Jan. 5, 1937. E. P. GRAY 2,066,467

MUFFLER

Filed Nov. 27, 1935 3 Sheets-Sheet 1

Fig. 1.

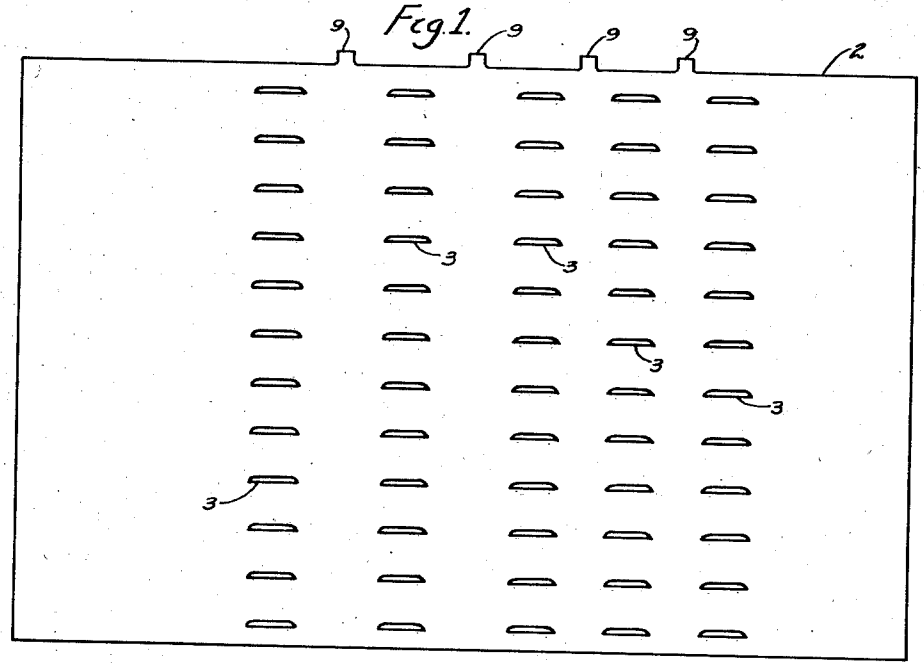


Fig. 4.

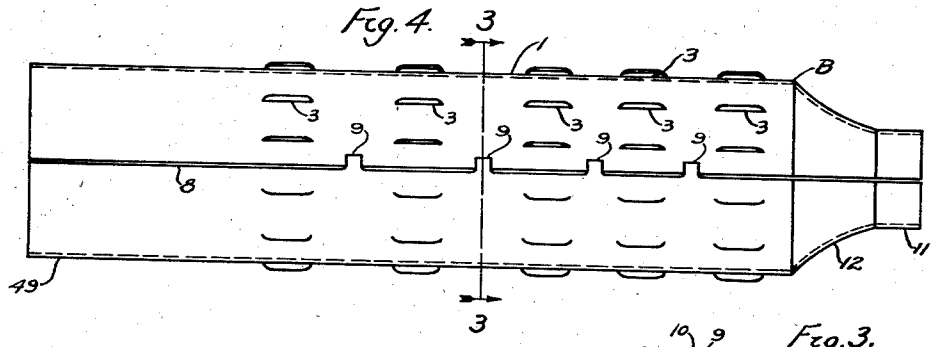


Fig. 2.

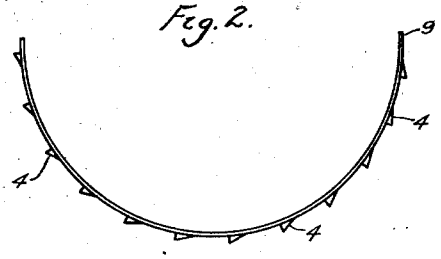
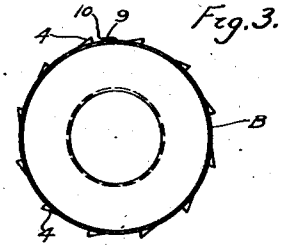


Fig. 3.



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MUFFLER

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Fig. 5.

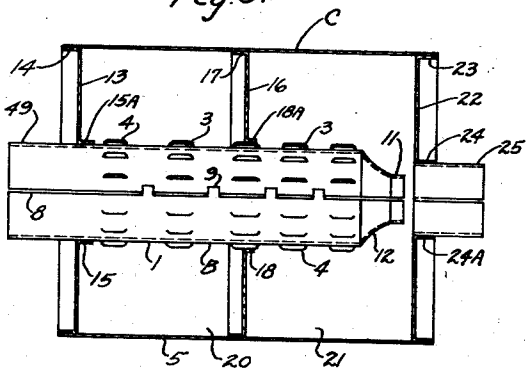


Fig. 8.

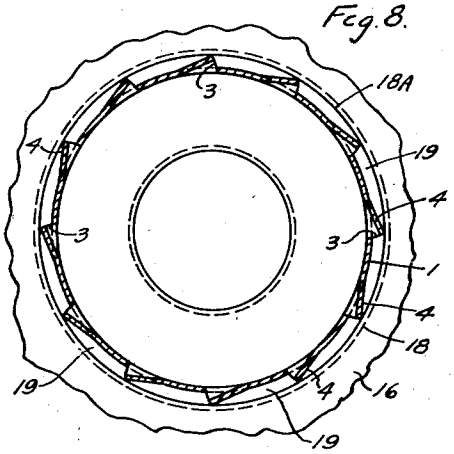


Fig. 6.

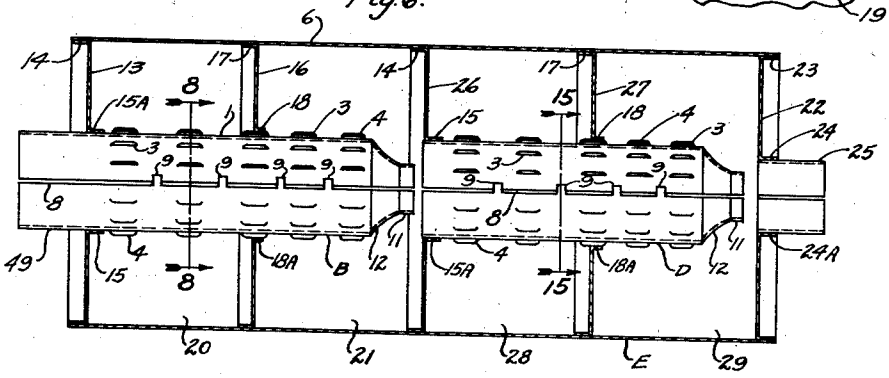
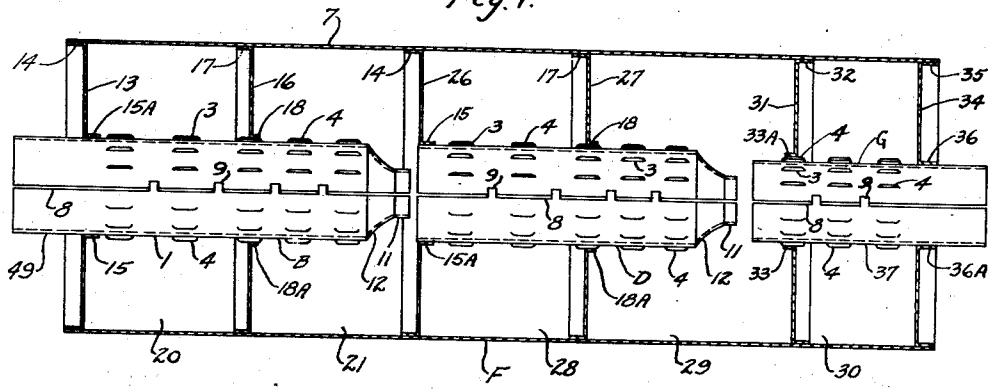


