United States Patent

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[54] **ULTRASONIC SILENCER**
8 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **181/33F,** 181/48
[51] **Int. Cl.** **F01n 1/00,** F01n 1/02
[50] **Field of Search** 181/33, 33.03, 33.04, 33.06, 33.22, 33.221, 33.5, 35, 41, 42, 48, 49, 54, 59, 64.2, 65

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ABSTRACT: A moving stream of gas such as is produced as the exhaust of an internal combustion engine, has audible frequencies which are abated, in accordance with this invention, by interacting with apparatus which converts the audible frequency in the moving stream of gas to inaudible frequencies.

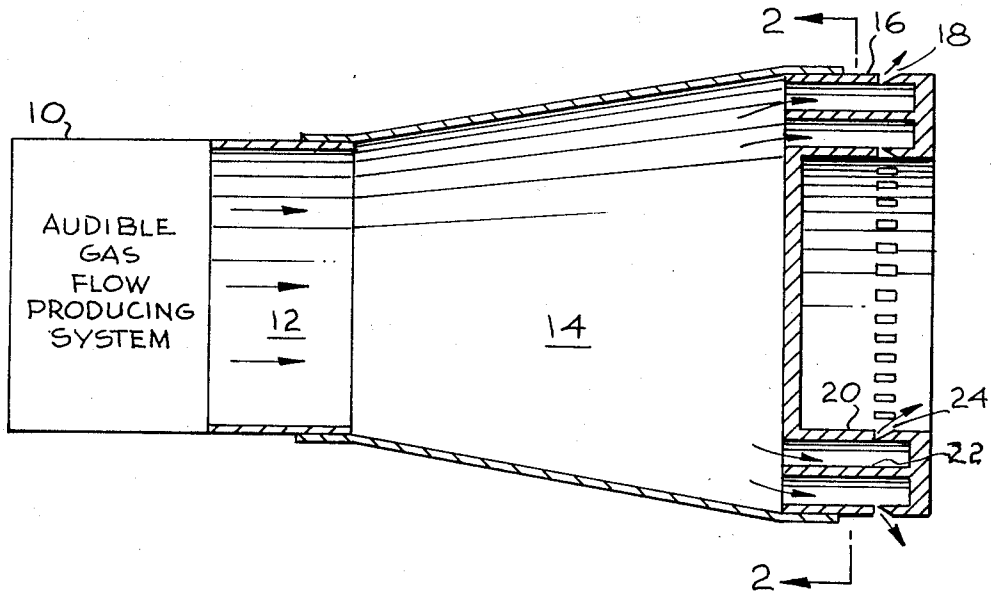
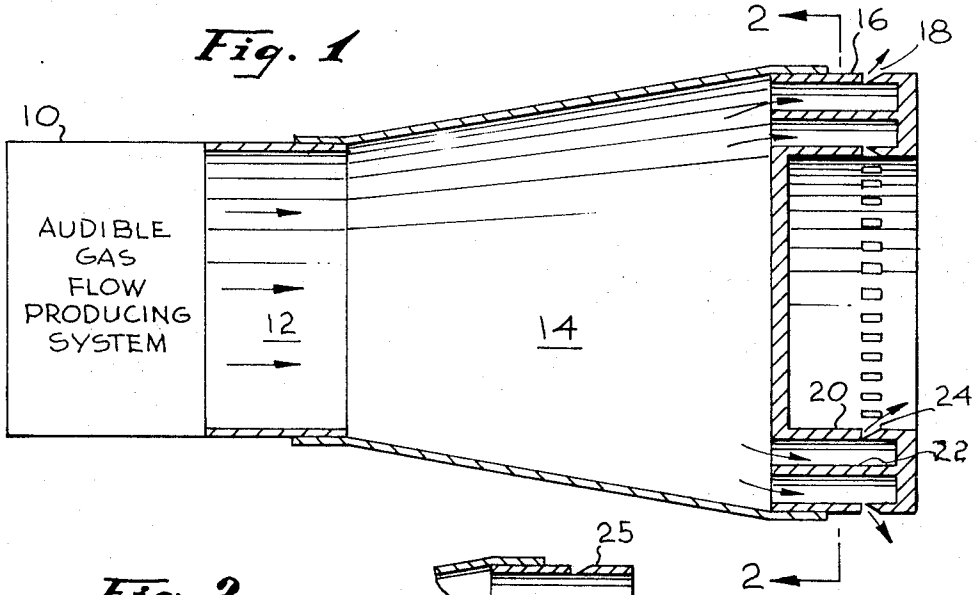


