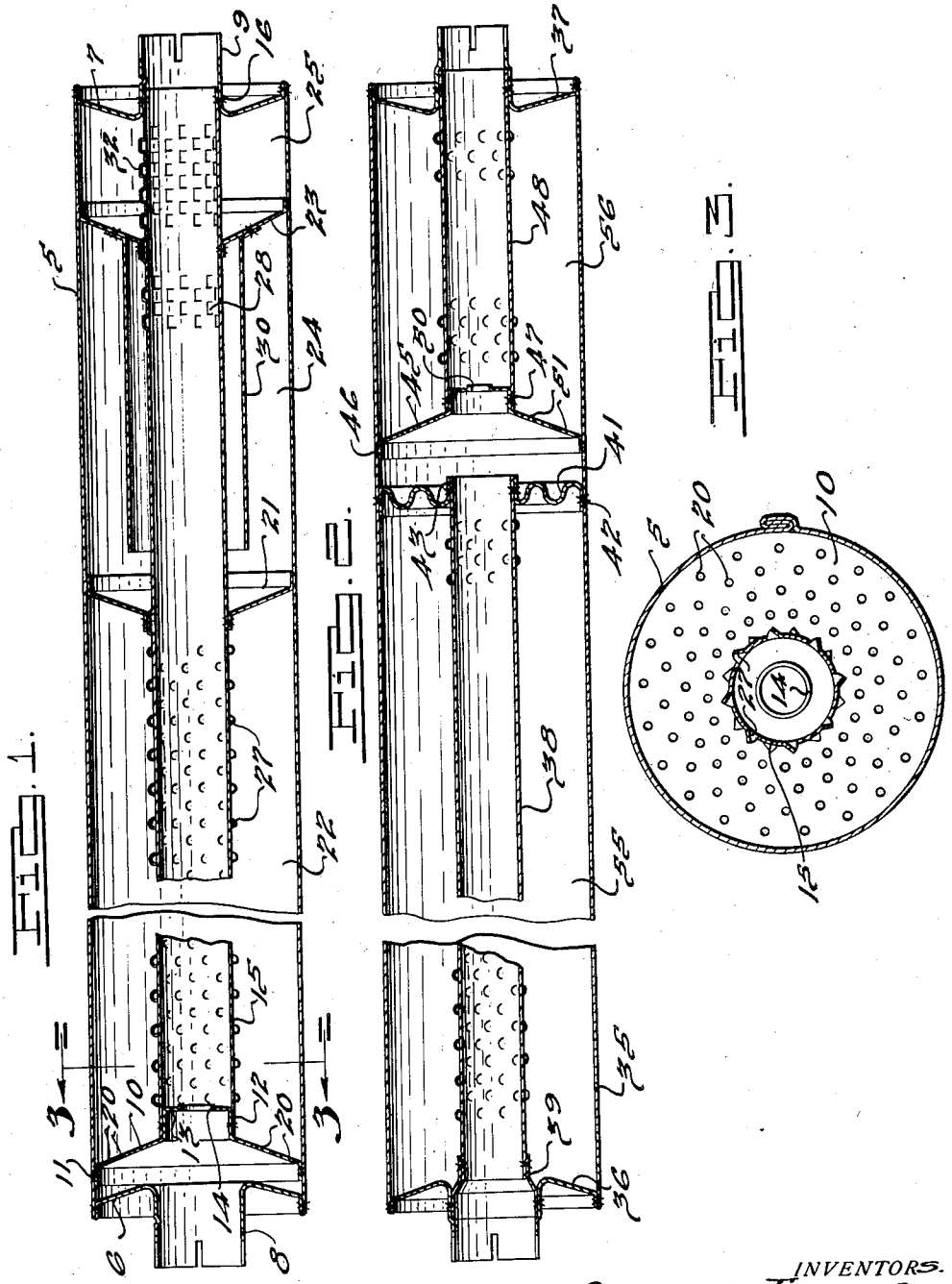
Nov. 5, 1940. G. JENSEN ET AL 2,220,866

EXHAUST SILENCER

Filed Jan. 7, 1939 2 Sheets-Sheet 1

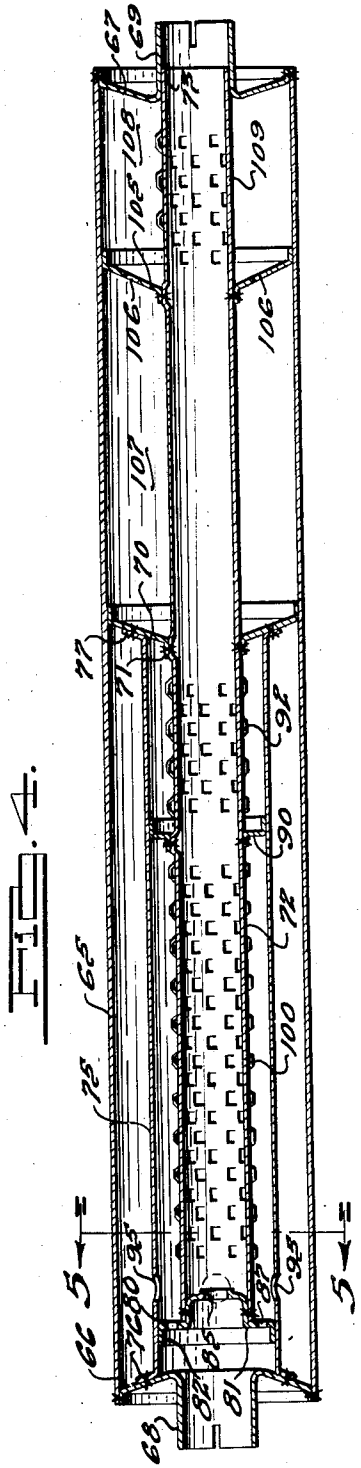


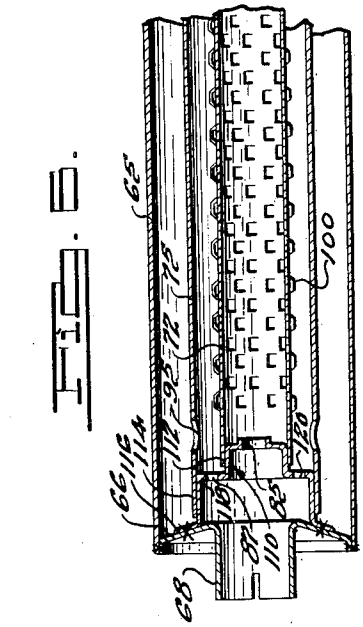
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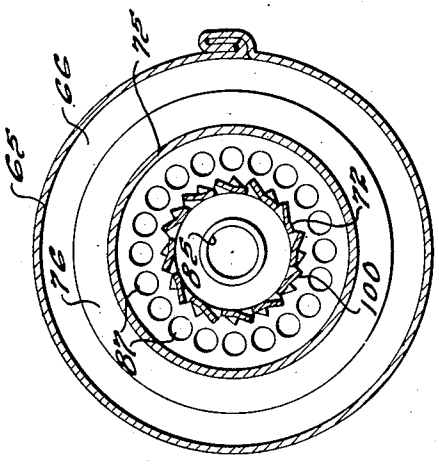
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EXHAUST SILENCER

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EXHAUST SILENCER

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Application January 7, 1939, Serial No. 249,694

16 Claims. (Cl. 181—48)

This invention relates to muffler constructions. More particularly, it relates to a novel and improved exhaust silencer construction primarily intended for attenuating the sound emanating from the exhaust of internal combustion engines of the type commonly used in the present day automotive vehicles.

The present invention relates primarily to the so-called straight-through type of mufflers and contemplates the provision of particularly simple, cheap, and quiet muffler constructions, which are effective in attenuating the sounds set up by the internal combustion engine, and particularly the objectionable harmonics of the firing frequency. It is generally considered that the most objectionable harmonics of the firing frequency are the second harmonic at the lower speeds and the first harmonic at the higher speeds, and the present construction is particularly designed to attenuate such harmonics without high back-pressure.