Fig. 7.



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Fig. 9.

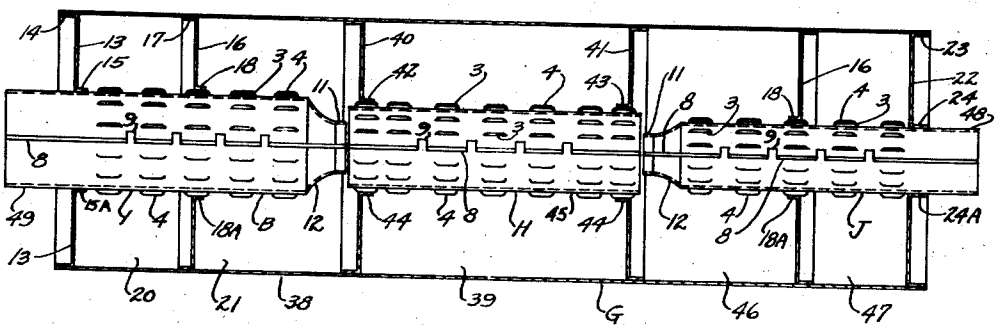


Fig. 14.

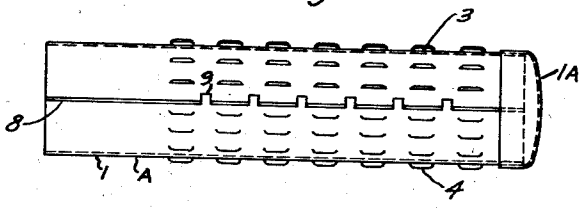


Fig. 16.

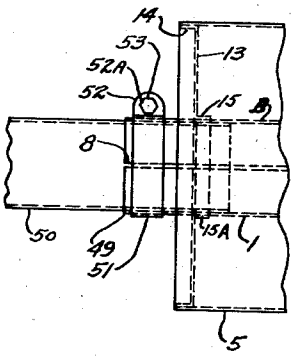


Fig. 15.

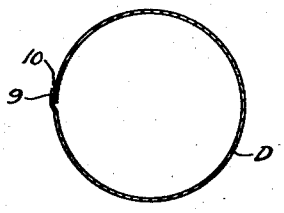


Fig. 11.

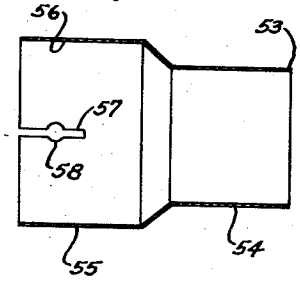


Fig. 10.

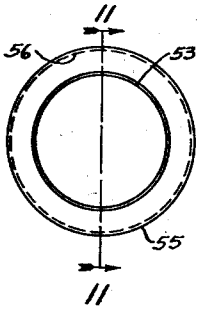


Fig. 13.

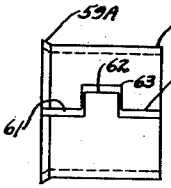
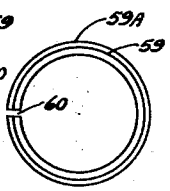


Fig. 12.



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MUFFLER

Emmet P. Gray, Detroit, Mich.

Application November 27, 1935, Serial No. 51,779

22 Claims. (Cl. 181—41)

My invention relates to improvements in mufflers for connecting with the exhaust conduits of internal combustion engines and similar units; and the objects of my improvements are, first, to provide a muffler which will cause fluids entering therein to flow with a rotary motion or tangentially relative to the outer wall portions of the muffler to prevent the fluids from impinging or striking directly against the outer wall portions of the muffler and causing "shell vibrations" thus eliminating sound waves; second, to provide a muffler which diffuses fluids entering therein so that they are uniformly cooled throughout the muffler and prevents localization of unduly high temperatures in any portion of the muffler; third, to provide a muffler having an open passage extending for the total length of the muffler to permit portions of the fluids entering the muffler to flow directly from the inlet and through the central portion of the muffler to and through its outlet; fourth, to provide a muffler that reduces back pressure to a minimum; fifth, to provide a muffler that absorbs sound waves of all frequencies and provides maximum efficiency in silencing the noises of exhaust fluids or gases; sixth, to provide a muffler having one or more silencing chambers together with means for allowing a portion of the exhaust fluids or gases entering the muffler to pass directly through the muffler at high velocity and to aid in drawing the fluids or gases from the silencing chamber or chambers into the stream flowing at high velocity; seventh, to provide a muffler in which fluid or gases passing therethrough are left free to follow a plurality of courses according to the natural law of least resistance; eighth, to provide a muffler which causes fluids or gases entering therein to be divided into a plurality of streams of different lengths and velocities, expanded, rotated and reversely rotated to absorb and destroy sound waves of different frequencies; ninth, to provide a new method of making a muffler; tenth, to provide a muffler having self-cleansing characteristics; eleventh, to provide a muffler having a nozzle member with means adapted for adjustable installation to regulate the free escape of fluids or gases therethrough and to increase or decrease the velocity of the fluids or gases at the nozzle member; twelfth, to provide a muffler tubular member, having means for guiding fluids or gases in straight and in rotary paths, made from sheet or strip of material; thirteenth, to provide a muffler with a connecting member for connecting the inlet pipe of the muffler with exhaust pipes having greater diameters than the inlet pipe; fourteenth, to provide a muffler with a bushing member for connecting the inlet pipe of the muffler with exhaust pipes having lesser diameters than the inlet pipe; fifteenth, to provide a muffler having a tubular member provided with hooded openings or louvered perforations arranged in rows circumferentially around the tubular member to cause fluids or gases escaping therethrough to whirl, rotate, or flow tangentially around the tubular member; and sixteenth, to provide a muffler having a tubular member having hooded openings or louvered perforations with support means engaging the hooded portions of the openings or louvered perforations to provide openings for the passage of fluids or gases therethrough.

