Nov. 25, 1941. R. B. BOURNE 2,264,195

SILENCING DEVICE

Filed Aug. 16, 1939

Fig. 1.

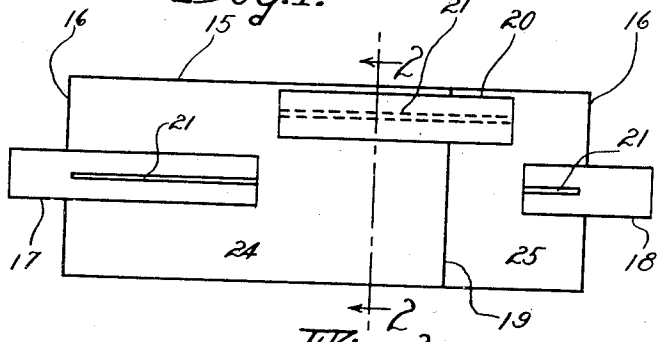


Fig. 2.

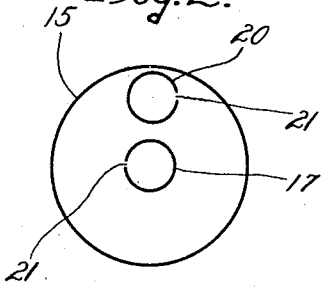


Fig. 3.

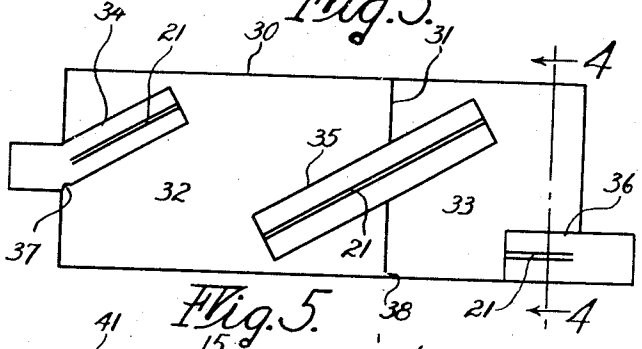


Fig. 4.

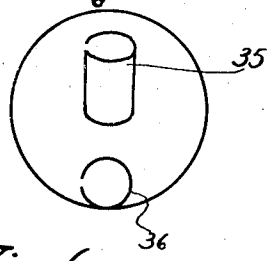


Fig. 5.

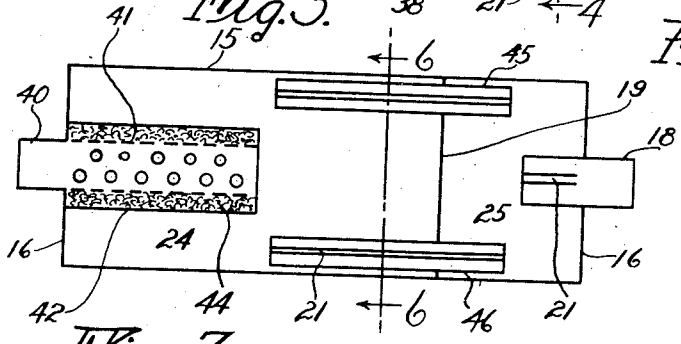


Fig. 6.

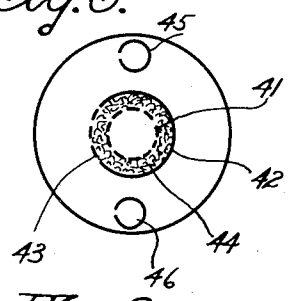


Fig. 7.

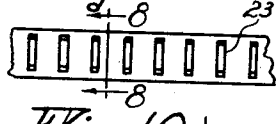


Fig. 8.



Fig. 9.

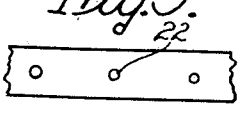


Fig. 10.

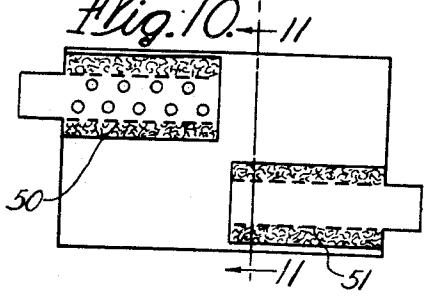
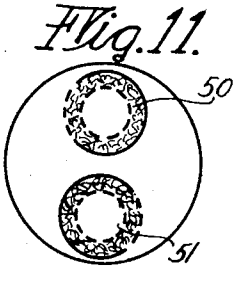


Fig. 11.



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UNITED STATES PATENT OFFICE

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SILENCING DEVICE

Roland B. Bourne, West Hartford, Conn., assignor to The Maxim Silencer Company, Hartford, Conn., a corporation of Connecticut

Application August 16, 1939, Serial No. 290,353

11 Claims. (Cl. 181—57)

This invention relates to improvements in silencing devices and has for its particular object the production of highly efficient silencing devices in such a manner as to reduce their cost. A further object is to provide a silencer in which the danger of so-called shell noise, due to vibration in the outer casing, is reduced to a point where lamination of this casing will not be required.

