece construction in which portions of the intermediate shell are provided with arcuate slits and in which portions 26 of the intermediate shell at one side of the slits are bent or pressed in contact with the conduit 24 and suitably welded or otherwise secured thereto, thus leaving the portions 27 at the other sides of the slits open to discharge gases into the interior of the muffler housing. This construction also forms openings 28 between the depressed portions 26 so that gases discharged through a group of perforations in the conduit 24 may pass either in one direction through the open end 27 of a part of the intermediate shell, or in the other direction through the channels 28. In this manner, a further splitting up of the gas pulses results and the intermediate shell may be made of a single cylindrical piece. In this construction, as well as the one shown in Figs. 1 and 2, the intermediate shell parts about the perforations cause the gases discharged through the perforations to impinge therewith and thus avoid the shell noises which would otherwise result.

As shown in Fig. 1, the inner open end of the discharge conduit 16 is cut at an angle, thus forming an open end 30 of larger cross sectional area than if the conduit were cut perpendicular to its length. This facilitates the entrance of gas into the conduit. Furthermore, the conduit is preferably, though not necessarily, provided near the open end thereof with a group of perforations or openings 31 through which gases and sound waves may pass from the interior of the muffler housing. These perforations have the advantage of providing an entrance into the discharge conduit of materially greater combined cross sectional area than that of the conduit, and this reduces the resistance to the flow of gases into the discharge conduit. Furthermore, gases and sound waves entering the perforations 31 will in general be out of phase with those entering the open end 30 of the conduit so that

further equalization of gas pulses and some silencing of sound waves will result.

We have found that in a muffler of the general type described in which the gas pulses are broken up so as to enter the discharge conduit in separate parts out of phase with each other and in which a large expansion chamber is provided about the inlet and discharge conduits, the gas pressure fluctuations and sound waves entering the discharge conduit are of such nature as to be more efficiently operated upon by an acoustical transmission system with high attenuation for high frequencies, built as a part of the outlet conduit, than in the case with the gas pulses and sound waves which initially enter the muffler. We have, consequently, found that by the provision of a high frequency acoustic train in connection with the discharge conduit, noises of the exhaust can be quieted to an unusual degree and also a further equalizing of the flow of gases through the discharge conduit and tail pipe results and this in turn results in a decreased back pressure in the muffler. The high frequency acoustic train used in connection with the discharge conduit may be of any suitable or desired form. In the construction illustrated, we have provided the discharge conduit with groups of perforations or openings 34, 35 and 36 which may be enclosed by any suitable or well known type of intermediate shell. By way of example, we have shown an intermediate shell 33, which may be supported from the discharge conduit 16 in any suitable manner, for example, by means of transverse baffles or partitions 37, 38 and 39 which form with the discharge conduit a pair of high frequency resonator chambers 40 and 41.

It has been found that the silencing of the muffler may be still further improved by providing in the discharge conduit 16 a suitable restriction capable of holding back to a slight extent the gas pressure fluctuations entering the discharge conduit 16. In the construction illustrated, we have provided between the groups of perforations 34 and 35 a restricting sleeve 43 which may have a flange 44 suitably welded or otherwise secured to the conduit 16. This restriction 43 has the further function of causing larger proportions of gases and sound waves to flow through the perforations 34 into the high frequency resonator chamber 40, and then back into the discharge conduit through the apertures 35, than would be the case, if the restriction 43 were not provided. The restriction, therefore, serves the double purpose of slightly holding back surges or pulses of gases and also of making the high frequency resonator chamber 40 more effective. Other means for slightly restricting the flow of gases through the discharge conduit may, of course, be employed, or if desired, this restriction may be entirely omitted.

In the muffler shown in Figs. 5 and 6, a modified form of inlet unit is provided. In this construction, the inlet conduit 50 is provided with two groups of perforations 51 and 52 and these perforate portions of the conduit are surrounded by an intermediate shell 53 supported from the conduit 50 by means of transverse baffles 54, 55 and 56. The baffle 55 may be substantially imperforate and the baffles 54 and 56 may be provided with suitable openings such, for example, as arcuate slots 57 and 58, see Fig. 6. The parts of the gas pulses discharged through the perforations 51 pass into the interior of the muffler housing through the openings or slots 57 of the head 54 which is adjacent to the inlet end of

the discharge conduit 59 and the gases discharged through the apertures 52 pass through the slots 58 adjacent to the other end of the muffler. This construction, consequently, divides each pressure pulse into two decidedly different parts which pass in paths of different length through the interior of the muffler, one part of the pressure pulse passing through the opening 57 into close proximity of the inlet opening of the discharge conduit 59, while the other part of the gas pulse discharging through the openings 58 must travel through the greater portion of the length of the muffler before it can pass into the inlet of the discharge conduit 59. By means of this arrangement, the two parts of each gas pulse are very decidedly out of phase with each other. Except as herein described, the other parts of the muffler shown in Figs. 5 and 6 are very similar to those employed in the muffler shown in Figs. 1 to 4.