I attain these objects by the mechanism illustrated in the accompanying drawings, in which:—

Figure 1 is a plan view of the piece, strip or sheet of material from which a tubular member of the radiator is made; Fig. 2, an end view of the strip or sheet of material disclosed in Fig. 1 partially formed in the operation of forming the strip or sheet of material into a tubular member; Fig. 3, an end view of the strip or sheet of material disclosed in Fig. 2 after forming into the tubular member; Fig. 4, a side view of the strip or sheet of material as disclosed in Fig. 1 and which has been formed into the tubular member; Fig. 5, an inner tubular member assembled together with an outer tubular member or housing, said outer tubular member or housing being disclosed sectionally on its vertical center; Fig. 6, an inner tubular member assembled within an outer tubular member of greater length than that disclosed in Fig. 5, together with a second inner tubular member installed at one end of the extended outer tubular member; Fig. 7, a muffler as shown in Fig. 6 with an extended outer tubular member of greater length and provided with an additional chamber and an additional inner tubular member therein; Fig. 8, a partial sectional view of an inner tubular member installed with a disc or plate member within the outer tubular member or housing, said partial sectional view being taken on the line 8—8, Fig. 6; Fig. 9. a vertical section of a muffler provided with an alternative mounting of inner tubular members of different diameters; Fig. 10, an end view of a coupling member for connecting my mufflers with an exhaust pipe of an engine; Fig. 11, a sectional view of the coupling disclosed in Fig. 10, and taken on the line 11—11, Fig. 10; Fig. 12, an end view of a bushing member used for connecting my mufflers with the exhaust pipe of an engine; Fig. 13, a side view of

the bushing member disclosed in Fig. 12; Fig. 14, a side view of an inner tubular member fully closed at its extreme rear end; Fig. 15, a sectional view of one of the tubular members taken on the line between the louver portions, said section being indicated as taken on the line 15—15, Fig. 6; and Fig. 16. a side view of the inlet portion of my mufflers connected with an exhaust pipe of an internal combustion engine together with clamping means for contacting the inlet pipe to grip the exhaust pipe.

Similar numerals refer to similar parts throughout the several views.

The inner tube or tubular member 1 is constructed by providing a piece, strip or sheet 2 of relatively thin material with a plurality of hooded openings, louvered perforations, or apertures 3 formed as a louver or opening and each provided with the hooded portion 4 as by displacing or raising a portion of the main wall portion of the piece, strip or sheet of material 2 to provide the openings or apertures 3 and thus position the openings and apertures 3 so that the gases or fluids which pass therethrough, as hereinafter more fully described, will be guided to flow with a rotary, whirling or tangential motion or movement relative to the outside surface of the tubular member 1 and also relative to the inside surface of the outer tube or tubular members of the housings 5, 6 and 7.

It is to be noted that the openings or apertures 3 together with the hood portions 4 will be arranged in rows or planes extending substantially at right angles to the axis of the muffler assembly, said rows extending circumferentially around the tubular member 1.

After the openings 3, together with the hood portions 4 have been formed in the strip or sheet of material 2, the strip or sheet of material 2 is then formed to substantially a semi-cylindrical shape, as disclosed in Fig. 2.

The next step in the method of manufacturing the inner tubular member 1 is to further form the strip or sheet 2 of the material from its semi-cylindrical shape as disclosed in Fig. 2 to a substantially fully closed or cylindrical shape as disclosed in Fig. 3 and which will form the tube or tubular member 1.

The tube 1 will be provided with the slot or gap 8 between the adjacent edge surfaces of the strip or sheet 2.

Also the strip or sheet 2 of material may be blanked with a plurality of extension or tongue portions 9 located preferably between the rows of apertures 3 and overlapping the opposite edge portion of the strip or sheet 2 to provide means for connecting the edge portions of the strip or sheet 2 and to assist in maintaining the strip or sheet 2 in the tubular shape, the extension or tongue portions 9 being spot welded as at 10.

The tube 1 may be formed at its inner end with the straight cylindrical portion 11, the straight cylindrical portion 11 being of smaller diameter than the diameter of the main portion of the tubular member 1, the straight cylindrical portion 11 being connected with the end body portion of the tubular member 1 by the conical shape or frusto-conical portion 12, said straight cylindrical portion forming a nozzle member and outlet portion for the tube 1.

Fig. 14 discloses the tubular member 1 constructed with its inner or rear end fully closed to prevent passage of fluids or gases directly through the total longitudinal length of the tubular member 1 and to cause the fluids or gases which are in the tubular member 1 to flow outwardly in tangential or rotary paths through the openings 3.

It is to be noted that the tubular member 1 with its fully closed end, which may be formed integrally from the sheet 2, or by the cap member 1A as disclosed in Fig. 14, constitutes an assembly unit that will be known as the tubular assembly A, and which will provide muffling characteristics by itself in operation when utilized in connection with internal combustion engines of small or adequate size for the capacity of the tubular member 1 disclosed in Fig. 14.

Also it is to be noted that when a muffler unit or assembly of larger capacity to operate with larger internal combustion engines or similar units is desired, the tubular member 1 with its straight cylindrical portion 11 will be installed in an outer tubular member or housing 5 as disclosed in Fig. 5, this muffler or unit assembly being hereinafter referred to as the tubular member or assembly B when used as an integral portion of a larger muffler assembly.

In order to support the tubular assembly B in the muffler assembly C, I provide the end plate or disc member 13 which closes the front end of the outer tubular member 5 between the inside surface of the outer tubular member 5 and the outside surface of the tubular member 1, the disc member 13 being provided with the flange 14 which is cylindrical in shape and fits within and engages the inner surface of the tubular member 1, the flange 14 being formed to extend outwardly from the main portion of the disc 13 and to have its edge portion located substantially flush with the front end or edge portion of the tubular member 5, the flange 14 being secured to the tubular member 5 as by spot welding or similar means. Also the disc member 13 is provided with the flange 15 which is formed to extend inwardly and to have a bore 15A therethrough to fit and engage with the outside diameter of the tubular member 1, the flange 15 being secured to the tubular member 1 as by spot welding or by similar means.