While the muffler herein disclosed is primarily directed to a construction which is particularly effective in a general attenuation of the above harmonics, it will be readily appreciated that muffler constructions formed in accordance with the teachings of the present invention have certain inherent advantages in eliminating other objectionable sounds normally occurring in the exhaust system.

Many other and further obvious advantages and features of the invention will become readily apparent upon consideration of the following specification in connection with the accompanying drawings forming a part thereof.

In the drawings:

Figure 1 is a longitudinal sectional view illustrating in detail a muffler construction embodying the principal features of one form of the invention;

Fig. 2 is a longitudinal sectional view similar to Fig. 1, illustrating a muffler construction embodying a modified form of the invention;

Fig. 3 is a transverse sectional view, taken on the line 3—3 of Fig. 1 and illustrating in detail the construction and arrangement of the attenuating member;

Fig. 4 is a longitudinal sectional view, illustrating a further modification of the invention;

Fig. 5 is a transverse sectional view taken along the line 5—5 of Fig. 4; and

Fig. 6 is a fragmentary longitudinal sectional view illustrating a further modification of the invention.

With more particular reference to the drawings and specifically to the embodiment of the invention shown in Figs. 1 and 3 thereof, it will be seen that the muffler construction comprises a generally cylindrical casing or outer shell 5, which is provided with conventional front and rear end wall members 6 and 7, respectively, which may be welded or otherwise secured to the outer shell in any suitable conventional manner. The end wall member 6 is provided with an axially extending, centrally disposed neck 8, which serves to provide means for connecting the forward end of the muffler to a pipe (not shown), which as is conventional in constructions of this character, serves to interconnect the muffler with the exhaust manifold of the engine with which the muffler is used. Similarly, the end wall 7 is provided with an axially extending, centrally disposed neck 9, which serves to provide means for connecting the conventional tail-pipe (not shown) to the muffler construction.

Adjacent the forward end of the muffler is mounted sound attenuating member 10, which at its outer periphery is provided with an axially extending flange 11 and which, in the present instance, extends to and is snugly but slidably seated within the shell 5. In the illustrated form, the member 10 is generally cone-shaped, although, in the broader aspects of the invention, other forms may be used. Adjacent its central portion, the member is provided with a projecting neck 12 and is also provided with a radially, inwardly directed annular flange 13, which serves to define a restricted orifice 14 of smaller cross-sectional area than the inlet opening provided by the neck 8. The neck 12 is received within and is welded to the forward end of a primary exhaust passage or tube 15, whereby the member 10 serves as a support for the tube 15. The tube 15 extends from the member 10 to the rear end of the muffler and is welded in telescoped relation within the neck 9 at the point 16.

The conical portion of the member 10 is provided with a plurality of relatively small openings 20, the purpose and function of which will hereinafter be described in greater detail. Intermediate the front and rear ends of the muffler and spaced at a distance substantially rearwardly of the midpoint is a partition member 21, which serves, together with the member 10, to define an annular chamber 22 surrounding the forward end of the primary exhaust tube 15. Adjacent the rear end of the muffler is a similar partition member 23, which, together with the partition member 21 and outer shell 5, serves to define a resonator chamber 24. The partition

member 23, together with the rear end wall member 7, and outer shell 5, serves to define a spit chamber 25 at the rear end of the muffler construction as a whole. The partitions 21 and 23 are each welded to the tube 15 and are snugly but slidably seated within the shell 5.

The portion of the primary exhaust tube lying within the chamber 22 is provided with a plurality of relatively closely spaced tangentially discharging louvers 27, which may be conveniently constructed in accordance with the teachings of the Gunn Patent No. 1,949,074, assigned to the assignee of the present invention.