In the modified construction shown in Fig. 7, an inlet conduit 65 is provided having two groups of perforations 66 and 67, which are surrounded by an intermediate shell 68 suitably secured to the conduit 65 by means of transverse baffles 69 and 70. The rear end of the intermediate shell is open so that gases discharged through the apertures 67 may pass through the open end of the intermediate shell toward the rear end of the muffler. The portion of the intermediate shell 68 between the baffles 69 and 70 is provided with a series of openings or perforations 72 through which those gases and sound waves are discharged which have entered the intermediate shell through the perforations 66 of the inlet conduit. The perforations 72 break up that part of each gas pulse which passes through the apertures 66 of the inlet conduit into a large number of different parts discharged at different intervals lengthwise of the inlet conduit and all of these apertures 72 are spaced at a distance from the open rear end of the intermediate shell 68, so that a breaking up of the gas impulses into a number of separate parts also results from this construction. In the construction shown in Fig. 7, the discharge conduit 74 has its open end 75 extending substantially perpendicular to the length of the conduit and is provided with a comparatively large group of perforations 76 to facilitate the entrance of gases and sound waves into the discharge conduit 74. Otherwise the muffler shown in Fig. 7 is similar in construction and operation to those heretofore described.

The modified construction of the inlet unit 55 shown in Fig. 8 differs from that shown in Fig. 7, in that the inlet conduit 80 is provided with three groups of perforations or openings 81, 82 and 83 which are surrounded by an intermediate shell 84 supported from the conduit 80 by means of transverse walls or baffles 85 and 86 which are spaced from the opposite ends of the intermediate shell 84. Consequently, the gases discharged through the group of apertures 81 pass out into the space within the muffler housing through the open front end of the intermediate shell 84 and the gases discharged through the apertures 83 pass out through the open rear end of this intermediate shell. The annular space between the conduit 80 and intermediate shell 84 and between the baffles 85 and 86 forms a resonator chamber which may advantageously be used to silence certain sounds in the exhaust.

The inlet and discharge units of the muffler 75

may be arranged and secured to the outer shell of the housing of the muffler in any suitable or desired manner. This outer shell may also be of any desired shape, that shown being of approximately circular cross section. The outer shell may be of greater diameter than the combined diameters of the intermediate shells arranged about the inlet and discharge conduits, in which case, the discharge conduit may be arranged at one side of the vertical central plane of the outer shell, as clearly shown in Figs. 2 and 6. This arrangement of the inlet and discharge units in the outer shell makes it possible to use mufflers embodying this invention to replace return flow mufflers of the type having three conduits, one of which carries the gases from the rear to the front end of the muffler. The arrangement shown in Figs. 2 and 6 also provides for a large volume within the housing of the muffler for equalizing pressure pulses and for destroying low frequency sound waves. The intermediate shells are preferably welded to each other at their line of contact and each intermediate shell is preferably also welded to the outer shell, thus forming a strong and rigid muffler construction.

The mufflers shown in the drawings are of simplified construction, in that they omit entirely the return tube commonly employed in reverse flow mufflers which carries the gases from the rear to the front end of the muffler and the omission of this tube makes possible the discharge of gases from the inlet passage at different intervals lengthwise of the conduit and their expansion in the relatively large interior of the housing. The construction described also provides a larger expansion chamber between the inlet and discharge units, which results in a treatment of the gases and sound waves in the muffler in such a manner that they are acted upon by the high frequency acoustic train associated with the discharge conduit with very much greater efficiency than in mufflers in which a third or reverse flow conduit is employed.

It will be noted that in mufflers constructed in accordance with this invention, a very rapid evening out of the rate of fluctuations of pressure results in the muffler, and also flow of gases through the muffler results with the minimum of turbulence, so that back pressure is kept low by avoiding turbulence, as well as by evening out the flow of gas through the discharge conduit and tail pipe.