Also I provide a plate or disc member 16 which is similar in construction to the disc member 13, said disc member 16 being provided with the cylindrical flange 17 for fitting within and engaging the inside surface of the outer tubular member 5, the disc member 16 being provided with the flange 18 which has a bore 18A slightly larger than the bore 15A of the flange 15 of the disc member 13, the bore 18A through the flange 18 of the disc member 16 being of sufficient size to fit with and engage the outer edges of the hooded portions 4 adjacent the openings 3, thus providing a plurality of openings or apertures 19 between the inside surface of the bore 18A of the flange 18 and the outer surfaces of the hooded portions 4 and the outside cylindrical portions of the tubular member 1 to permit the flow of fluids and gases from the chamber 20 into the chamber 21 of the muffler assembly C, Fig. 8 disclosing said apertures 19 as appearing in the muffler assembly E of Fig. 6, although the sectional view, Fig. 8, is typical also of the muffler assembly C and the other muffler assemblies as hereinafter disclosed.

The chamber 21 is formed between the disc member 16 and the walls of the tubular member 5 by assembling the disc member 22 at the rear end of the tubular member 5, the disc member 22 being provided with the cylindrical flange 23

which fits with and engages the inner surface of the tubular member 5.

Also the disc 22 is provided with the flange 24 which is formed on the same side of its main wall portion as the flange 23, the flange 24 extending rearwardly and being provided with the bore 24A in which is mounted the outlet or exhaust pipe or tube 25, the tube 25 being suitably secured in the bore 24A of the flange 24 by spot welding or similar means, thus providing an outlet or passage for the fluids or gases from the chamber 21 to the outside atmosphere through the pipe or tubular member 25.

It is now to be noted that where still larger internal combustion engines or similar units are to be provided with muffler units or assemblies, I install a second tubular assembly D within the tubular member 6, as disclosed in Fig. 6, the tubular member 6 being substantially twice the length of the tubular member 5 of the muffler assembly C, the muffler assembly containing the tubular assemblies B and D being designated by E.

The second tubular assembly D is similar to the tubular assembly B and is mounted at the rear of the tubular assembly B and in alignment therewith by supporting it in the disc members 26 and 27 which are respectively provided with the flanges 14, 15, 17 and 18, the front end of the second tubular assembly D being substantially flush with the main wall portion of the disc member 26.

Also the muffler assembly E is provided with one of the disc members 22 which is similar to the disc member 22 of the muffler assembly C and is provided with flanges 23 and 24 together with the exhaust pipe or tube 25 at the end of the muffler, the muffler assembly E thus being provided with the additional chambers 28 and 29.

Also when it is desired to provide my muffler assembly for use with internal combustion engines or similar units, of still greater capacity or displacement, I provide the muffler assembly F as disclosed in Fig. 7, which is provided with the tubular member 7 of still greater length and in which is mounted the tubular assembly G at the rear end thereof in conjunction with the tubular assemblies B and D, similar to the installations heretofore disclosed.

Also it is to be noted that the muffler assembly F is provided with the additional chamber 30 formed by the installation of the disc member 31 having a cylindrical flange 32 for fitting within and engaging the inside surface of the tubular member 7, the disc member 31 being provided with the flange 33 having the bore 33A therethrough, said bore 33A being larger, for fitting around the louvered perforations 3 and to accommodate the increased displacement or size of an internal combustion engine or similar unit as compared with the bore 24A through the flange 24 of the disc member 22 of the muffler assemblies C or E.

Also in a similar way the disc member 34 will be installed in the rear end of the tubular member 7 and is provided with the cylindrical flange 35 extending within and engaging the inside surface of the tubular member 7, said disc member 34 being provided with the flange 36 which is provided with the bore 36A and is similar in construction but of smaller diameter than the flange 33 of the disc member 31.

Then instead of the exhaust pipe or tube 25, as utilized in Fig. 6, I provide the tubular member 37 which is mounted at its inner end in the bore 33A of the flange 33 of the disc member 31 and is further supported at a point intermediate its ends in the bore 36A of the flange 36 of the disc member 34, the tubular member 37 extending through the disc member 34 to provide an outlet portion extending beyond the end of the housing 7.

The tubular member 37 is secured in the bores 33A and 36A respectively by spot welding or similar means and is provided with a plurality of the apertures 3 and the hooded portions 4 similarly to the tubular assemblies B and D, the tubular member 37, however, having a passage extending therethrough of the nominal inside diameter of the tubular member 37.

Also it is to be noted that in Fig. 9 I have disclosed a muffler assembly G which comprises the outer tubular member 38 which is substantially of the same length as the tubular member 7 of the muffler assembly F as disclosed in Fig. 7.

In the muffler assembly G, I utilize one of the tubular assemblies B together with a pair of the discs 13 and 16 in a similar manner to that disclosed in Figs. 5, 6 and 7 for supporting the tubular assembly B. However, in the muffler assembly G it may be desirable in some installations to provide a chamber 39 immediately behind the chamber 21 formed by installing the disc members 40 and 41 respectively provided with the flanges 42 and 43 extending inwardly toward one another and each provided with the bores 44 for receiving and supporting the tubular member 45 of the tubular assembly H, said tubular member 45 being secured therein as by spot welding or similar means, the tubular member 45 being provided with the rows of openings or apertures 3 and hooded portions 4 similar to the tubular members above described, the tubular member 45 being supported in alignment with the tubular member 1 of Fig. 9, the tubular member H being of lesser diameter than the tubular member 1.

The muffler assembly G is also provided with the chambers 46 and 47 which are formed by utilizing one of the disc members 16 but in a reversed assembled position for supporting one end of a tubular assembly J mounted in a reversed position in which its straight cylindrical and conical portions 11 and 12 are assembled immediately behind or adjacent the rear end opening of the straight cylindrical portion of tubular assembly J being of lesser diameter than the tubular assembly H.

The rear end of the outer tubular member 38 is closed between the inner surface of the outer tubular member 38 and the outside surface of the tubular assembly J by one of the disc members 22 having a flange 24 together with the bore 24A therethrough for supporting the tubular assembly J, the disc member 22 being provided with the cylindrical flange 23 for fitting within and engaging the inner surface of the outer tubular member 38 at its rear end.

It is now to be noted that the tubular assembly J will be supported in alignment with the tubular assemblies B and H, in Fig. 9, and will have its straight cylindrical portion extended beyond the rear end of the muffler assembly G to form the outlet pipe or exhaust tube 48.

It is to be noted that the various tubular members or assemblies B, when assembled as above disclosed, at the front end of the various muffler assemblies, will have a straight cylindrical portion extended beyond the front end of the muffler assemblies to provide an inlet tube or por-

tion 49 for connection with the exhaust pipe, indicated at 50 in Fig. 16, of an internal combustion engine or similar unit.

Also due to the construction of the tubular member or assembly B, the tubular member 1 will provide a slot extending through the inlet portion 49 so that the inlet portion 49 may be clamped around the exhaust pipe 50 which is connected with the internal combustion engine, the inlet portions 49 of the muffler assemblies being sized to fit pipes of larger or smaller size.

