

Sept. 5, 1944.

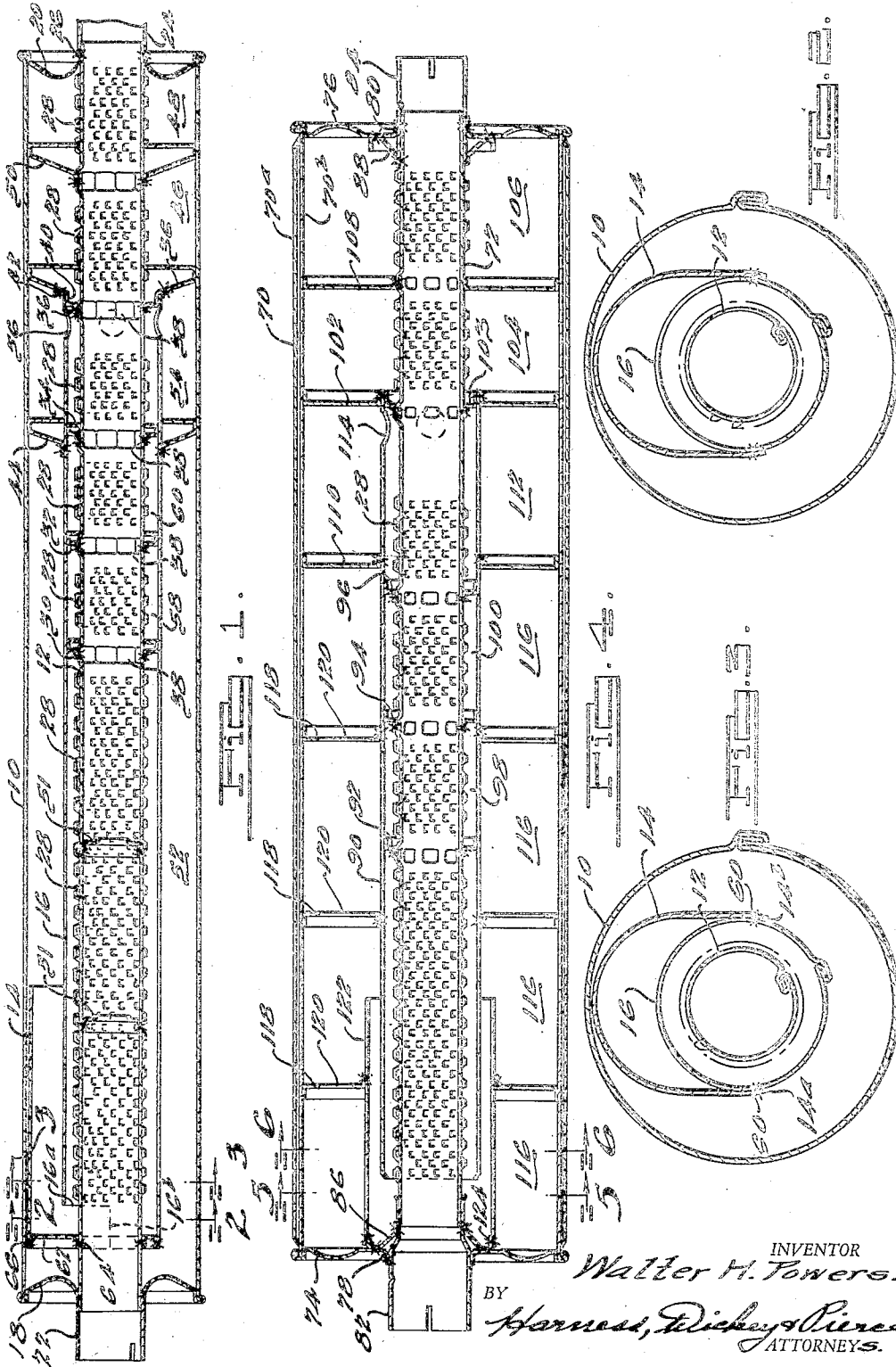
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2,357,792

