April 29, 1930. R. B. BOURNE 1,756,626

SILENCER

Filed July 22, 1927

Fig. 1.

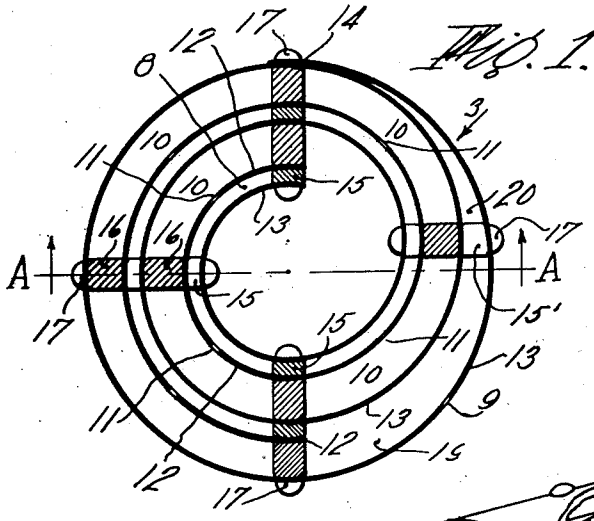


Fig. 3.

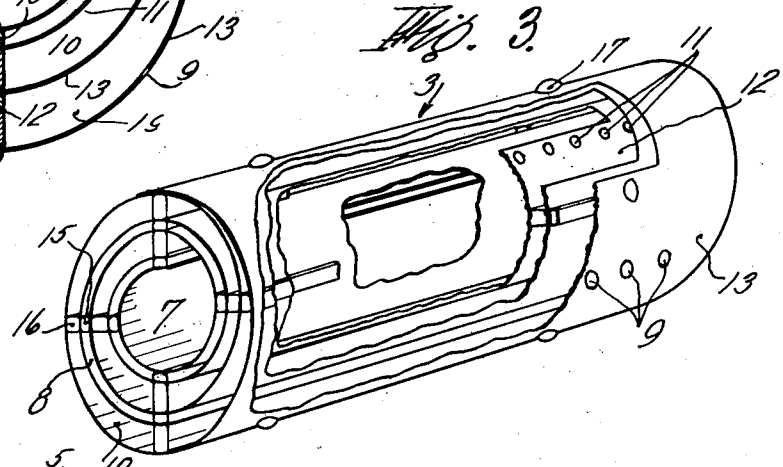
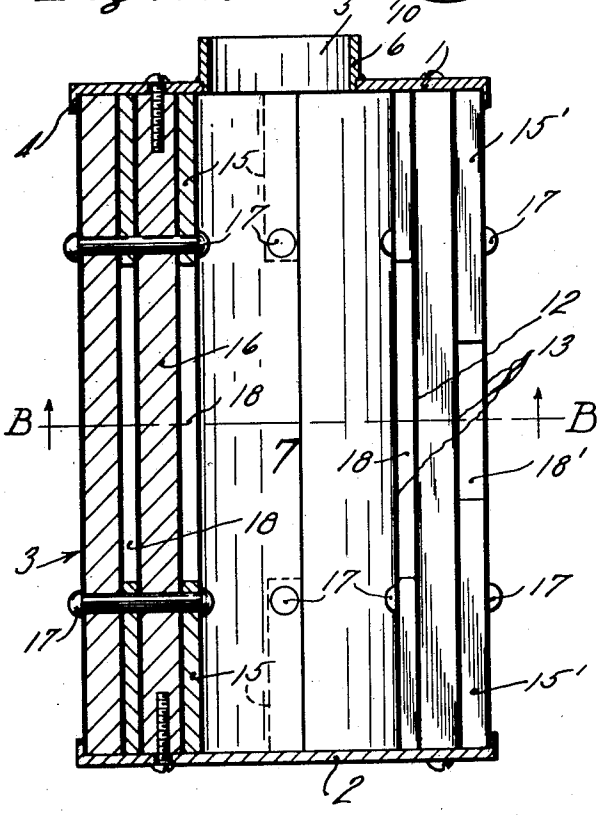


Fig. 2.



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Patented Apr. 29, 1930

1,756,626

UNITED STATES PATENT OFFICE

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SILENCER

Application filed July 22, 1927. Serial No. 207,787.

This invention relates to devices for freely conducting a gaseous medium, or carrier of pressure pulsations such as are concerned with sound waves, to or from the apparatus at which said pulsations originate and at the same time limiting the transmission of said wave pulsations therethrough. More particularly, it refers to silencers which are designed for explosive engines, and for the exhaust or intake of air pumps, blowers, air compressors and the like.