Fig. 16 discloses a general method whereby all of the various muffler assemblies which have been herein described, are connected to the exhaust pipe of an internal combustion engine or unit when provided with an exhaust pipe having a diameter substantially equal to the inside diameter of the inlet portion 49, the rear end of the exhaust pipe being located as indicated and disclosed as extending into and fitting within the inlet portion 49 at the front end of one of the tubular members or assemblies B.

A clamping member 51 extends around the outside of the inlet portion 49 and is provided with the spaced lug portions 52 which are clamped together by the bolt 52A to squeeze or compress the inlet portion 49 together to clamp the end of the exhaust pipe 50, the slot 8 in the tubular member 1 permitting the tubular member 1 to be compressed tightly around the end of the exhaust pipe 50.

Figs. 10 and 11 disclose a coupling member 53 which is adapted for use with exhaust pipes having a larger diameter than the diameter of the inlet portion 49 and which may be made of different sizes and which are adapted to fit within the inlet portion 49 of the various muffler assemblies, the coupling member 53 being provided with a cylindrical portion 54, which enters the inlet portion 49 and is thus adapted to be clamped in position in the inlet portion 49 similar to the exhaust pipe as disclosed at 50 in Fig. 16.

Also the coupling member 53 is provided with the enlarged end 55 which is provided with the bore 56 of sufficient size to receive an exhaust pipe of larger size than would normally be received in the inlet portion 49.

The enlarged end 55 is provided with the slot 57 extending for a portion of its length.

Also the slot 57 may be enlarged substantially at its central portion by forming the circular opening 58 through the side wall of the enlarged end 55, the circular opening 58 being intercepted by the slot 57 to facilitate clamping the wall portions of the enlarged portion 55 together to grip the end of an exhaust pipe similar to 50 by means of a clamping member similar to 51, the opening 58 being adapted for engagement by a suitable tool to facilitate removal of the coupling member 53 from the inlet portion 49.

It is to be noted that the coupling member 53 can be made with any desired diameters at its opposite ends to adapt it to a series of standard mufflers having standard inlet portions 49 to accommodate the diameters of exhaust pipes of various sizes for different displacements of internal combustion engines or similar units.

Figs. 12 and 13 disclose a bushing member 59 which is utilized for adapting various mufflers having different sizes of inlet portions 49 to exhaust pipes of smaller diameter than the nominal size of the inlet portion 49 of the tubular member 1.

The bushing member 59 is provided with the upset or enlarged end 59A to permit the bushing 59 to be assembled within the inlet portion 49 of a muffler assembly and to prevent the bushing member 59 from being assembled too far into or through the tubular member 1, the enlarged portion 59A engaging the front or outer end of the inlet portion of the tubular member 1 and positioning the bushing member longitudinally therewithin.

The bushing member 59 is provided with the slots 60 and 61 at its opposite ends together with the tongue or extension portion 62 therebetween and which extends within the opening or notch 63.

The tongue or extension portion 62 engages the side walls of the opening or notch 63 and thus prevents the bushing 59 from becoming deformed in its assembly and it will also enable the bushing 59 to be clamped between the outer surface of the end of the exhaust pipe 50 and the inside surface of the inlet portion 49 of a muffler assembly, the opening or notch 63 being of sufficient length or depth to allow the tongue or extension portion 62 to be clamped to its tight position without engaging the bottom edge of the opening or notch 63.

It is to be noted that where I have described my various muffler assemblies as being adaptable for use with internal combustion engines they are also adaptable for use in marine installations or units where water or similar fluids are flowing through the muffler instead of gases, as well as when my muffler assemblies are used in operation with internal combustion engines.

The fluids as herein referred to are intended to comprise any fluids or gases which may be passed or flowed through a muffler assembly. In operation the use of my muffler assembly will be described in conjunction with internal combustion engines and similar units and for this purpose the operation will refer to the flow of gases through the muffler assembly as discharged from the exhaust conduit or pipes of the internal combustion engine and similar unit, and it is to be understood that when used in marine work, the operation will be similar in principle.

In operation the exhaust gases from internal combustion engines or similar units are passed through the exhaust pipe 50 connected therewith and through the inlet portion 49 into the interior of the tubular member 1 of the muffler assembly A or of the other muffler assemblies herein described according to the various installations.

If the muffler assembly A is used in conjunction with an internal combustion engine or similar unit of small displacement and having an exhaust pipe 50 connected with inlet portions 49 thereof, the exhaust gases will all pass outwardly through the apertures or openings 3 to the atmosphere, the exhaust gases being expelled through the apertures or openings 3 in a series of whirling disc formations due to the hooded portions 4 of the openings 5 forcing the gases to flow radially or tangentially around the tubular member 1, all of the gases passing out through the opening 3 due to the end of the tubular member 1 being closed by the end or cap member 1A.

When the tubular assembly B is installed as a portion of the muffler assemblies C, E, F, and G, Figs. 5, 6, 7 and 9, the exhaust gases will pass through the end 50 of the exhaust pipe into the tubular assembly B and a portion of the exhaust gases will pass directly out through the outlet or straight cylindrical portion 11, the reduced size of the straight cylindrical portion 11 causing a portion of the gases to pass outwardly

through the openings or apertures 3 into the chambers 20 and 21, the amount of gas passing outwardly through the openings or apertures 3 into the chambers 20 and 21 being determined by the size and number of the apertures 3 as well as the size of the outlet opening of the straight cylindrical portion 11.

It is to be noted that when the gases which do not pass directly and longitudinally through the tubular assembly 1 and out through the outlet opening of the straight cylindrical portion 11 and which are forced to pass out of the openings or apertures 3 past the hooded portions 4, said gases will be restrained to move or whirl tangentially around the tubular assembly 1 in the chambers 20 and 21, and instead of being expelled through conventional or plain openings in the wall portion of the tubular assembly 1 and thus guided to directly impinge or strike the side surface of the wall portion of the housing 5, the exhaust gases in my muffler assembly will be caused to flow tangentially around the inside surface of the tubular member 5, thus avoiding any direct engagement or impingement on the wall portions of the tubular member 5 and thus eliminating sound waves caused by vibrations or deflections or displacements of the wall portion of the tubular member 5.

It is to be noted that the gases which pass outwardly and tangentially from the inside of the tubular assembly B in the chamber 20, of the muffler assembly C, will tend to also gradually pass through the openings 19 between the tubular assembly B and the flange 18 of the disc member 16 into the chamber 21 where they will be met and turbulently mixed with the gases which are flowing tangentially out of the openings 3 at the rear end of the tubular assembly B into the chamber 21 where they will be mixed with and whirled tangentially with the flow of gases from the openings 3 located in the chambers 21, and will tend to displace and draw the gases from the chambers 21 into and out through the opening of the outlet or exhaust pipe 25 and as these gases tend to flow into the opening of the outlet pipe 25 they will be met by the gases which are flowing directly through the tubular assembly B and out of the opening of the straight cylindrical portion tending to bore through the whirling gases which are flowing from the chamber 21 into the pipe 25, thus again tending to set up an extreme turbulent mixture and tending to smooth out and decrease the sound waves and substantially eliminate them altogether.