We claim as our invention:

1. A muffler including a housing having an inlet at one end and a discharge at the other end thereof, an inlet conduit and a discharge conduit in said housing and connected respectively with said inlet and said discharge and having portions thereof longitudinally coextensive with each other, the volume of said housing being materially greater than the combined volume of said conduits, and the space in said housing enclosing said coextensive portions being substantially unobstructed, said discharge conduit having its open end arranged near the end of the housing remote from said discharge, and said inlet conduit being provided with a plurality of openings at different distances from the opening of said discharge conduit and out of which gases flow from said inlet conduit into the interior of said housing to said open end of said discharge conduit, whereby parts of gas impulses discharged through said openings must travel through different distances in

said housing to reach the opening in said discharge conduit.

2. A muffler including a housing having an inlet at one end and a discharge at the other end thereof, an inlet conduit and a discharge conduit in said housing and connected respectively with said inlet and said discharge and having portions thereof longitudinally coextensive with each other, the volume of said housing being materially greater than the combined volume of said conduits, and the space in said housing enclosing said coextensive portions being substantially unobstructed, said discharge conduit having its open end arranged near the end of the housing remote from said discharge and said inlet conduit being provided with a plurality of openings at different distances from the opening of said discharge conduit, out of which gases flow from said inlet conduit through said housing to said open end of said discharge conduit, and sheet metal members having imperforate portions arranged between said openings in said inlet conduit and said housing to prevent gases discharged from said openings from impinging directly on said housing and for directing gases and sound waves discharged through said openings in said inlet conduit into different parts of said housing located at different distances from the open end of said discharge conduit.

3. A muffler including a housing having an inlet at one end and a discharge at the other end thereof, an inlet conduit and a discharge conduit in said housing and connected respectively with said inlet and said discharge and arranged in substantially parallel relation to each other, the volume of said housing being materially greater than the combined volume of said conduits, said discharge conduit having its open end arranged near the end of the housing remote from said discharge and said inlet conduit being provided with a plurality of openings at different distances from the opening of said discharge conduit and out of which gases flow from said inlet conduit through the interior of said housing, to said open end of said discharge conduit, the portion of said housing enclosing said conduits being substantially unobstructed, whereby parts of gas impulses discharged through said openings must travel through different distances in said housing to reach the opening in said discharge conduit, said discharge conduit being provided with perforate portions, and an imperforate shell enclosing perforate portions of said discharge conduit to form therewith a high frequency acoustic chamber.

4. A muffler including a housing having an inlet at one end and a discharge at the other end thereof, an inlet conduit and a discharge conduit in said housing and connected respectively with said inlet and said discharge and arranged in substantially parallel relation to each other, the volume of said housing being materially greater than the combined volume of said conduits, said discharge conduit having its open end arranged near the end of the housing remote from said discharge and said inlet conduit being provided with a plurality of openings at different distances from the opening of said discharge conduit and out of which gases flow from said inlet conduit through the interior of said housing, to said open end of said discharge conduit, the portion of said housing enclosing said conduits being substantially unobstructed, whereby parts of gas impulses discharged through said openings must travel through different distances in said housing to reach the opening in said discharge conduit,

said discharge conduit being provided with perforate portions, and an imperforate shell enclosing perforate portions of said discharge conduit to form therewith a high frequency acoustic chamber, said discharge conduit having a restricted portion to retard the flow of gases there-through.

5. A muffler including a housing having an inlet at one end and a discharge at the other end thereof, an inlet conduit and a discharge conduit in said housing and connected respectively with said inlet and said discharge and having longitudinally coextensive portions in said housing, said discharge conduit having its open end arranged near the end of the housing remote from said discharge and said inlet conduit being provided with a plurality of openings at different distances from the opening of said discharge conduit and out of which gases flow from said inlet conduit through the interior of said housing, to said open end of said discharge conduit, the portion of said housing enclosing said conduits being substantially unobstructed, whereby parts of gas impulses discharged through said openings must travel through different distances in said housing to reach the opening in said discharge conduit, said discharge conduit being provided with perforate portions, a shell enclosing perforate portions of said discharge conduit to form therewith a high frequency acoustic chamber, and a restriction in said discharge conduit arranged between said perforate portions.