An annular series of louvers 28 are formed in the primary exhaust passage adjacent the rear end of the sound resonating chamber 24. This sound resonating chamber 24 preferably has a tuning neck 30 secured in position on the partition member 23 and extending forwardly therefrom, to a point adjacent to, but spaced from, the partition member 21. From this construction, it will be obvious that sound waves and exhaust gases passing through the primary exhaust passage 15 may be discharged in a tangential direction within the tuning neck 30 and through this tuning neck may pass into and out of the resonating chamber 24.

A series of louvers 32 may similarly be provided on the primary exhaust conduit throughout that portion thereof which is disposed within the spit chamber 25 and it will, of course, be understood that this spit chamber functions in the conventional, well recognized manner, merely serving the purpose of eliminating certain of the unpitched sounds normally emanating from a muffler system.

The resonating chamber 24 may be constructed and proportioned for the elimination of the tailpipe resonances and may be regulated for the primary purpose of eliminating come-down noises, or may be constructed and arranged for any suitable purpose in order that its operation will obtain the maximum effectiveness.

As explained above, the chamber 22 and associated parts are primarily intended for the purpose of eliminating the harmonics of the firing frequency. The restricted opening 14 causes a portion of the gases and sound waves entering the muffler to be bypassed through the perforations 20 in the cone 10. The aggregate area of the openings 14 and 20 may be proportioned in such a manner that an undesirable degree of back-pressure will not be created in the muffler system as a whole. Sound waves and exhaust gases will pass inwardly and outwardly through the louvers 27, into and out of the chamber 22 as a result of pressure fluctuations inherent in muffler systems of this general type and due to tangential discharge from the louvers will set up a swirl in the chamber 22, as described in the Gunn patent referred to above. The sound waves and exhaust gases which are bypassed through the openings 20 in the member 10 will re-enter the primary exhaust passage through the louvers 27 and the destructive interference causes by the gases passing into and out of the louvers as well as through the openings 20 has been found to effect a very marked attenuation of sound, which has been found to be particularly effective in eliminating the harmonics of the firing frequency.

It will be further understood from the foregoing description of the present embodiment of the invention, that in a generic sense, the primary exhaust passage, such as 15, should be arranged so that sufficient back-pressure exists therein to cause a desired quantity of the exhaust gases to be bypassed through the openings 20 in the sound attenuating member 10. In the present instance, this back-pressure is produced in part by the restrictor 14, and in part by the inherent resistance to flow through the passage 15, and it will be understood that the size of the restrictor 14 is determined in accordance with the degree at which the inherent back-pressure is required to be supplemented in order to produce the desired degree of total back-pressure in the primary passage. In a generic sense, and in certain instances such as where the primary exhaust passage is relatively long and of relatively small diameter, the inherent back-pressure created thereby may be substantial enough to enable the restrictor 14 to be provided with a substantially larger opening than that shown, or to be dispensed with entirely. Again, in other instances, as where the primary exhaust passage has only a very low back-pressure, it may be necessary to increase the effect of the restrictor 14, by correspondingly decreasing the size of the opening therein.

Outside of the effective sound attenuating characteristics of the system, it will be readily appreciated that the above described construction is exceedingly cheap and simple to manufacture. The perforated member 10 not only serves the purpose of providing a support for the forward end of the primary exhaust passage 15, but may be preformed in such a way that this member also serves to provide the restricted orifice 14 as a unitary integral part of the member 10. It will further be readily appreciated that the muffler as a whole is simple in construction, and easily fabricated.

In the modified form of the invention shown in Fig. 2, the construction shown comprises an outer shell 35 having front and rear end wall members 36 and 37, respectively, similar in construction to the end wall members 6 and 7, described in connection with the preferred embodiment of the invention. In the modified form of the invention, the primary exhaust passage is discontinuous and includes a forward section 38 which may be mounted in direct communication with the inlet opening and which may have its front end supported by a suitable neck 39 which telescopes over the forward end of the section 38 and telescopes into the inlet opening. The rear end of the section 38 of the primary exhaust passage is supported by means of a partition member 41 which may be annularly corrugated and have its outer flange 42 welded directly to the outer shell 35 and an inner annular flange 43 welded in telescoping relation to the rear end of the section 38 of the primary exhaust conduit. It will be readily understood that the purpose and function of the annular corrugations is to permit relative axial movement between the section 38 and the outer shell, thereby greatly facilitating relative movement of these parts as a result of expansion and contraction due to heating and cooling. A perforated member 45 similar in construction and arrangement to the perforated member 10 is mounted directly rearwardly of the partition member 41 and includes an outer flange 46 which may be slidably seated within the outer shell and at its central portion may include an axially extending cylindrical portion 47, which serves to provide a telescoped mounting for the forward end of a second section 48 of the primary exhaust passage, the rear end of which is telescoped into the discharge opening in the end wall member