SILENCER

Filed Sept. 24, 1941

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

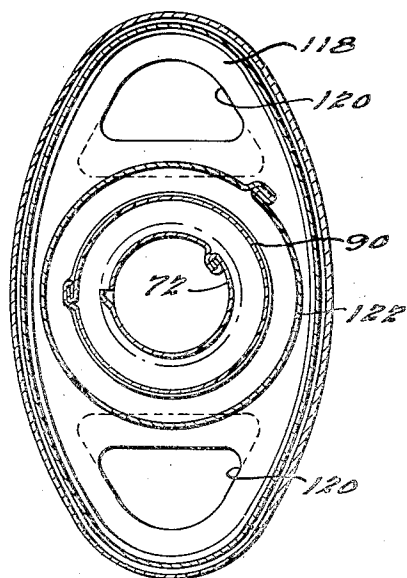


FIG. 6.

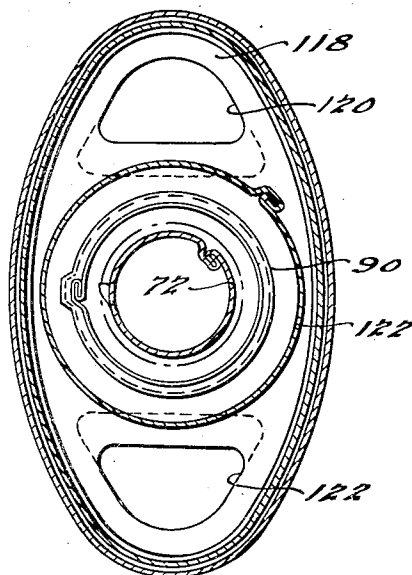


FIG. 5.

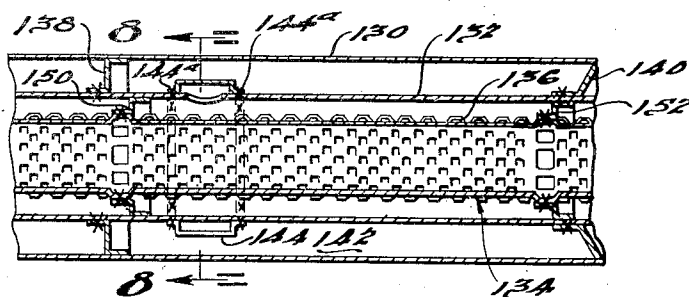


FIG. 7.

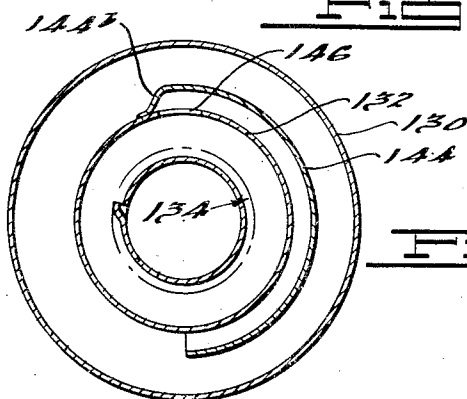


FIG. 8.

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SILENCER

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6 Claims. (Cl. 181—48)

The present invention relates to silencing structures, and in particular provides improvements in the construction and arrangement of automotive silencers.

The principal objects of the present invention are to provide structures of the above generally indicated type, which are simple in construction, economical of manufacture and assembly, and which are efficient in operation; to provide such structures comprising a conduit or other passage for the flow of gases, a tuning or resonator chamber associated with said conduit or passage, and a tuning neck which forms a coupling therebetween, particularly characterized in that the several structural elements are so related as to afford a tuning neck of unusually long length, while at the same time the over-all dimensions of the silencer are minimized; to provide such structures wherein the gases pass from the primary conduit to the tuning neck through an outlet constituted by a series of louver openings in the conduit, and wherein such louver openings are distributed throughout a substantial length of the conduit; to provide such structures wherein the tuning neck is defined by the annular space between a pair of telescopically related tubular members through which the primary conduit passes, and wherein the aforesaid louver openings are distributed in that part of the conduit which lies within the inner one of said members; to provide such structures wherein, in certain embodiments, the tuning neck extends axially of the silencer, and in other embodiments, the tuning neck extends circumferentially of the silencer; and to generally improve the construction, arrangement and operation of automotive silencers.