It is now to be noted that with the muffler assemblies E and F, the gases are forced to flow through a second operation of turbulent mixing in the chambers 28 and 29 similar to that in the chamber 21 before passing out of the exhaust pipe 25 in the muffler assembly E or out of the rear end opening of the tubular assembly G in the muffler assembly F, the various muffler designs according to their size and number of chambers, necessitating the turbulent mixing and flowage of the exhaust gases over and over again and enabling a larger volume of gases to be not only decreased in temperature but to have their sound waves decreased and to be substantially eliminated entirely before passing out through the exhaust pipes or tubes into the atmosphere.

It is now to be noted that the position of the disc member 16 in the muffler assembly C and the other muffler assemblies disclosed has an important bearing on the muffling characteristics and the disc member 16 is adapted to be installed at different desired positions or points intermediate the ends of the housing 5, 6, 7, or 38 to produce the desired muffling characteristics.

In explanation, as the tubular assembly B is provided with six rows of openings 3, together with the hooded portions therewith, and the louver or opening portions are constructed of substantially 1 inch length and ⅛ of an inch width, this will provide a total area of openings of one square inch in each row of louvers or openings 3.

If the outlet diameter of the straight cylindrical portion 11 is 1 inch and if the disc member 16 were to be placed in a selected position where it uncovered only one row of the openings or apertures 3 in the chamber 21, then the total area for the escape of the gases flowing through the tubular member assembly A into the chamber 21 and through the opening of the straight cylindrical portion 11 would be two square inches.

Now if the disc 16 were to be moved forwardly in the muffler assembly C so that two rows of the louvers or openings are open or in connection with the chamber 21, then the total area for the escape of the gases into the chamber 21 would be increased to three square inches, thus permitting the position of the disc member 16 to be determined in accordance with the amount of the opening desired into the chamber 21 and directly through the tubular assembly B and thus through the muffler assembly C, the louver perforations of the tubular assembly B between the disc member 16 and the straight cylindrical end causing the gases passing through the louvered perforations 3 to enter a partially dead chamber 21, said chamber being always open to the atmosphere, with a whirling or tangential motion relative to the outer tube and thus avoids a direct flow against the outer tube and eliminates shell vibrations, this motion of the gases creating such turbulence that the sound waves are destroyed with the consequent reduction of noise.

Also the installation or support of the tubular assembly B with its louvers and hood portions in the bore 18A of the flange 18 of the disc member 16 allows the gases which enter the chamber 20 to escape slowly through the openings 19 and permits continuous passage of the gases through the silencing chambers and to the atmosphere. The disc member 16 may thus be adjusted in its position to permit regulating the free escape of the gases and to permit increasing and decreasing the velocity of the gases at the nozzle or opening of the straight cylindrical portion 11 by restricting the escape of the gases through the openings 3 in accordance with the number of louvers or openings located between the disc member 16 and the outlet end of the tubular assembly C.

Also it is to be noted that if the disc member 16 is adjustably located to reduce the free passage of the gases therethrough, the area of the partially dead chamber 20 will be increased or vice-versa, the gases passing into and through the opening of the straight cylindrical portion 11 or nozzle travelling at a velocity which will create a vacuum and which will tend to draw the gases from the chambers 20 and 21 and through the openings 3 into the chambers adjacent thereto and thus out through the outlet 25 of the muffler assembly.

Also it is to be noted that as the gases pass outwardly through one row of the louvered openings 3, the gases will form into a whirling or tan-

gentially moving mass having the formation of discs of substantially the width of the louvered openings 3 and that each whirling or tangentially moving disc of gases will contact with a similar disc which is issuing from an adjacent row of louvered openings and thus my muffler presents in operation a plurality of disc formations of gases which are whirling in engagement with one another and are moving tangentially relative to the tubular members and these whirling disc formations of gas are impinging one upon the other, thus further tending to grind out and reduce the sound waves.

It is to be understood that the operation as above disclosed will be repeated in the various muffler assemblies in accordance with the number of chambers contained therein and the lengths of the muffler assemblies.

It is also to be noted that in conjunction with the muffler assembly C and the muffler assembly E that there will be no dead chambers as the gases will always be continually progressing therethrough and the total exhaust or outlet areas can be arranged so that there will be no restriction as the total openings of said exhaust or outlet areas can be determined to be of sufficient maximum area to always be equal or greater than the inlet areas of the muffler.

Also the muffler assembly F may be provided with the chamber 30 if desired, which forms an additional chamber in which the gases may flow into for expansion and cooling purposes, and this chamber may be connected with the inlet tube similar to that disclosed in the other mufflers, as desired, or it may be left substantially a dead chamber as desired.

It is also to be noted that with the flowing of the gases outwardly and tangentially and in disc formation and then to and through the secondary chambers into the masses of whirling or tangentially moving discs of gas that are being developed therein, the heat will be distributed over the total area of the outer tube or portions of the muffler so that substantially no localizations in the heat of the gases will occur, thus eliminating extremely heated portions of the muffler walls.

Also it is to be noted that the action of the gases above disclosed will form self-cleansing characteristics which will cause all carbon formations developed in the muffler assemblies to be carried on and out of the muffler.

Also it is to be noted that the mounting of the tubular assembly B as above described in the two disc members 13 and 16 of the various muffler assemblies will provide a two point support for the tubular assembly B which will strengthen the tubular assembly B by eliminating stresses at its front portion and at the same time permit of the adjustable positioning of the disc member 16 to accomplish the desired muffling characteristics in accordance with various sizes and displacements of internal combustion engine and similar units.

Also it is to be noted that in the operation of my muffler ample space is provided for expansion of the gases when entering the muffler assemblies and to enable a portion of the gases to always escape directly through the center of the muffler assembly to their outlets, the exhaust gases always being left free to follow the natural course of least resistance, the exhaust spaces being divided into numerous streams or different lengths and velocities, said streams being expanded, rotated, and reversedly located so that sound waves of all frequencies are caught and absorbed, thus efficiently silencing the exhaust gases from internal combustion engines or similar units as well as reducing the back pressure of the gases to a minimum.

I claim:

1. In a muffler for use with an exhaust pipe of an internal combustion engine or similar unit, the combination of a tube provided with perforations through its walls, said tube having an end adapted to fit said exhaust pipe, and means partially closing the opposite end of said tube to cause a portion of the exhaust gases entering said tube to escape through said perforations, said means being provided by constructing said opposite end of said tube with a cylindrical portion of lesser diameter than the main portion of said tube, said cylindrical portion being connected with said main portion of said tube by a frustro-conical section.