6. A muffler including a housing having an inlet at one end and a discharge at the other end thereof, an inlet unit in said housing including a conduit connected with said inlet and having openings arranged at intervals lengthwise thereof through which gases pass from said conduit into said housing and sheet metal members arranged about said openings in said conduit and having openings for discharging gas into said housing about said inlet unit to prevent gases discharged through said openings from impinging directly on said housing, a discharge unit arranged in said housing and including a discharge conduit connected with said discharge and having an opening to receive gases from said housing and having a perforate portion, and a substantially imperforate shell surrounding said perforate portion to form a high frequency acoustic chamber, the entire interior of said housing not occupied by said units serving as an expansion and equalizing chamber through which gases and sound waves pass in paths of different lengths from said openings in said inlet unit to said discharge unit and being substantially unobstructed to permit free flow of gases in said housing from said inlet unit to said outlet unit.

7. A muffler including a housing having an inlet at one end and a discharge at the other end thereof, an inlet unit in said housing including a conduit connected with said inlet and having openings arranged at intervals lengthwise thereof through which gases pass from said conduit into said housing and sheet members arranged about said openings in said conduit to prevent gases discharged through said openings from impinging directly on said housing, and a discharge unit arranged in said housing and including a discharge conduit connected with said discharge and having an opening to receive gases from said housing and having a perforate portion, and a substantially imperforate shell surrounding said perforate portion to form a high frequency acoustic chamber, the entire interior of said

housing not occupied by said units serving as an expansion and equalizing chamber and being substantially unobstructed to permit gases and sound waves to pass in paths of different lengths from said openings in said inlet unit to said discharge unit, said discharge conduit being provided with perforations in a portion thereof adjacent to its open end beyond its shell, whereby gases and sound waves from said housing may pass into the open end and into said last mentioned perforations.

8. A muffler including a housing having an inlet at one end and a discharge at the other end thereof, an inlet unit in said housing including a conduit connected with said inlet and having perforations throughout a substantial portion of the length thereof, said inlet unit also including a shell arranged about said perforations against which gases discharged through said perforations may impinge and having openings arranged at intervals lengthwise thereof through which gases pass into said housing, and a discharge unit including a conduit connected with said discharge and having a gas receiving opening in said housing which is arranged at different distances from said openings in said shell, said units having longitudinally coextensive portions in said housing, the portion of said housing enclosing said coextensive portions being substantially unobstructed to permit gases to flow through paths of different lengths through said housing from said inlet unit to said opening of said discharge conduit.

9. A muffler including a housing having an inlet at one end and a discharge at the other end thereof, an inlet conduit and a discharge conduit connected respectively with said inlet and discharge and having longitudinally coextensive portions in said housing and provided with perforations extending throughout a substantial portion of the length of each conduit, a shell arranged within said housing about the perforate portion of said inlet conduit and having openings out of which gases may pass into said housing at different distances lengthwise of said shell, and a second shell which is substantially imperforate and which is arranged about and encloses a perforate portion of said discharge conduit to form therewith a high frequency acoustic train, said discharge conduit having a gas receiving opening at the end thereof arranged at different distances from said openings in said first mentioned shell, said shells being secured to each other and to said housing, the portion of said housing enclosing said coextensive portions being substantially free from obstructions to permit gases to flow freely through paths of different lengths through said housing from said inlet unit to said opening in said discharge conduit.

10. A muffler including a housing having an inlet at one end and a discharge at the other end thereof, an inlet conduit and a discharge conduit connected respectively with said inlet and discharge and having longitudinally coextensive portions in said housing and provided with perforations extending throughout a substantial portion of the length of each conduit, a shell arranged within said housing and about the perforate portion of said inlet conduit and having openings through which gases may pass into said housing at different distances lengthwise of said shell, and a second substantially imperforate shell arranged about and enclosing a perforate portion of said discharge conduit to form therewith a high frequency acoustic train, the end of said discharge

conduit opposite to the end thereof connected with said discharge being open and being arranged at different distances from said openings in said first shell and provided adjacent said open end with perforations into which gases and sound waves from said housing may pass.

11. A muffler including a housing having an inlet at one end and a discharge at the other end thereof, an inlet conduit and a discharge conduit in said housing and connected respectively with said inlet and said discharge and arranged in substantially parallel relation to each other, said discharge conduit having an opening adjacent to the inlet end of said housing and said inlet conduit having an opening intermediate of the ends thereof and having its end nearest to the discharge end of said housing substantially closed, and an intermediate shell arranged about said opening of said inlet conduit and receiving gas discharged from said opening in said inlet conduit and having a plurality of discharge openings through which gases pass into said housing, said openings of said intermediate shell being arranged at different distances from the opening of said discharge conduit to cause different portions of gas pulses entering said housing to travel through different distances to the opening of said discharge conduit.