Fig. 1



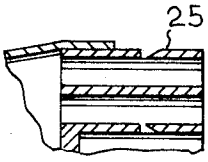
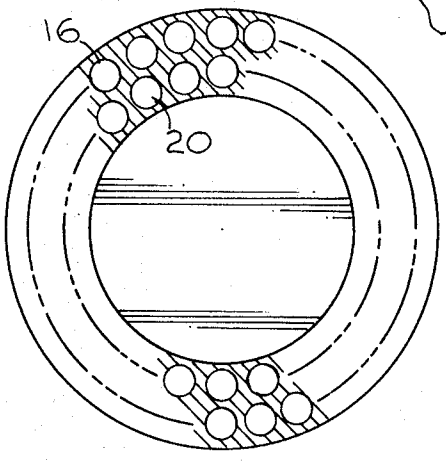


Fig. 3

Fig. 2



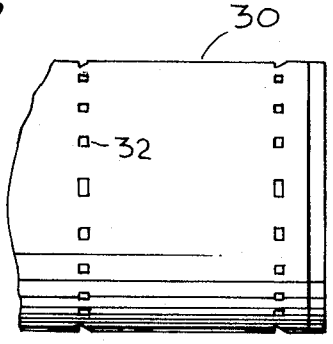


Fig. 4

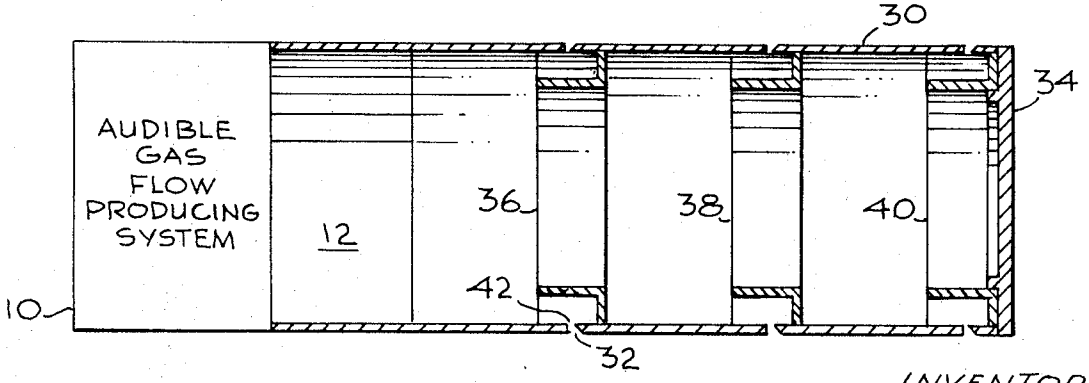


Fig. 5

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ULTRASONIC SILENCER

BACKGROUND OF THE INVENTION

This invention relates to a method and means of abating the noise caused by a moving gas stream produced, for example, as the exhaust of an engine, and more particularly to improvements therein.

OBJECTS AND SUMMARY OF THE INVENTION

An object of this invention is the provision of an exhaust noise abatement system, which is simple and inexpensive to fabricate.

Still another object of the present invention is the provision of a novel and unique noise abatement system.

The novel features of the invention are set forth herein with particularly in the appended claims. The invention will best be understood from the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of an embodiment of the invention;

FIG. 2 is a view along the lines 2–2 of FIG. 1;

FIG. 3 is a fragmented cross section of an alternative embodiment of the invention;

FIG. 4 is a view of still another embodiment of the invention; and

FIG. 5 is a view in section of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

It is known that if there is a column of air in a pipe which is closed at one end, and the column of air is set into vibration, the length of the pipe is one-fourth wavelength of the stationary longitudinal wave established by the vibration. The frequency of the stationary wave is determined by the velocity of sound in the air of the tube divided by the wavelength. The wavelength is four times the length of the pipe. The one-fourth wavelength standing wave may be excited by blowing air over a sharp edge, as in an organ pipe. Similarly, if a pipe having a column of air is open at both ends, the length of the pipe is on the order of one-half wavelength of the stationary wave which may be excited thereon.