37. The central portion of the perforated member 45 is preformed to provide a restricted orifice 50 which, as described in connection with the preferred embodiment of the invention, serves to cause the bypassing of a portion of the gases and sound waves through perforations 51 in the conical portion of the member 45.

The chamber between the front end wall member 36 and partition member 41 serves to provide a primary expansion chamber 55 and the gases and sound waves which are discharged from the rear end of the front section of the primary exhaust conduit 38 in part will pass through the orifice 50 and in part will be bypassed through the perforations 51 in the member 45. It will be readily appreciated that the sound attenuating chamber 56 formed by the outer shell, rear end wall 37, and perforated member 45 will function in substantially the same manner as the chamber 20, described in connection with the preferred embodiment of the invention.

The arrangement of Figs. 4 and 5 illustrates the adaptation of a sound attenuating member analogous to the previously described members 10 and 45 to muffler constructions utilizing an inner shell interposed between the outer shell and the primary exhaust passage.

The muffler construction shown comprises a generally cylindrical outer casing 65 which has its ends closed by means of partition members 66 and 67 at the front and rear thereof, respectively. As in the previous embodiments, these partition members are respectively provided with necks 68 and 69 and it will, of course, be understood that the neck 68 is adapted to be secured in communication with the rear end of a pipe (not shown) connecting with the exhaust manifold of an internal combustion engine of an automotive vehicle. The neck 69 is intended for direct connection with a tail pipe (not shown) as is customary in constructions of this general character.

The outer shell 65 is provided, intermediate its ends, with a member 70, the outer flange whereof is secured, as by welding, to the shell 65, and the inner flange 71 whereof is similarly secured to an axially extending primary exhaust tube or pipe 72. This tube or pipe 72 extends substantially throughout the entire axial length of the muffler construction and has its rear end 73 slidably but snugly supported within the neck 69 at the rear end of the muffler. The forward end of the tube or pipe 72 is supported in the manner hereinafter described in detail.

An inner shell 75 of cylindrical configuration and having a diameter substantially smaller than the outer shell but considerably larger than the tube 72 is axially arranged within the shell 65 and has its forward end flanged at 76 and secured, as by welding, to the end wall 66. Its rear end is similarly flanged at 77 and is correspondingly secured to the partition member 70. Within the inner shell 75 is a sound attenuating member 80 which serves to support the forward end of the tube 72 and which has a radially extending portion 81 provided with an axially extending flange 82 snugly but slidably seated within the inner shell 75. The member 80 is provided with a restricted axial opening 85 of materially smaller diameter than the diameter of the tube 72 which serves to restrict the flow of gases through the primary exhaust tube 72. The radially extending portion of the member 80 is provided with a circumferentially arranged series of openings 87 which serve to permit a portion of the gases entering the forward end of the muffler to pass into the space between the inner shell 75 and the primary exhaust tube 72.

A partition member 90 of conventional form is secured to the primary exhaust tube 72 and is snugly but slidably seated within the inner shell 75 intermediate the ends of the intermediate shell 75. The portion of the primary exhaust tube between the partition member 70 and the partition member 90 is provided with a series of tangentially disposed louvers 92 of any suitable form, these louvers preferably being constructed in accordance with the disclosure of Gunn Patent No. 1,949,074, assigned to the assignee of the present invention. The chamber formed by the intermediate shell 75 and the partition members 70 and 90 constitutes a small spit chamber such as is conventionally employed for the elimination of unpitched sounds in the high frequency range.