With the above, as well as other objects in view, which appear in the following description and in the appended claims, preferred but illustrative embodiments of the invention are shown in the accompanying drawings, throughout the several views of which corresponding reference characters are used to designate corresponding parts and in which:

Figure 1 is a view in longitudinal central section of one embodiment of the invention;

Fig. 2 is a view in transverse section taken along the line 2—2 of Fig. 1;

Fig. 3 is a view in transverse section taken along the line 3—3 of Fig. 1;

Fig. 4 is a view in longitudinal central section of a modified embodiment of the invention;

Fig. 5 is a view in transverse section taken along the line 5—5 of Fig. 4;

Fig. 6 is a view in transverse section taken along the line 6—6 of Fig. 4;

Fig. 7 is a fragmentary longitudinal central section of a further modification of the invention; and

Fig. 8 is a view in transverse section taken along the line 8—8 of Fig. 7.

It will be appreciated from a complete understanding of the present invention that the improvements thereof may be embodied in silencers of widely differing constructions, and adapted for a wide variety of different uses. It is at present preferred to utilize the improvements of the present invention in the construction of automotive silencers, more particularly automotive silencers of the so-called "straight-through" type. In an illustrative but not in a limiting sense, the present improvements are so disclosed herein.

Referring first to Figs. 1, 2 and 3, an illustrative automotive silencer of the straight-through type is shown as comprising an outer cylindrical shell 10, a primary exhaust conduit 12, cooperating intermediate conduit sections 14 and 16, and end heads 18 and 20. In accordance with conventional practice, the end heads 18 and 20 are secured to the shell 10 at the respectively opposite ends thereof and are formed to define neck portions 22 and 24 by which they may be connected, respectively, to the exhaust pipe and tail pipe of the associated engine. The primary exhaust conduit 12 passes longitudinally through the shell 10, preferably in concentric relation thereto, as shown, and the respectively opposite ends of the conduit 12 are telescopically received in the neck portions 22 and 24. Preferably, and as shown, the conduit 12 is secured to the neck portion 24 by a plurality of circumferentially distributed spot welds 26, and has a sliding fit within the neck portion 22 so as to permit some relative movement between the members as the silencer structure heats and cools.

The primary exhaust conduit 12 is provided, along its length, with a plurality of outlets constituted by groups of relatively closely spaced louver openings 28 which may and preferably do have the tangential form described and claimed in Gunn Patent No. 1,949,074, which is assigned to the assignee hereof. As is described in more detail in the Gunn patent, the tangentially directed louvers impart to gases flowing outwardly therethrough a circumferential or swirling motion which has a substantial silencing effect.

The intermediate conduit 16 is fitted over the primary conduit 12 and is supported in concentric relation thereto by a plurality of partitions

30, 32 and 34, the inner flanges of each whereof are welded or otherwise secured to usual annular embossments 38 formed on the conduit 12. The outer flanges of the just-mentioned partitions have a sliding fit relative to the conduit 16. The righthand end of the conduit 16 is seated upon a shoulder 40 formed on an additional partition 36, the inner flange whereof is also seated upon and permanently secured to an additional embossment 38 on the conduit 12. The outer flange of the partition 36 has a sliding fit within the shell 10, and, as shown, the intermediate conduit 16 is permanently secured to the partition 36 by means of a plurality of circumferentially distributed spot welds 42. Additional support for the intermediate conduit 16, as well as for the primary conduit 12, is afforded by a partition 44, the inner flange whereof is secured to the intermediate conduit 16 and the outer flange whereof has a sliding fit within the shell 10.

The space between the partition 36 and the end head 20 is divided into two chambers 46 and 48 by an additional partition 50, the inner flange whereof is secured to the conduit 12, and the outer flange whereof has a sliding fit within the shell 10.

The space between the partition 36 and the lefthand end head 18 is divided into a primary tuning or resonator chamber 52 and a smaller or secondary tuning chamber 54 by means of the previously-mentioned partition 44, and it will be noticed that the intermediate conduit 16 has, within the chamber 54, an outlet constituted by a plurality of circumferentially distributed, relatively large openings 56 which, with the louver openings 28, afford communication between the conduit 12 and the chamber 54. The openings 28 are spaced somewhat to the left of the openings 56. Thus, that part of the conduit 16 which lies between the openings 28 and 56 functions as a tuning neck.