The present invention in one embodiment takes advantage of this phenomenon by effectively providing an organ pipe whose dimensions are such that when the column of air in the organ pipe is excited the standing wave frequency is in the ultrasonic or inaudible frequency region. The noisy gas stream which it is desired to quiet is directed across the sharp edge of the organ pipe whereby the air in the pipe is set into vibration and modulates the gas stream to the ultrasonic or inaudible frequency of the organ pipe whereby the gas stream noise is abated.

FIG. 1 shows in cross section an embodiment of the invention. An audible gas flow producing system **10**, can comprise any type of engine such as an internal combustion engine or, an engine which operates on compressed air. The output of this engine constitutes a gas flow which excites audible frequencies in the atmosphere. Normally this gas flow is directed by a suitable pipe coupling means into a muffler which operates to quiet the noise of the gas flow by either reducing its energy or by converting the frequency of the gas flow to some other frequency which is less disturbing. One of the problems caused by most mufflers is the fact that they cause a back pressure on the engine thereby reducing efficiency.

In accordance with this invention, the gas flow from the audible gas producing system which is exhausted into a exhaust pipe **12**, is directed by means of a transition pipe section **14** at the openings in a plurality of organ pipes **16** which have their other ends closed. It is known that if the cross-sectional area of the exhaust pipe **12** equals the total cross-sectional area of the openings to all of the organ pipes, then no back pressure is produced. Therefore, on the assumption that the exhaust pipe **12** has a diameter of 1⅝ inches, or 2.07 square inches, the total area of the openings of the organ pipes **16** to the exhaust gas flow is made equal to 1⅝ inches diameter or 2.07 square inches.

As shown in FIG. **2**, the organ pipes are arranged to form two circles, the inner one of which is concentric with the outer one. Each of the outer organ pipes **16** has a V-cut opening **18** in the outer wall to form the sharp edge or lip of the organ pipe. The region of the pipe between the lip opening and the bottom constitutes the region in which the standing wave of air is established and thus is dimensioned to produce the desired ultrasonic frequency. For 30 kilohertz (30 m. cycles per second) at sea level, this dimension need only be 0.110 inch.

The inner circle of organ pipes, each of which is respectively designated by the reference numeral **20**, may have a common wall **22** with the organ pipe **16**. The V-cut opening **24** in the inner organ pipes **20** is established in the wall adjacent to the center of the structure.

There will be a gas flow through the transition region **14** into the organ pipes and the gas will exit through the respective V-cuts **18** and **24**. The exciting gas will have a frequency, for the dimensions given on the order of 30 kilohertz and thus is rendered inaudible.

FIG. **3** is a fractional cross-sectional illustration representative of the embodiment of the invention when an open organ pipe **25** is employed. It will be appreciated that the appearance and dimensions of the structure are similar to that shown in FIGS. **1** and **2** except that the pipe is open at both ends and its length is one-half wavelength. Thus, for 30 kilohertz the length from the V opening to bottom is 0.440 m.

FIG. **4** illustrates the appearance of another arrangement for an embodiment of the invention and FIG. **5** is a cross section of FIG. **4**. This arrangement may be employed where it is desired to maintain the diameter of the noise abatement attachment in accordance with this invention the same, or even less than the exhaust pipe. In this arrangement, the audible gas flow producing system **10** exhausts the audible gas into the exhaust pipe **12** as before. The noise abatement attachment in accordance with this invention comprises a cylinder **30** which is attached to the exhaust pipe **12**. This cylinder has a large number of V-cuts **32** made in the wall thereof. These V-cuts are spaced to define rings and the rings are spaced along the cylinder **30**. The number of V-cuts is determined by the number of organ pipes required to avoid back pressure being applied to the gas flow producing system.