The primary exhaust conduit 72, throughout the portion thereof which is disposed between the member 80' and the partition member 90, is provided with a plurality of tangentially disposed discharge louvers 100 similar to the louvers described above, and which afford communication between the interior of the tube 72 and the interior of the inner shell 75. In turn, the inner shell 75 is provided with an annular series of openings 95 which serve to provide communication between the interior of the intermediate shell and the chamber formed by the outer casing 65 and the end wall 66, the partition 70, and the intermediate shell 75. The openings 95 are illustrated as being positioned adjacent the forward end of the shell 75, but depending upon operating considerations, may be positioned near the rear end of the shell 75, intermediate the ends thereof, or may be distributed therealong.

The sound waves and exhaust gases entering the interior of the intermediate shell 75 through the openings 87 and the louvers 100 may enter the closed resonator chamber formed between the outer shell 65 and the intermediate shell 75 and it will be readily appreciated that the forward portion of the intermediate shell 75 acts as tuning means through which this communication is established.

The rear portion of the muffler rearwardly of the partition member 70 is divided into two annular chambers by means of a member 105 which is in the nature of a partition member extending between the outer shell 65 and the primary exhaust conduit 72 and is provided with an annular series of openings 106 which permit axial communication between the chamber 107 defined by the partition members 70 and 105 and the outer shell 65 and the primary exhaust conduit 72 and the member 108 defined by the partition 105 and end wall member 67. The portion of the primary exhaust tube 72 lying within the chamber 108 is provided with a plurality of tangentially discharging louvers 109 similar in construction to the louvers 92 and 100 described above and it will be seen that exhaust gases may pass outwardly through these louvers through the openings 106 into the chamber 107. It is noted that the portion of the primary exhaust tube 72 lying within the chamber 107 is imperforate and it will be readily appreciated, therefore, that the chamber 107 is entirely closed except for the openings 106.

This construction at the rear end of the muffler is particularly effective in its silencing action because of the fact that the sound waves must pass through the restricted louvers 109 in the pri-

mary exhaust tube before reaching the tuning apertures 106 in the partition member 105 which apertures in addition offer resistance which is very important in that the controlling of this resistance broadens the frequency response of the chambers to such an extent that it covers quite a large frequency range.

The arrangement shown in Fig. 6 corresponds to the arrangement shown in Figs. 4 and 5, except in respect to the form and supporting relation of the sound attenuating member.

In Fig. 6, the filter member 110 is provided with a pair of neck portions 112 and 114, which are connected together by a radially extending portion 118, and the latter whereof terminates in a radially extending flange 116 which is secured, as by welding, to the end partition 66. The neck portion 112 is snugly but slidably received within the forward end of the primary exhaust tube 72 and so constitutes a support for such forward end in the manner described above with reference to Figs. 4 and 5. The neck portion 114 is correspondingly snugly but slidably seated within the forward end of the inner shell 75, and so affords a support for the forward end of the inner shell. As in the previous embodiment, a flow restricting opening 85 is formed in the base of the member 110 and the radially extending portion 118 is provided with a series of openings 87, the function and arrangement of these openings being as described above.

It will be appreciated from the foregoing that many very substantial modifications of the above specifically described muffler constructions may be made, which at the same time will fall within the scope of the invention, as set forth in the claims.

What is claimed is:

1. In a straight-through muffler construction having an outer shell, an apertured conduit providing a portion of the primary exhaust passage through said shell, an apertured baffle means positioned between the shell and conduit and serving to support the forward end of the conduit in predetermined position within said shell, said baffe extending interiorly of said conduit and serving to restrict flow therethrough.

2. In a straight-through muffler construction having an outer shell, an apertured conduit providing a primary exhaust passage through said shell, the forward end of said conduit being spaced from the forward end of said shell, and an apertured baffle member telescoped within said shell, said baffle member being preformed to provide an axial projection adapted to telescope within and support the forward end of said conduit.