12. A muffler including a housing having an inlet at one end and a discharge at the other end thereof, an inlet conduit and a discharge conduit in said housing and connected respectively with said inlet and said discharge and having longitudinally coextensive portions, said discharge conduit having an opening adjacent to the inlet end of said housing and said inlet conduit having an opening intermediate of its ends and having its end adjacent to the discharge end of said housing substantially closed, an intermediate shell arranged within said housing about said opening of said inlet conduit and receiving gas discharged from said opening in said inlet conduit, transverse baffles connecting the end portions of said intermediate shell with said inlet conduit and provided with openings through which gases pass from said intermediate shell into said housing at different distances from the opening in said discharge conduit.

13. A muffler including a housing having an inlet at one end and a discharge at the other end thereof, an inlet conduit and a discharge conduit in said housing and connected respectively with said inlet and said discharge and having longitudinally coextensive portions, said discharge conduit having an opening adjacent to the inlet end of said housing and said inlet conduit having apertures arranged at intervals lengthwise thereof, an intermediate shell arranged about said apertures, transverse baffles connecting said intermediate shell and said inlet conduit, and forming with said shell and conduit a high frequency resonator chamber communicating with some of said apertures, said intermediate shell also covering apertures of said inlet conduit located at opposite sides of said baffles and having openings at opposite ends thereof to discharge gases into said housing.

14. A muffler including a housing having an inlet at one end thereof and an outlet at the other end thereof, a conduit in said housing receiving gases from said inlet and having perforations arranged at intervals lengthwise thereof, through which gases and sound waves are discharged, a second conduit in said housing and connected with said outlet and having a portion coextensive

with said first mentioned conduit and having an opening for receiving gases and sound waves from the interior of said housing, and an imperforate shell extending about said perforations of said first conduit and having open ends through which gases and sound waves may pass into different portions of said housing located at different distances from said opening of said second conduit, the portion of said housing enclosing said coextensive portions of said conduits being substantially unobstructed to permit gases to flow freely through said housing from the open ends of said shell to said opening in said second conduit.

15. A muffler including a housing having an inlet at one end and a discharge at the other end thereof, a conduit in said housing receiving gases from said inlet at one end thereof and having its other end substantially closed, a second conduit in said housing having a portion thereof arranged longitudinally coextensive with a portion of said first mentioned conduit, said first mentioned conduit having openings arranged at different distances lengthwise thereof in the coextensive portion thereof and said other conduit having an inlet for gases within said housing which is located at different distances from said openings in said first conduit, the portion of said housing enclosing said coextensive portions of said conduits forming a substantially unobstructed space, through which gases discharged from different openings in said first conduit travel through different distances in said housing in passing from said openings to the inlet in said second conduit.

16. A muffler including a housing having an inlet at one end and a discharge at the other end thereof, a conduit in said housing receiving gases from said inlet at one end thereof and having its other end substantially closed, a second conduit in said housing having a portion thereof arranged longitudinally coextensive with a portion of said first mentioned conduit, said first mentioned conduit having openings arranged at different distances lengthwise thereof in the coextensive portion thereof and out of which gases are discharged into said housing, said other conduit having its inner end open to receive gases from within said housing, said inner end being located at different distances from said openings in said first conduit, the portion of said housing enclosing said coextensive portions of said conduits forming a substantially unobstructed space, to cause gases discharged from different openings in said first conduit to travel through different distances in said housing in passing from said openings to the inlet in said second conduit, said second conduit also having perforations near the open inner end thereof and opening into said space to enable gases and sound waves from the interior of said housing to pass into said conduit through the open end thereof and through said perforations.

17. A muffler including a housing forming a chamber having an inlet at one end and a discharge at the other end thereof, a pair of conduits in said chamber having portions thereof longitudinally coextensive with each other, one of said conduits being connected with said inlet and the other conduit with said discharge, both of said conduits having openings therein communicating with the interior of said chamber to permit gases to flow out of an opening in said inlet conduit through said chamber and into an opening in said outlet conduit, one of said conduits having a plurality of openings of approximately the same size

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arranged at different distances from an opening in the other of said conduits, whereby substantially equal streams of gases passing through said chamber from one conduit to another travel in paths which differ in length, whereby gas pulsations travelling in said paths of different

lengths will be out of phase with each other when passing through said conduit connected with said discharge.

LUTHER GRANT HECTOR.
HOWARD L. SCHULTZ.

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