2. In a muffler for use with an exhaust pipe of an internal combustion engine or similar unit, the combination of a tube having a sole nominal diameter throughout and provided with perforations through its walls, said perforations being arranged in a plurality of rows extending circumferentially around said tube in parallel planes, and means partially closing an end of said tube to cause a portion of the exhaust gases entering said tube to escape through said perforations, said means being provided by constructing said end of said tube with a cylindrical portion of lesser diameter than the nominal diameter of said tube, said cylindrical portion being connected with said nominal diameter of said tube by a frustro-conical section.

3. In a muffler for use with an exhaust pipe of an internal combustion engine or similar unit, the combination of a tube provided with perforations through its walls, said perforations being arranged in a plurality of rows extending circumferentially around said tube in parallel planes, each of said perforations being provided with hood portions to cause the exhaust gases passing therethrough to flow tangentially around said tube, and means partially closing an end of said tube to cause a portion of the exhaust gases entering said tube to escape through said perforations, said means being provided by constructing said end of said tube with a cylindrical portion of larger diameter than the main portion of said tube, said cylindrical portion being connected with said main portion of said tube by a frustro-conical section.

4. In a muffler for connection with an exhaust pipe of an engine, the combination of a tube provided with perforations through its walls, said tube having a sole nominal diameter throughout the greater portion of its length, means partially closing an end of said tube to cause a portion of the fluids entering said tube to escape through said perforations, said means being solely supported by said tube and comprising a frustro-conical portion formed from the wall portion of said tube, and a second tube surrounding said first mentioned tube, said second tube being closed, at one of its ends, around said first mentioned tube, said second tube being provided at its opposite end, with an opening for the passage of fluids therethrough.

5. In a muffler for connection with an exhaust pipe of an engine, the combination of a tube provided with perforations through its walls, said perforations being arranged in a plurality of rows extending circumferentially in parallel planes

around said tube, each of said perforations being provided with hood portions to cause said fluids escaping therethrough to flow tangentially around the outer surfaces of said first mentioned tube, means partially closing the opposite end of said tube to cause a portion of the fluids entering said tube to escape through said perforations, and a second tube surrounding said first mentioned tube, said second tube being closed, at one of its ends, around said first mentioned tube, said second tube being provided, at its opposite end, with an opening for the passage of fluids therethrough.

6. In a muffler for receiving the fluids therein, the combination of an outer tube, a second tube within said outer tube and provided with a portion of itself formed to provide a frustro-conical portion for partially closing one of its ends, said second tube being provided with a plurality of rows of louvers, said rows of louvers extending circumferentially around said second tube in parallel planes, said louvers being provided with hood portions to cause said fluids passing through said louvers to flow tangentially between and relative to said outer and said second tubes, a disc member mounted at the inlet end of said second tube between said outer tube and said second tube, and a second disc member at the opposite end of said outer tube and provided with an opening for said fluids to pass therethrough.

7. In a muffler, the combination of a housing comprising a chamber provided with an inlet opening together with a chamber provided with an outlet opening, louvered means for causing fluids entering said housing to flow tangentially relative to the outer wall portions of said housing, and means connecting said chambers to permit fluids to flow from one of said chambers to the other, said last mentioned means comprising members surrounding said louvered means at its louvers to provide spaces adjacent said louvers and connecting with said chambers.

8. In a muffler, the combination of a housing, a disc member in said housing and provided with a bore therethrough, a tube supported in said housing, said tube extending through said bore of said disc member, said tube being provided with a plurality of louvers extending in a row arranged circumferentially around said tube, said louvers engaging said bore of said disc member to support said tube and to form a plurality of openings between said disc member and said tube, said tube forming an inlet for the muffler, and an outlet member connected with said housing.

9. In a muffler, the combination of a sole outer tube having an outlet, and a sole inner tube supported in said sole outer tube and forming an inlet for the muffler, one end of said sole inner tube being partially closed, said sole inner tube being provided with louver perforations to cause fluids entering the muffler and escaping through said louver perforations to flow tangentially relative to the inner wall surfaces of said sole outer tube and relative to the outer wall surfaces of said sole inner tube.

10. In a muffler, the combination of a tube partially closed at one of its ends, and adapted for connection with an exhaust pipe, said tube being provided with hooded openings through its wall portions, said hooded openings being arranged in rows extending circumferentially around said tube, a tube surrounding said first mentioned tube and fitted tightly around said first mentioned tube adjacent its end portion opposite said partially closed end, said second mentioned tube being provided with an opening for the passage of fluids therethrough, and a disc member mounted in said second mentioned tube and supporting said first mentioned tube at its hooded openings to position it rigidly and to relieve said first mentioned tube from stresses at its end portion opposite its partially closed end, said support of said second mentioned tube by said disc member at its hooded openings forming openings through said disc member connecting with opposite sides of said disc member and with said hooded openings.

11. In a muffler, the combination of a tube partially closed at one of its ends and adapted for connection with an exhaust pipe, said tube being provided with louvered perforations provided with hooded portions for causing fluids escaping therethrough to flow tangentially around said tube, a larger tube surrounding said first mentioned tube, an end member fitting tightly therearound at one end of said larger tube, said end member fitting tightly around said first mentioned tube, said larger tube being provided with an opening for the passage of fluids therethrough, and a plate fitted tightly around the inside wall surface of said larger tube, said plate extending around said hooded portions of said louvered perforations and supporting said first mentioned tube, said plate being adapted to be adjustably assembled in various positions relative to the louvered perforations of said first mentioned tube to regulate the free escape of fluids through the partially closed end of said first mentioned tube and to increase or decrease the velocity of fluids at the partially closed end of said first mentioned tube by restricting the escape of fluids through said louvered perforations.

12. In a muffler, the combination of a tube partially closed at one of its ends and adapted for connection with an exhaust pipe, said tube being provided with louvered perforations for causing fluids escaping therethrough to flow tangentially around said tube, a larger tube surrounding said first mentioned tube, an end member fitting tightly therearound at one end of said larger tube, said end member fitting tightly around said first mentioned tube, said larger tube being provided with an opening for the passage of fluids therethrough, and a plate fitted tightly around the inside wall surface of said larger tube, said plate supporting said first mentioned tube, said plate being provided with a bore larger than the normal outside size of said first mentioned tube to permit said bore to surround and engage a plurality of said louvered perforations of said first mentioned tube, said bore providing a plurality of openings between said louvered perforations to permit fluids to flow therethrough with a relative slow rate of speed, said plate being adapted to be adjustably assembled in various positions relative to the louvered perforations of said first mentioned tube to regulate the free escape of fluids through the partially closed end of said first mentioned tube and to increase or decrease the velocity of fluids at the partially closed end of said first mentioned tube by restricting the escape of fluids through said louvered perforations.