The noises and vibrations or pulsations of audible or inaudible frequencies are generally existent in pipes, chambers or other enclosures which for the purposes of this invention are considered acoustic elements and they are in general incident to the exhausting, pumping, discharging, sucking, releasing and the like of masses of gas.

One object of the invention is to provide, in a silencer having one or more acoustic channels in the form of curved or spiral passageways, sidebranches, successively disposed along the length of the passageways; these sidebranches being in the form of chambers acoustically connected with the passageways and so disposed as to contribute to the silencing of the noises and the attenuating of the pulsations or vibrations of the exhaust or the intake of the apparatus to which the silencer is connected, without excessive back pressure.

Further objects and advantages will appear and be readily appreciated from the detailed description of the invention and the operation of same which follows, taken in connection with the accompanying drawings which show an embodiment of the invention.

Referring to the drawings:

Fig. 1 is a transverse sectional view of a silencer taken along the line B—B of Fig. 2;

Fig. 2 is a longitudinal sectional view taken along the line A—A of Fig. 1; and

Fig. 3 is an isometric view of the silencer with the header members removed and with parts of the channel wall broken away.

Referring more particularly to the drawings, 1 and 2 indicate header members consisting of circular plates abutting the ends of the silencing unit proper, generally indicated at 3. The header members 1 and 2 are provided with suitable inwardly turned flanges 4 for fitting over the ends of the exterior casing of the silencing unit 3 and the header member 1 is also provided with a central opening 5 which may be either the inlet or outlet of the silencer, depending on whether the silencer is attached to an apparatus which is exhausting or intaking. An outwardly extending flange 6 may be fitted on the header 1 in any suitable manner to serve as a pipe connection to the apparatus to be silenced.

The silencing unit 3 as a whole is formed as a cylindrical-like casing enclosing an interior chamber 7 and in said casing there is provided a single, long and wide, but relatively shallow depth passage 8 leading spirally from the interior chamber 7 to the exterior of said casing. This device is not necessarily limited to the use of a wide shallow passageway or channel, although such passageways, by virtue of their large surface, afford a means for effectively utilizing the viscosity of the medium adjacent to the bounding surfaces of such passageways in attenuating alternations or vibrations of relatively high frequencies, which might otherwise pass unhindered therethrough. The communication of said passage 8 with the outside is afforded by outlets 9 (as indicated in Figs. 1 and 3) in the outer shell of said casing.

Through the said spiral passage 8 both the flow of gas or air and alternations of pressure therein are conducted on the way from the inlet 5 of said casing to the outlets 9 thereof. The passage 8 will permit a substantially unimpeded travel of the gaseous medium therethrough, such as a stream of exhaust gas from an explosive engine or the air coming from or going to a pump. As regards its function as an acoustic channel, however, said spiral passage 8 is modified in certain important particulars with a view to greatly reducing the amplitude of the pressure alternations transmitted therethrough, whereby substantially no noise will be delivered from said silencer.

The behavior characteristics of an acoustic system depend on the acoustic reactance and resistance of its elements and the disposition of these elements with relation to each other.

The modification of the acoustic channel 8 involves the use of acoustic elements in a manner which is analogous, within the limitations of the art, to the employment of inductance, capacitance, and resistance in the construction of electrical filter networks. For an example of such an arrangement in the electrical art, reference is made to the U. S. patent to Campbell, No. 1,227,113 of May 22, 1917. The acoustic elements of the passage or channel 8 are the channel itself, a series of closed chambers 10, distributed lengthwise of said channel 8 and laterally disposed thereto and various combinations thereof and therebetween. Said chambers 10, in the disposition shown are substantially closed except for certain openings 11 therefrom into the channel 8. The chambers 10 may be regarded as acoustic elements in shunt with the acoustic channel 8 and are generally termed acoustic side branches. The number and dimensions of the side branches or chambers 10, and their disposition along the channel, as well as the size and number of the communicating orifices 11, together with the shape and dimensions of the channel 8, will determine the effectiveness thereof in limiting the transmission of alternations of certain frequencies.

In addition to the side branches 10, the channel 8 is further modified along its length by being periodically enlarged and contracted in width. This modification is not always necessary, but in some cases may be desirable in that such changes in the acoustic channel may provide the proper relation between the parts of said channel or between the elements of said channel and side branches, whereby the functioning of the acoustic system as a whole is made more effective. The peripheral distance between such enlargements is not necessarily uniform.