It will also be noticed that the partitions 30, 32 and 34 cooperate with the conduit 12 and the intermediate conduit 16 to define an additional pair of relatively small chambers 58 and 60.

In accordance with the present invention, a tuning neck is interposed between the primary silencing chamber 52 and the conduit 12. This tuning neck is constituted by the conduit 14 and that part of the conduit 16 which is telescoped within the conduit 14. The marginal edges 14a and 14b of the conduit 14, which is of downwardly presenting U-shaped form, are positioned at approximately diametrically opposite points on the conduit 16, and are secured to the latter by a plurality of longitudinally distributed welds 60. The righthand end of the conduit 14 is open, as indicated, and the lefthand end thereof is closed by a partition 62, the inner flange whereof is secured to the conduit 12 by a plurality of circumferentially distributed welds 64, and the outer flange whereof is secured to the conduit 14 by means of a series of peripherally spaced welds 66. In order to afford a gas passage around the lefthand end of the conduit 16 and into the tuning neck afforded by the chamber 14, the upper one-half of the lefthand end portion of the conduit 16 is cut away, as indicated by the marginal edges 16a and 16b.

As will be appreciated, the primary resonator chamber 52 functions primarily to attenuate those frequencies, which, in automotive practice, are usually referred to as "note." That is to say, those sounds having frequencies following, for example, in the range from 40 to 110 cycles per

second and certain of the harmonics thereof. The remaining chambers, including the secondary tuning chamber 54 and the related chambers 46, 48, 58 and 60, serve to attenuate the so-called unpitched sounds, which, as will be understood, are of relatively high frequency, and the secondary chamber also functions to attenuate the higher "notes," such as the come-down notes.

Considering now the operation of the structure of Figs. 1, 2 and 3, it will be appreciated that, for purposes of description, the gas stream which enters the inlet 22 may be regarded as made up of a succession of pressure peaks alternating with valleys. This gas stream, under a substantial velocity head, passes through the inlet 22 into the primary exhaust conduit 12. A portion of this gas stream may be regarded as passing directly through the conduit 12 to the outlet 24, the ratio of which to the entire gas stream is controllable by the usual restrictors 51. Another portion of this gas stream, however, under the influence of the pressure peaks, passes outwardly through the series of louver openings which lie to the left of the partition 30, and flows through the tuning neck into the primary resonator chamber 52. Each body of gas which thus enters the resonator chamber 52 builds up the pressure therein, and under the influence of this increased pressure, the inflow to the resonator 52 is followed by an outflow of gas therefrom through the tuning neck and the louver openings into the primary gas conduit 12. As will be understood, the return or outflow from the resonator 52 joins a valley in the oncoming gas stream, which rejoinder produces the silencing action which is characteristic of resonator structures.

The gas stream, after being subjected to the silencing action of the resonator 52, passes along the conduit 12 and is thereafter subjected to the silencing actions of the chambers 58, 60, 54, 46 and 48, as will be understood.

It has been found in practice that a substantially improved silencing action is afforded when the coupling between the primary gas conduit and the resonator chamber is constituted by a relatively large number of relatively small closely spaced louver openings, such as the louver openings 28. It is, therefore, desirable to be able to distribute these openings over a considerable length of the gas conduit 12. It will be understood, further, that generally stated, the frequency or range of frequencies over which a resonator chamber is effective is a function of the size of the resonator chamber and of the length and area of the associated tuning neck. Also, it will be understood that, for a given frequency or range of frequencies, increases in the length of the tuning neck enable decreases in the size of the resonator chamber.

The present chamber is particularly advantageous because, without increasing either the length or diameter of the silencing structure, the present tuning neck arrangement makes it possible to provide a tuning neck of substantial length and at the same time provides a relatively long louvered section opening into the tuning neck. The present structure is, therefore, materially more efficient than prior structures with which the present applicant is familiar.