As seen in cross section, the end of the cylinder **30** opposite the end into which gas is permitted to be introduced is closed by a plug **34**. Inside of the cylinder **30** there are rings respectively **36**, **38**, **40** each of which has openings **42** cut in the outer periphery. These openings are positioned so that when the rings are inserted within the cylinder they will match the V-cuts **32** in the wall of the cylinder forming therewith an organ pipe with one open and one closed end. It should be obvious that the cuts **42** together with the wall of the cylinder form the organ pipe of the type shown in FIG. **1**. It is immaterial whether the cuts **42** are round or square as long as the dimensions of the organ pipes formed are those which will provide a standing wave having an ultrasonic frequency. By way of illustration, the dimensions of the organ pipes which are formed in the structure of FIG. **3** may be the same as those in FIG. **1**. Each organ pipe has a diameter of thirteen sixty-fourths inch and a depth of the pipe below the V-cut is 0.110 inch. Sixty-eight of these organ pipes are provided to match the diameter of a 1⅝-inch exhaust pipe. The organ pipes may also be the open-ended type in which event they will be two times longer than shown.

The gas will flow through the structure shown in FIGS. **4** and **5** in a manner so that any gas which does not escape to the ambient through the organ pipe openings in the first ring **36** will escape through the organ pipe openings in one of the subsequent rings **38** or **40**.

While the foregoing description refers to a conversion of a moving gas stream audible frequencies to the ultrasonic frequencies, it should be understood that subsonic frequencies which are inaudible may also be employed if circumstances indicate a preference. However, the length of subsonic frequency pipes is rather great. It is intended, however, that it is within the scope of this invention to cover conversion of the audible gas stream frequencies into inaudible frequencies whether they be supersonic or subsonic.

There has accordingly been described and shown herein a novel, simple and relatively inexpensive arrangement for rendering substantially inaudible the noise produced by a gas flow which heat is emitted at audible frequencies.

Although particular embodiments of this invention have been described and illustrated herein, it is recognized that modifications and variations may readily occur to those skilled in the art and, consequently, it is intended that the claims be interpreted to cover such modifications and equivalents.

I claim:

1. In a system which produces audible noise in the form of a moving stream of a gas having audible frequencies;

a noise abatement apparatus comprising a means for establishing a column of gas with a standing wave at an inaudible frequency; and

means for directing said moving stream of gas at said column of gas for converting its audible frequencies to the inaudible frequency of said standing wave to thereby abate the noise of said moving stream of gas.

2. In a system as recited in claim 1 wherein said means for establishing a column of gas with a standing wave at an inaudible frequency comprises organ pipe means within which said standing wave of gas is established.

3. Apparatus for abating the audible noise caused by a moving stream of a gas which is within an exhaust pipe and which produces audible frequencies comprising:

a plurality of organ pipe means for establishing a plurality of standing waves at an inaudible frequency;

each organ pipe means comprising a pipe having an open end;

a closed end;

a slot in the wall of said pipe displaced from said closed end;

said pipe length establishing a column of air in said pipe which is resonant at said ultrasonic frequency; and

means for coupling said exhaust pipe to the open ends of all of said organ pipe means for causing said moving stream of gas to flow into said organ pipe means and out through said slots to thereby render inaudible the audible frequencies of said stream of gas.

4. Apparatus as recited in claim 3 wherein the total area of all of the open ends of all of said organ pipe means is equal to the area of said pipe.

5. Apparatus as recited in claim 3 wherein there is included means for supporting said plurality of organ pipe means in a circle with their open ends all facing the same direction; and said mans for coupling said pipe to the open ends of all of organ pipe means includes a pipe transmitter section extruding between said pipe and the outer dimension of said plurality of organ pipe means.

6. Apparatus as recited in claim 3 wherein said plurality of organ pipe means are disposed as spaced rings of organ pipes along the inside of a hollow cylinder having one end closed and the other end open to receive said gas stream.

7. The method of converting the audible noise produced by a moving stream of a gas having audible frequencies to an inaudible form comprising:

establishing a column of gas with a standing wave at an inaudible frequency; and

applying said moving stream of gas to said column of gas to be modulated thereby to the frequencies of said moving stream of gas to the inaudible frequency of said standing wave.

8. The method of abating the audible noise of a moving gas stream comprising:

establishing a plurality of columns of gas each having a standing wave with a frequency which is inaudible;

dividing said moving gas stream into the same number of smaller gas streams as there are columns of gas; and

applying each smaller gas stream to a different one of said plurality of columns of gas to convert the frequency thereof to said inaudible frequency.