A preferred method of forming the acoustic or conducting channel 8 with its side branches and periodic enlargements is as follows: Two long and wide sheets 12 and 13 spaced in relatively close parallel relation are coiled in the form of a spiral (as shown in Fig. 1). Preferably the radial space between the successive convolutions of said spiral (which provides the depth for the chambers 10) is greater than the space between the sheets 12 and 13 (which is the depth of the channel 8). The inner ends of said sheets 12 and 13 may be conterminous, but the outer ends thereof do not terminate at the same radial line. Sheet 13, at its outer portion, is preferably continued beyond the end of sheet 12 for an additional coil and is then overlapped upon itself and fastened at 14 to complete the outside cylindrical casing of said silencer and to form a terminal chamber 19 for the channel 8.

The space between the sheets 12 and 13 forming the channel 8 is provided by channel spacing bars 15. The space between successive convolutions of said pair of sheets is provided by chamber spacing bars 16. Such spacing bars are preferably disposed transversely of the sheets at four different points around the circumference of the casing and those in the same radial line may be held together and held to said sheets by suitable tie bolts 17. In this manner, the entire assembly of sheets and spacing bars is held together as a unit and in the form described. The headers 1 and 2 abut the marginal edges of the sheets and may be fastened to the ends of said unit by suitable screw bolts 20.

The channel spacers 15 (as shown in Fig. 2) extend only part way from the marginal edges of the sheets 12 and 13 toward the center thereof and provide the spaces 18, as shown in Fig. 2. The innermost one of such spacers serves as an entrance to the channel 8 from the chamber 7. Throughout the length of channel 8, (as will be clear from Fig. 1), the channel spacers 15 will at intervals restrict the width of said channel 8 to that of the space 18. The portions of said channel 8 in which said spacers 15 do not occur, have a width of the entire length of the casing 3, between the headers 1 and 2. The chamber spacers 16 (as shown in Fig. 2) extend continuously across the entire width of the sheets 12 and 13 from margin to margin thereof and therefore completely block off each end of the side chambers 10, whereby said chambers 10 are substantially closed as previously described. The outer end of the channel 8 opens into or terminates in the chamber 19 which chamber is open to the outside through the apertures 9. Beyond the terminal chamber 19 and formed by the converging portions of the sheet 13 is a further terminal chamber 20 which is closed except for its communication with chamber 19 through the restricted space at 18′ between the spacers 15′. The terminal chambers 19 and 20, together with the restricted opening 18′, provide suitable terminating impedance for the system, thereby assisting the structure acoustically ahead thereof to function more effectively. It will be noted that the space 18′ (from Fig. 2) is narrower than the other similar spaces 18 and that the spacers 15′ are correspondingly longer than the spacers 15. Considerable dissipation may be expected in the terminal chamber 20 due to its shape.

In operation, the silencer will be connected by the flange 6 to the source of the objectionable noise, which may be the inlet of some types of apparatus or the outlet of others. Assuming an exhaust gas of an explcsive engine enters at 5, it will leave the central chamber 7 through the entrance 18 and follow a smooth course out through the spiral passage 8 to the terminal chamber 19, and thence through the openings 9 to the outside. Except for a slight eddying effect on the current in passing the spacers 15, this out-

ward flow of gas will be relatively unchecked and substantially no back pressure will be caused at the exhaust port of said engine. The sound waves, on the other hand, will be so attenuated in passing through the system as to be scarcely audible when emerging from the outlets 9.

Obviously, the design and arrangement of the specific apparatus shown and described can be varied within the scope of the invention as hereinafter claimed.

What I claim is:

1. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a spirally disposed conducting channel and a series of adjacent chambers laterally disposed with respect thereto, said chambers being acoustically coupled to said channel.

2. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a spirally disposed conducting channel, relatively extensive in length but small in depth and a series of adjacent chambers laterally disposed with respect thereto, said chambers being acoustically coupled to said channel.

3. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a spirally disposed conducting channel, and a series of adjacent chambers of different sizes, laterally disposed with respect thereto, said chambers being acoustically coupled to said channel.

4. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a spirally disposed conducting channel relatively extensive in length but small in depth, and a series of adjacent chambers of different sizes laterally disposed with respect thereto, said chambers being acoustically coupled to said channel.

5. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a spirally disposed conducting channel, a series of adjacent chambers laterally disposed with respect thereto, said chambers being acoustically coupled to said channel and said channel terminating in a chamber.

6. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a spirally disposed conducting channel, a series of adjacent chambers laterally disposed with respect thereto, said chambers being acoustically coupled to said channel and a terminal structure for said channel comprising a chamber arranged for dissipating acoustic energy.

7. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a spirally disposed conducting channel of changing cross-sectional area with respect to the length thereof, and a series of adjacent chambers laterally disposed with respect thereto, said chambers being acoustically coupled to said channel.

8. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a spirally disposed conducting channel, said channel being alternately enlarged and contracted throughout its length and a series of adjacent chambers laterally disposed with respect thereto, said chambers being acoustically coupled to said channel.

9. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a spirally disposed conducting channel relatively extensive in length but small in depth and having the width thereof alternately enlarged and contracted in the direction of its length and a series of adjacent chambers laterally disposed with respect thereto, said chambers being acoustically coupled to said channel.

10. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a spirally disposed conducting channel, said channel along its length being alternately enlarged and contracted in width, a series of adjacent chambers laterally disposed with respect thereto, said chambers being acoustically coupled to said channel and a terminal structure for said channel comprising a chamber arranged for the dissipation of acoustic energy.

11. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a spirally disposed conducting channel relatively extensive in length but small in depth and along its length being alternately enlarged and contracted in width, a series of adjacent chambers laterally disposed with respect thereto, said chambers being of different size and acoustically coupled to said channel, and a terminal structure for said channel comprising a chamber arranged for dissipating acoustic energy.

12. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a spirally disposed conducting channel and a series of adjacent chambers laterally disposed with respect thereto, said chambers being closed except for one or more relatively small ports opening into said channel.

13. A device for conducting a flow of gas to

or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a cylindrical-like casing formed from a pair of sheets coiled together about the axis of said casing in the form of a spiral, the marginal edges of said sheets being abutted by headers at each end of said casing, spacers disposed transversely of said sheets and located at intervals in the length thereof, certain of said spacers being between said sheets to provide with said sheets a conducting channel, and others of said spacers being between convolutions of said spiral to provide with said sheets substantially closed chambers laterally disposed with respect to said conducting channel, said chambers being acoustically coupled to said channel.

14. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a cylindrical-like casing formed from a pair of sheets coiled together about the axis of said casing in the form of a spiral, the marginal edges of said sheets being abutted by headers on at each end of said casing, spacers disposed transversely of said sheets and located at intervals in the length thereof, certain of said spacers being between said sheets to provide with said sheets a conducting channel, others of said spacers being between convolutions of said spiral to provide with said sheets substantially closed chambers laterally disposed with respect to said channel, said chambers being acoustically coupled to said channel, and radially disposed members for securing said sheets and spacers together.

15. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a cylindrical-like casing formed from a pair of sheets coiled together about the axis of said casing in the form of a spiral, the marginal edges of said sheets being abutted by headers, one at each end of said casing, spacers disposed transversely of said sheets and located at intervals along the length thereof, certain of said spacers being between said sheets to provide with said sheets a conducting channel and extending part way from the marginal edges of said sheets towards the center thereof to periodically restrict the width of said channel, others of said spacers being between convolutions of said spiral and extending from margin to margin of said sheets to provide with said sheets chambers laterally disposed with respect to said conducting channel, said chambers being acoustically coupled to said channel.

16. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a cylindrical-like casing formed from a pair of sheets coiled together about the axis of said casing in the form of a spiral, one of said sheets being extended in such a manner as to finally overlap itself to form a terminal chamber, the marginal edges of said sheets being abutted by headers, one at each end of said casing, spacers transversely disposed of said sheets and located at intervals along the length thereof, certain of said spacers being between said sheets to provide with said sheets a conducting channel and extending part way from the marginal edges of said sheets toward the center thereof to periodically restrict the width of said channel, other of said spacers being between convolutions of said spiral and extending from margin to margin of said sheets to provide with said sheets chambers laterally disposed with respect to said conducting channel, said chambers being acoustically coupled to said channel.

17. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a continuously winding conducting channel and a series of chambers laterally disposed with respect thereto, said chambers being acoustically coupled to said channel.

18. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a continuously winding conducting channel and a series of closed chambers of different sizes, laterally disposed with respect to and acoustically coupled to said channel.

19. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a continuously winding conducting channel, a series of closed chambers laterally disposed with respect to and acoustically coupled to said channel, and a terminal structure presenting a terminating acoustic impedance for the system comprising the channel and chambers.

20. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a continuously winding conducting channel, a series of closed chambers of different sizes laterally disposed with respect to and acoustically coupled to said channel, and a terminal structure presenting a terminating acoustic impedance for the system comprising the channel and chambers.

21. A device for conducting a flow of gas to or from an apparatus and limiting the transmission of wave pulsations therethrough, comprising a continuously winding conducting channel, a plurality of acoustic elements acoustically coupled to the channel at in-

tervals along its length, and a terminal structure into which the channel leads, said terminal structure presenting a terminating acoustic impedance for the system comprising the channel and the acoustic elements.

In testimony whereof I have affixed my signature.

ROLAND B. BOURNE.