3. In a straight-through muffler construction having an outer shell, an apertured conduit providing a primary exhaust passage through said shell, the forward end of said conduit being spaced from the forward end of said shell, and an apertured baffle member positioned within said shell, said baffle member having an apertured part extruding into said conduit so as to restrict flow through said conduit and having an apertured part positioned between said conduit and said shell to afford a bypass around said restriction.

4. In a straight-through muffler construction having an outer shell, a conduit extending through said shell and providing a primary exhaust passage, spaced forward and rearward partition members extending between the conduit and the shell to provide a chamber within the shell, said conduit being apertured within said chamber, and flow restricting means positioned in said conduit toward the forward end of said muffler from said rearward partition, said conduit being imperforate between the flow restricting means and the forward one of said partitions, the forward one of said partitions being apertured, and said muffler having a by-pass circuit through said apertured partition into said chamber around said flow restricting means.

5. In a straight-through muffler construction having an outer shell, first and second conduits positioned within said shell in axially spaced relation to each other and forming together a straight-through but discontinuous primary exhaust passage through said shell, partition members associated with the rearmost one of said conduits and extending between such one conduit and the shell so as to define a chamber adjacent the rear end of the shell, and flow restricting means positioned in said rearmost one of the conduits, said rearmost one of the conduits being apertured rearwardly of the flow restricting means and the forward one of the partition members being apertured to provide a by-pass into said chamber around the flow restricting means.

6. In a straight-through muffler construction having an outer shell with the forward end thereof spaced rearwardly from the front end of the shell, a conduit within said shell and having openings in the surface thereof serving to provide communication between the interior of said conduit and the interior of said shell, flow restricting means positioned in said conduit forwardly of said openings, and a sound attenuating member positioned within the shell and extending from the shell to the conduit, said sound attenuating member being apertured so as to establish communication between the interior of the shell and the portion of said conduit forwardly of said flow restricting means.

7. In a straight-through muffler construction having an outer shell, an apertured inner shell positioned within said outer shell with the forward end thereof spaced rearwardly from the front end of the shell, a conduit within said shell and having openings in the surface thereof serving to provide communication between the interior of said conduit and the interior of said shells, flow restricting means positioned in said conduit forwardly of said openings, and a sound attenuating member positioned within said outer shell and associated with said conduit so as to establish communication between the interior of said shells and the portion of said conduit forwardly of said flow restricting means.

8. In a straight-through muffler construction having an outer shell, an apertured inner shell positioned within said outer shell with the forward end thereof spaced rearwardly from the front end of the shell, a conduit within said shell and having openings in the surface thereof serving to provide communication between the interior of said conduit and the interior of said shells, flow restricting means positioned in said conduit forwardly of said openings, and a sound attenuating member positioned within said outer shell and associated with said conduit so as to establish communication between the interior of said shells and the portion of said conduit forwardly of said flow restricting means, said sound attenuating member being supported by said outer shell and acting to support said inner shell and said conduit.

9. In a straight-through muffler construction having an outer shell, an apertured inner shell

positioned within said outer shell with the forward end thereof spaced rearwardly from the front end of the shell, a conduit within said shell and having openings in the surface thereof serving to provide communication between the interior of said conduit and the interior of said shells, flow restricting means positioned in said conduit forwardly of said openings, and a sound attenuating member positioned within said outer shell and associated with said conduit so as to establish communication between the interior of said shells and the portion of said conduit forwardly of said flow restricting means, said sound attenuating member being supported by said inner shell and being adapted to support said conduit.

10. In a straight-through muffler construction having an outer shell, an apertured conduit providing a primary exhaust passage through said shell, the forward end of said conduit being spaced from the forward end of said shell, an apertured baffle member positioned within said shell and extending radially from said conduit to said shell, and a flow diverting element positioned in said conduit adjacent the forward end of the conduit.