13. In a muffler, the combination of a pair of tubes mounted one within the other, the inner of said tubes providing an inlet for the muffler and having a plurality of louvered perforations through its side walls, said inner of said tubes having a partially closed end, the outer of said

tubes being provided with an outlet for the muffler, and a plate member fitted tightly around the inside wall surface of the outer of said tubes, said plate member being intermittently fitted around the outer surfaces of the inner of said tubes to provide openings therebetween for the passage of fluids therethrough, said plate member being adapted to be adjustably assembled in various positions to restrict or increase the flow of fluids through said louvered perforations and the partially closed end of said inner of said tubes.

14. In a muffler, the combination of a tube provided with an outlet opening, a plurality of tubes within said first mentioned tube and each provided with a partially closed end together with louvered perforations through its wall portions to cause fluids escaping therethrough to flow tangentially relative to the inside wall surfaces of said first mentioned tube, one of said plurality of tubes having its end extended beyond the end of said first mentioned tube to provide means for connecting with an exhaust pipe, and a pair of plates fitted tightly around the inside wall surface of said first mentioned tube and supporting each of said plurality of tubes, one of said pair of plates for one of said plurality of tubes being fitted tightly around one of said plurality of tubes to close one end of said first mentioned tube, one of each of said pair of plates being fitted around each of said plurality of tubes to provide openings therebetween for the passage of fluids, one of each of said pair of plates supporting each of said plurality of tubes being adapted to be adjustably assembled in various positions to restrict or increase the flow of fluids through said louvered perforations and said partially closed ends of said plurality of tubes.

15. In a muffler, the combination of a tube formed from a sheet of material into a cylindrical shape, one of the edges of said sheet of material being provided with extension portions for engaging an opposite edge portion of said sheet of material, said edge portions of said sheet being located adjacent one another to provide a slot extending therebetween longitudinally of said tube, said sheet of material being provided with a plurality of hooded perforations arranged in rows and extending circumferentially around said tube, said tube having a straight cylindrical portion forming an outlet portion at one of its ends, said tube being further provided with a conically shaped portion connecting said straight cylindrical portion with the main portion of said tube, a tube surrounding said first mentioned tube and provided with an outlet portion at one of its ends, said last mentioned tube being closed at the other of its ends around said first mentioned tube, and a disc member mounted in said second mentioned tube and supporting said first mentioned tube.

16. In a muffler provided with a slotted inlet pipe for connecting with an exhaust pipe having a lesser diameter than said slotted inlet pipe, the combination of a bushing member adapted to extend within said slotted pipe, said bushing member being adapted to receive said exhaust pipe therein, said bushing member having one of its end wall portions expanded to form a shouldered portion for engaging the end of said slotted inlet pipe to limit the distance to which said bushing member extends therein, said bushing member being formed from a sheet of material and having adjacent edge portions providing slots therebetween, one of said edge portions being provided with an extension portion located intermediate its ends, the other of said edge portions being provided with a notch for receiving said extension portion therein, said notch engaging opposite sides of said extension portions, and clamp means for contracting said slotted inlet pipe to contract said bushing member to grip said exhaust pipe.

17. In a muffler, the combination of an outer tube, an inner tube having its inner end partially closed and provided with a plurality of hooded louvers in its side walls, said inner tube providing an inlet for the muffler, a plate member closing one end of said outer tube around said inner tube, a second plate member secured to the walls of said outer tube and supporting said inner tube, said second plate member being connected to said inner tube so as to provide openings therebetween for the flow of fluids therethrough, a second inner tube having a smaller diameter than said first mentioned inner tube, and provided with a plurality of hooded louvers in its side walls, a pair of plate members secured to the walls of said outer tube and to said second inner tube, said pair of plate members supporting said second inner tube in alignment with said first mentioned inner tube, a third inner tube having its inner end partially closed and provided with a plurality of hooded louvers in its side walls, said third inner tube having a smaller diameter than said second inner tube, said third inner tube providing an outlet for the muffler, a fifth plate member closing the opposite end of said outer tube around said third inner tube, and a sixth plate member secured to the walls of said outer tube and said third inner tube, said sixth plate member being connected to said third inner tube so that it will provide openings therebetween for the flow of fluids therebetween, said fifth and said sixth plate members supporting said third inner tube in alignment with said second inner tube.

18. In a muffler for exhaust gases, the combination of a pair of chambers separated by a wall member, and a tubular member mounted to extend within said pair of chambers and through said wall member, said tubular member being provided with hooded perforations engaging said wall member, said hooded perforations and said wall member forming openings connecting said pair of chambers.

19. In a muffler for exhaust gases, the combination of a tubular member having an exit opening, and a second tubular member within said first mentioned tubular member and provided with entrance and exit openings, said exit opening of said second tubular member being located within said first mentioned tubular member, said second tubular member being provided with a plurality of louvered openings arranged circumferentially therearound in parallel planes, said lowered openings being provided with hooded portions for directing exhaust gases tangentially relative to said first mentioned tubular member.

20. In a muffler for exhaust gases, the combination of a tubular member having an exit opening, a second tubular member within said first mentioned tubular member and provided with entrance and exit openings, said exit opening of said second tubular member being located within said first mentioned tubular member, said second tubular member being provided with a plurality of louvered openings arranged circumferentially therearound in parallel planes, said louvered openings being provided with hooded portions for directing exhaust gases tangentially

relative to said first mentioned tubular member, and a wall member separating a pair of chambers within said first mentioned tubular member, said wall member surrounding said hooded portions of one of said parallel planes to provide passages between said pair of chambers.

21. In a muffler for exhaust gases, the combination of a tubular member, a second tubular member mounted in said first mentioned tubular member and provided with a row of hooded perforations extending circumferentially thereround, and a wall member mounted in said first mentioned tubular member and defining an end portion of a pair of chambers, said wall member engaging said hooded portions of said perforations intermediate their ends to enable said perforations to connect with each of said pair of chambers, said wall member and said hooded portions forming passages connecting with each of said pair of chambers.

22. In a muffler provided with a slotted inlet pipe for connecting with an exhaust pipe of lesser diameter, a bushing between said exhaust and said slotted inlet pipes, said bushing being provided with a shouldered portion for engaging an end of said slotted inlet pipe, said bushing being provided with a slot extending longitudinally therethrough, said bushing being provided with a tongue extending from one of the edges of said slot, said tongue being located intermediate the ends of said bushing, said bushing being further provided with a notch in the other edge of said slot, said notch being adapted to engage opposite edges of said tongue, said tongue and said notch preventing longitudinal distortion of said bushing in two directions.

EMMET P. GRAY.