In the modified embodiment of the invention shown in Figs. 4, 5 and 6, the silencer is provided with an oval shell 70 formed by circumferentially disposed inner and outer plies 70a and 70b, and as before is provided with a primary gas conduit 72, which extends entirely through the

shell 70. If desired, a layer of asbestos or similar insulating material may be interposed between the plies 70a and 70b. The ends of the shell 70 are closed by end heads 74 and 76, which are formed to define relatively short flanges 78 and 80. The inlet nipple 82, which is adapted for connection to the exhaust pipe of the engine, is rigidly secured to the flange 78, and the reduced inner end thereof slidably receives the lefthand end of the conduit 72. Similarly, the outlet nipple 84 is rigidly secured to the flange 80 and receives the righthand end of the conduit 72. The latter end of the conduit 72 is rigidly secured to the nipple 84 by means of a series of circumferentially distributed spot welds. Preferably, and as illustrated, reinforcing members 86 and 88 are connected between the respective end heads 74 and 76 and their associated nipples 82 and 84, and are permanently secured thereto by circumferentially distributed spot welds.

As in the previous instance, an intermediate conduit 90 is fitted over the primary conduit 72 and is maintained in centered relation thereto by a plurality of partitions 92, 94 and 96, which correspond to the previously described partitions 30, 32 and 34 and, with the conduits 72 and 90, define a pair of auxiliary chambers 98 and 100. The righthand end of the conduit 90 is seated in the annular space between the inner and outer flanges, respectively, of the aligned partitions 102 and 103. The space between the partition 102 and the head 76 is divided into two chambers 104 and 106 by an additional partition 108, which corresponds to the previously described partition 50. The partition 102 also cooperates with a partition 110 to define a chamber 112, which corresponds to the previously described chamber 54. Communication between the chamber 112 and the conduit 72 is afforded through a series of circumferentially spaced, relatively large openings 114 in the conduit 90 and through the louver openings 28 in the conduit 72.

The space between the partition 110 and the lefthand head 74 constitutes, as before, a primary tuning chamber 116, which chamber receives a plurality of partitions 118. The partitions 118 are provided with relatively large apertures 120 therein, the areas whereof are such as to enable a substantially unrestricted flow of gas throughout the chamber 116.

In the present instance, the lefthand end of the conduit 90 is entirely open and is spaced somewhat to the right of the head 74. The tuning neck in the present instance is afforded by the auxiliary conduit 122, the lefthand end whereof is fitted upon and is rigidly secured to the outer flange 124 of the reinforcing member 86, and the righthand end whereof extends over and to the right of the lefthand end portion of the conduit 90. Additional support for the neck 122 is afforded by the lefthand partition 118.

It is believed to be evident that the operating characteristics of the arrangement of Figs. 4, 5 and 6 correspond, in all respects which are pertinent to an understanding of the invention, to the operation of the embodiment of Figs. 1, 2 and 3.

In the remaining embodiment shown in Figs. 7 and 8, the tuning neck, which is interposed between the primary gas conduit and the primary tuning chamber, extends in a direction circumferentially of the primary gas conduit rather than in a direction axially of such con-

duit. More particularly, in the illustrative arrangement of Figs. 7 and 8, the silencer is provided with a shell 130, an intermediate conduit 132, and a primary conduit 134, having an outlet defined by a series of louver openings 136 of the previously described type. The louver openings 136 are positioned between the partitions 150 and 152, and with the hereinafter described neck, acoustically couple the conduit 134 and the chamber 142. Partitions 138 and 140 cooperate with the shell 130 and the intermediate conduit 132 to define a tuning chamber 142. Communication between the chamber 142 and the annular space between the conduit 134 and the conduit 132 is afforded through the neck member 144. The member 144 is in the form of an arcuately extending stamping, channel-shaped in section, as viewed in Fig. 7. The member 144 is secured to the conduit 132 by means of flanged portion 144a on the member 144, and the upper end thereof, as viewed in Fig. 8, is closed by an end wall 144b. The lower end of the member 144, as viewed in Fig. 8, is open. The conduit 132 is provided with an outlet, illustrated as a single, relatively large opening 146, which opens into the member 144 immediately adjacent to the closed end thereof. With this relationship, it will be observed that a desirably long louvered section (between the partitions 150 and 152) is afforded, and, at the same time, a relatively long tuning neck is provided by the member 144.