11. An exhaust silencer comprising, in combination, a shell part having an inlet and an outlet, means including primary exhaust tube means positioned within said shell part in such relation that the space between the shell part and the tube constitutes a silencing chamber having a closed rear end, the tube means having a perforate part to afford communication between the interior of the tube and the chamber, the silencer having an expansion chamber between the inlet and said tube means of larger cross-sectional area than the tube means, and means affording communication between the expansion chamber and the silencing chamber in by-pass relation to the perforate part of the tube means.

12. An exhaust silencer comprising, in combination, a shell part having an inlet and an outlet, means including primary exhaust tube means positioned within said shell part in such relation that the space between the shell part and the tube constitutes a silencing chamber having a closed rear end, the tube means having a perforate part to afford communication between the interior of the tube and the chamber, the silencer having an expansion chamber between the inlet and said tube means of larger cross-sectional area than the tube means, means affording communication between the expansion chamber and the silencing chamber in by-pass relation to the perforate part of the tube means, and flow diverting means positioned in said tube means adjacent the said expansion chamber.

13. An exhaust silencer comprising, in combination, a shell part having an inlet and an outlet, a primary exhaust passage positioned within the shell part with the inlet end thereof spaced rearwardly from the said shell inlet, the space between the tube and the shell part constituting a silencing chamber, the tube having an apertured part to afford communication between the interior of the tube and the silencing chamber and the chamber being closed at its rear end, the silencer having between the shell inlet and the inlet end of the tube an expansion chamber of greater cross-sectional area than the tube, and means affording communication between the expansion chamber and the silencing chamber in by-pass relation to the said apertured part of the tube.

14. An exhaust silencer comprising, in combination, a shell part having an inlet and an outlet, a primary exhaust passage positioned within the shell part with the inlet end thereof spaced rearwardly from the said shell inlet, the space between the tube and the shell part constituting a silencing chamber, the tube having an apertured part to afford communication between the interior of the tube and the silencing chamber and the chamber being closed at its rear end, the silencer having between the shell inlet and the inlet end of the tube an expansion chamber of greater cross-sectional area than the tube, means affording communication between the expansion chamber and the silencing chamber in by-pass relation to the said apertured part of the tube, and a flow diverting means positioned in the tube adjacent the inlet end thereof.

15. An exhaust silencer comprising, in combination, a shell part having an inlet and an outlet, a primary exhaust passage positioned within the shell part with the inlet end thereof spaced rearwardly from the said shell inlet, the space between the tube and the shell part constituting a silencing chamber, the tube having an apertured part to afford communication between the interior of the tube and the silencing chamber and the chamber being closed at its rear end, and apertured partition means between the tube and the shell part adjacent the inlet end of the tube forming the front end of the silencing chamber and cooperating with the shell part to define an expansion chamber between the shell inlet and the inlet end of the tube of larger cross-sectional area than the tube.

16. An exhaust silencer comprising, in combination, a shell part having an inlet and an outlet, a primary exhaust passage positioned within the shell part with the inlet end thereof spaced rearwardly from the said shell inlet, the space between the tube and the shell part constituting a silencing chamber, the tube having an apertured part to afford communication between the interior of the tube and the silencing chamber and the chamber being closed at its rear end, apertured partition means between the tube and the shell part adjacent the inlet end of the tube forming the front end of the silencing chamber and cooperating with the shell part to define an expansion chamber between the shell inlet and the inlet end of the tube of larger cross-sectional area than the tube, and a flow diverting means positioned in the tube adjacent the inlet end thereof.

GUNNAR JENSEN.
WALTER H. POWERS.

CERTIFICATE OF CORRECTION.

Patent No. 2,220,866. November 5, 1940.

GUNNAR JENSEN, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, second column, lines 27, 28 and 29, lines 43, 44 and 45, lines 58, 59 and 60, and page 5, first column, lines 1, 2 and 3, claims 6, 7, 8 and 9 respectively, for the words "outer shell with the forward end thereof spaced rearwardly from the front end of the shell, a conduit within said shell" read --outer shell, a conduit within said shell with the forward end thereof spaced rearwardly from the front end of the shell--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 21st day of January, A. D. 1941.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)

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