One common type of silencing device employs the principle of a chamber into which lead laterally separated tubes, one serving as an inlet and the other as an exhaust. It has hitherto been considered necessary to continue these tubes to such a length that the gases can bleed out into the casing through the lateral openings to such an extent that there is comparatively little force left in whatever gas may issue from the ends of the tubes. It will be understood readily that if the length of the tubes is sufficient all the gas can pass out through the openings and it will make no difference whether the ends are left open or closed.

I have discovered that the length of the tubes can be reduced materially provided that care is taken to position the ends at such a point that the force of any gas passing out into the chamber through these ends will not tend to create a standing system of sound waves within the chamber. Such a point is a pressure node for the wave system being considered. The fundamental and odd harmonics being of primary importance, I have found specifically that if the tubes are terminated at substantially the longitudinal mid-point of the chamber, the tendency to set up standing waves of these frequencies will be materially reduced.

The result of the present discovery is that instead of having the perforated tubes overlap they may be located with their axes laterally spaced but with their ends terminating at or just short of a common plane. The silencing results of an arrangement of this type are superior to former devices on account of the diminished tendency to set up standing waves, and the material cost is considerably less.

The manner in which the foregoing objects have been accomplished will be understood best from the following description and claims.

Referring to the drawing:

Fig. 1 is a diagrammatic view of a silencer constructed in accordance with the invention;

Fig. 2 is a section on line 2—2 of Fig. 1;

Fig. 3 is a diagrammatic view of a modification;

Fig. 4 is a section on line 4—4 of Fig. 3;

Fig. 5 is a diagrammatic view of a further modification;

Fig. 6 is a section on line 6—6 of Fig. 5;

Fig. 7 is a detail of a modified manner of forming the lateral discharge openings;

Fig. 8 is a section on line 8—8 of Fig. 7;

Fig. 9 is a detail of another modified manner of forming the lateral openings;

Fig. 10 is a diagrammatic view of a modified form of the apparatus shown in Fig. 5; and

Fig. 11 is a section on line 11—11 of Fig. 10.

Referring to Fig. 1, the silencer comprises a casing 15 closed at its ends by headers 16 through which pass inlet and exhaust pipes 17 and 18, either of which may serve as an inlet and the other as an exhaust. At an intermediate point of its length the casing is provided with a transverse partition 19 through which passes an intermediate tube 20 mounted eccentrically of the casing and offset laterally from the pipes 17 and 18, and serving as an outlet from chamber 24 and as an inlet for chamber 25. The pipes 17 and 18 may, if desired, be arranged eccentrically on the side of the casing opposite to the pipe 20, but are preferably made concentric with the casing in order to give greater facility in mounting the latter in the exhaust line. The tubes 17, 18 and 20 have their ends open and are provided with lateral escape openings which may be formed of slots 21, perforations as at 22, Fig. 9, or by any form of transverse slots such as shown at 23, Figs. 7 and 8. The total area of the slot in each tube in this and other forms is preferably made less than the cross-sectional area of the tube. In the case of a 2½ inch pipe a slot may be from $\frac{1}{8}$ to $\frac{3}{8}$ of an inch in width, and in case of a 10 inch pipe from ½ to 1½ inches in width. The two chambers 24 and 25 formed by the partition 19 are preferably of different lengths, but the larger is preferably not an even multiple of the lesser in order to avoid series resonance effects. The pipes 17, 18 and 20 extend substantially to the mid-point of their respective sections.

Figs. 3 and 4 show a modification which is particularly useful in case an extremely compact form is desired and also has the advantage of providing a self-draining structure which may be suitable for submarine work. In this case the casing 30 is divided by a partition 31 into two chambers 32 and 33 which are preferably not integral multiples one of the other. The inlet pipe 34 preferably enters at the center of the casing and extends upwardly toward the top

thereof. A tube 35 extends through the partition 31 on a slant running from a point near the bottom of the chamber 32 to a point near the top of the chamber 33. An outlet pipe 36 is located tangentially with respect to the bottom of the chamber 33, and the several tubes are provided with lateral openings 21 of the types previously described. It will be seen that by locating the lateral openings in the pipe 34 at the bottom, or by employing an additional perforation 37, and by forming a perforation 38 at the bottom of the partition 31 this device can be rendered completely self-draining.

The silencing device shown in Figs. 5 and 6 is similar to that of Fig. 1 with the exceptions to be noted. The inlet pipe 40 is formed, within the chamber 24, of perforated metal as shown at 41 and is surrounded by a sleeve 42 perforated on one side as shown in Fig. 6 at 43, sound absorbing material 44 is placed between the pipe and the sleeve. The sound absorbing material absorbs the heavier gas pulses and prevents shock excitation of the silencer to a point which would produce so-called shell noise. Instead of a single pipe 20 extending through the partition 19, two pipes 45 and 46 are provided spaced at diametrically opposite points. These pipes may be made less in diameter than the single pipe 20 as long as their combined cross-sectional area is at least equal to that of the inlet pipe 40. The outlet pipe 18 is formed as before and it, together with the pipe 45 and 46, is formed with lateral openings 21.