Although only several embodiments of the invention have been described in detail, it will be appreciated that further modifications in the form, number and arrangement of parts may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. In a silencer, the combination of acoustic silencer structure including means defining a primary conduit, said conduit having an outlet in the side thereof through which gases may pass, means defining a silencing chamber, a conduit member extending along said conduit and into which said outlet opens, and means defining a tuning neck the length whereof extends circumferentially of said primary conduit, said tuning neck opening at one end into said conduit member and opening at the other end into said chamber.

2. In a silencer, the combination of acoustic silencer structure including means defining a primary conduit, said conduit having an outlet in the side thereof, an intermediate conduit through which said primary conduit passes and into which said outlet opens, means including a shell member for including the aforesaid conduits and cooperating with said intermediate conduit to define a silencing chamber, and a shell-like tuning neck member carried by said intermediate conduit with its length extending circumferentially thereof, said tuning neck opening at one end into said intermediate conduit and opening at the other end into said chamber.

3. In a silencer, the combination of a shell having an apertured inlet header at one end and an apertured outlet header at the other end, means including a primary gas conduit positioned within the shell and forming a path through which gases may flow through the silencer from the inlet header to the outlet header, said conduit having a series of openings in the side thereof distributed along at least a part of its length, a second conduit surrounding but spaced from at least that portion of the periphery of the primary

conduit which includes said openings and defining with said portion a gas passage, the end of said passage remote from the said inlet header being closed and the end of said passage adjacent said inlet header being open, the space between the shell and the second conduit defining a resonator chamber one end whereof is closed by said inlet header, and a tuning neck fitted over said second conduit and extending lengthwise of said conduits, the end of the neck adjacent the inlet header communicating with said open end of said passage, and the other end of the neck communicating with said chamber.

4. In a silencer, the combination of a shell having an apertured inlet header at one end and an apertured outlet header at the other end, means including a primary gas conduit positioned within the shell and forming a path through which gases may flow through the silencer from the inlet header to the outlet header, said conduit having a series of openings in the side thereof distributed along at least a part of its length, a second conduit surrounding but spaced from at least that portion of the periphery of the primary conduit which includes said openings and defining with said portion a gas passage, the end of said passage remote from the said inlet header being closed and the end of said passage adjacent said inlet header being open, the space between the shell and the second conduit defining a resonator chamber one end whereof is closed by said inlet header, and a tuning neck fitted over said second conduit and extending lengthwise of said conduits, the end of the neck adjacent the inlet header communicating with said open end of said passage, and the other end of the neck communicating with said chamber said tuning neck being carried by said second conduit and extending generally parallel to said primary conduit.

5. In a silencer, the combination of a shell having an apertured inlet header at one end and an apertured outlet header at the other end, means including a primary gas conduit positioned within the shell and forming a path through which gases may flow through the silencer from the inlet header to the outlet header, said conduit having a series of openings

in the side thereof distributed along at least a part of its length, a second conduit surrounding but spaced from at least that portion of the periphery of the primary conduit which includes said openings and defining with said portion a gas passage, the end of said passage remote from the said inlet header being closed and the end of said passage adjacent said inlet header being open, the space between the shell and the second conduit defining a resonator chamber one end whereof is closed by said inlet header, and a tuning neck fitted over said second conduit and extending lengthwise of said conduits, the end of the neck adjacent the inlet header communicating with said open end of said passage, and the other end of the neck communicating with said chamber said tuning neck being telescopically fitted over said second conduit and being secured to the inlet header.

6. In a silencer, the combination of a shell having an apertured inlet header at one end and an apertured outlet header at the other end, means including a primary gas conduit positioned within the shell and forming a path through which gases may flow through the silencer from the inlet header to the outlet header, said conduit having a series of openings in the side thereof distributed along at least a part of its length, a second conduit surrounding but spaced from at least that portion of the periphery of the primary conduit which includes said openings and defining with said portion a gas passage, the end of said passage remote from the said inlet header being closed and the end of said passage adjacent said inlet header being open, the space between the shell and the second conduit defining a resonator chamber one end whereof is closed by said inlet header, and a tuning neck fitted over said second conduit and extending lengthwise of said conduits, the end of the neck adjacent the inlet header communicating with said open end of said passage, and the other end of the neck communicating with said chamber said tuning neck being carried by said second conduit with its length extending circumferentially thereof.

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