The lateral openings 21 may be directed toward the same side of the casing or towards opposite sides, the exact positions of the openings apparently making little difference. The tubes not overlapping, it is not necessary in this construction to avoid pointing the openings of the tubes toward one another.

Figs. 10 and 11 show a form of device similar to that of Fig. 5, except that but a single chamber is used and both inlet and outlet pipes 50 and 51 are formed in the same manner as the inlet pipe 40 of the latter figure. The added attentuating effect of the sound absorbing material, together with its tendency to iron out gas pulses, renders it possible in many cases to dispense with the second chamber.

Other modifications and combinations of the forms shown may obviously be made as may prove desirable in special circumstances.

I claim:

1. A silencer comprising a casing divided by a transverse partition into two chambers the lengths of which are non-integral multiples one of another, an inlet conduit extending into one chamber, one or more intermediate conduits passing through the partition from one chamber to the other, and an outlet conduit extending into the second chamber, all of said conduits having lateral escape openings within said chambers and terminating without substantial mutual overlap at a pressure nodal point for the fundamental of the longitudinal standing wave system within the respective chambers.

2. A silencer comprising a casing divided by a transverse partition into two chambers the lengths of which are non-integral multiples one of another, an inlet conduit extending into one of said chambers and having lateral escape openings in its wall within the chamber, a sheath surrounding said conduit and having lateral escape openings in its walls, sound absorbing material between the conduit and the sheath, one or more intermediate conduits passing through the partition from one chamber to the other, and an outlet conduit extending into the second chamber, said outlet and intermediate conduits having lateral escape openings, and all of said conduits terminating without substantial mutual overlap at the longitudinal centers of the respective chambers.

3. A silencer comprising a chamber, mutually offset open ended inlet and outlet conduits extending into the chamber from opposite ends thereof, and terminating at the longitudinal center of the chamber without substantial mutual overlap, said conduits each having open ends and one or more lateral escape openings less in combined area than the cross-sectional area of the open end of the respective conduit.

4. A silencer comprising a chamber, mutually offset open ended inlet and outlet conduits extending into the chamber from opposite ends thereof and terminating at the longitudinal center of the chamber without substantial mutual overlap, said conduits each having lateral escape openings and at least one of said conduits being surrounded by a sleeve having lateral escape openings therein, the space between the sleeve and the conduit being filled with sound absorbing material.

5. A silencer comprising a chamber, mutually offset open ended inlet and outlet conduits extending into the chamber from opposite ends thereof and terminating at the longitudinal center of the chamber without substantial mutual overlap, said conduits each having lateral escape openings and at least one of said conduits being surrounded by a sleeve having an angularly restricted zone of lateral escape openings therein, the space between the sleeve and the conduit being filled with sound absorbing material.

6. A silencer comprising a casing divided by a transverse partition into two chambers, an inlet conduit entering one of said chambers and extending diagonally towards one side thereof, an intermediate conduit extending diagonally through the partition from a point opposite the terminus of the inlet conduit, and an outlet conduit leading from a point opposite the terminus of the intermediate conduit, each of said conduits having lateral escape openings within the casing.

7. A silencer comprising a casing divided by a transverse partition into two chambers, an inlet conduit entering one of said chambers and extending diagonally towards one side thereof, an intermediate conduit extending diagonally through the partition from a point opposite the terminus of the inlet conduit, and an outlet conduit leading from a point opposite the terminus of the intermediate conduit, each of said conduits having lateral escape openings within the casing, said outlet conduit being substantially flush with one side of the casing opposite the terminus of the inlet conduit, and drainage openings at the lowermost point of the inlet conduit and of the intermediate partition.

8. A silencer comprising a chamber, a foraminous conduit extending into said chamber and open at its inner end, a layer of sound absorbing material of substantial thickness surrounding said conduit, and confining means for said material having at least one opening therein whereby the interior of said inlet conduit is in acoustic communication with the interior of said chamber both through the walls and through the open end of said conduit.

9. A silencer comprising a chamber, a conduit extending into the chamber and open at its inner end, a casing surrounding and spaced from the conduit, and sound absorbing material between the conduit and the casing, both the conduit and the casing having their walls perforated whereby the interior of the conduit is in communication with the interior of the chamber both through the walls of the conduit and casing and through the open end of the conduit.

10. A silencer comprising a casing having inlet and outlet openings therein and open-ended conduits extending into the interior of the casing from said openings, said conduits being of foraminous material, a sleeve co-axially disposed around at least one of said conduits, a portion of the area of said sleeve being imperforate and a circumferentially restricted portion being perforate, and sound absorbing material in the space between the conduit and the sleeve.

11. A silencer comprising a generally cylindrical chamber having inlet and outlet openings at opposite ends thereof, open-ended inlet and outlet conduits extending into the casing from said openings to a region substantially half way along the length of the chamber, said conduits being laterally offset with respect to each other, at least one of said conduits having lateral escape openings in the wall thereof, sound absorbing material disposed around said conduit, and a sleeve confining said sound absorbing material, said sleeve having lateral escape openings to afford acoustic communication between the body of sound absorbing material and said chamber..

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