United States Patent

[11] 3,596,734

[72] Inventor **Donald N. Yates, Jr.**
Chatsworth, Calif.

[21] Appl. No. **839,318**
[22] Filed **July 7, 1969**
[45] Patented **Aug. 3, 1971**
[73] Assignee **Leisure Systems Corporation**
Manhattan Beach, Calif.

[54] **MEANS AND METHOD FOR NOISE SUPPRESSION**
10 Claims, 3 Drawing Figs.

[52] U.S. Cl. 181/33, 181/52, 181/55
[51] Int. Cl. F01n 3/04, B64d 33/06
[50] Field of Search 181/33, 43, 51, 33.21, 33.22, 33.221, 33.222, 33.223, 33.4, 42, 50, 52, 55; 239/265.11, 265.13, 265.17, 127.3

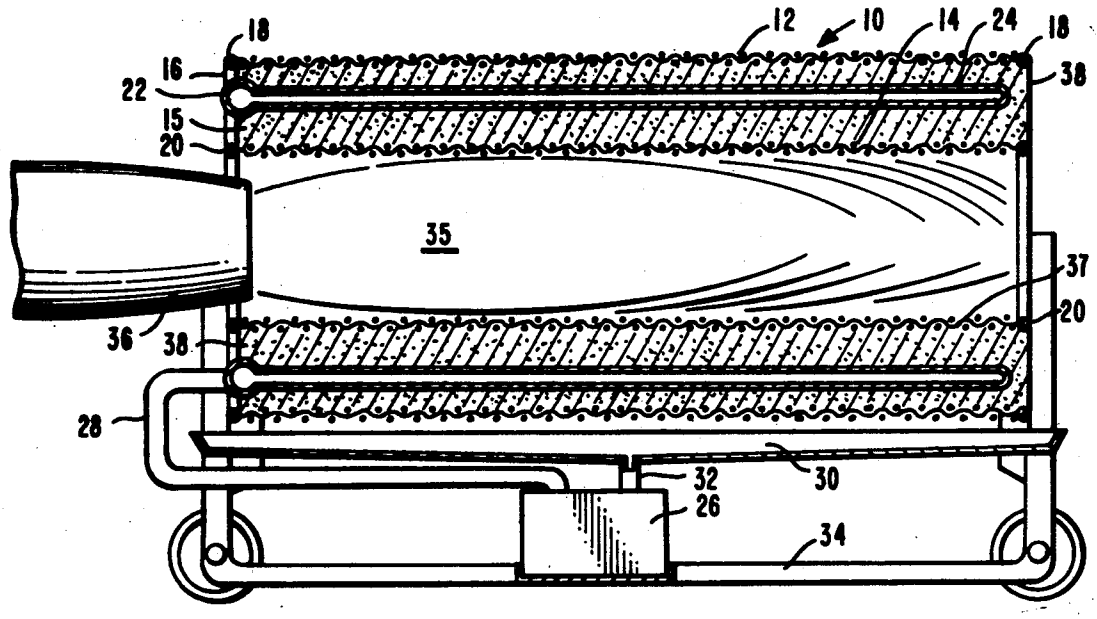
[56] **References Cited**

UNITED STATES PATENTS

1,348,828	8/1920	Fessenden	181/33.02
3,047,267	7/1962	Peyrin	181/33.02
3,208,552	9/1965	Seifert	181/33.221
3,270,835	9/1966	Kramer	181/33.221
3,442,350	5/1969	O'Brien	181/52 X

Primary Examiner—Robert S. Ward, Jr.
Attorney—Beehler & Arant

ABSTRACT: The suppression of noise radiating from a high-velocity, unconfined stream of gas is accomplished by radially surrounding the unconfined stream of gas with a blanket of foam from a location adjacent its origin and extending axially of the stream of gas for a distance equal to several diameters of the stream at its origin.



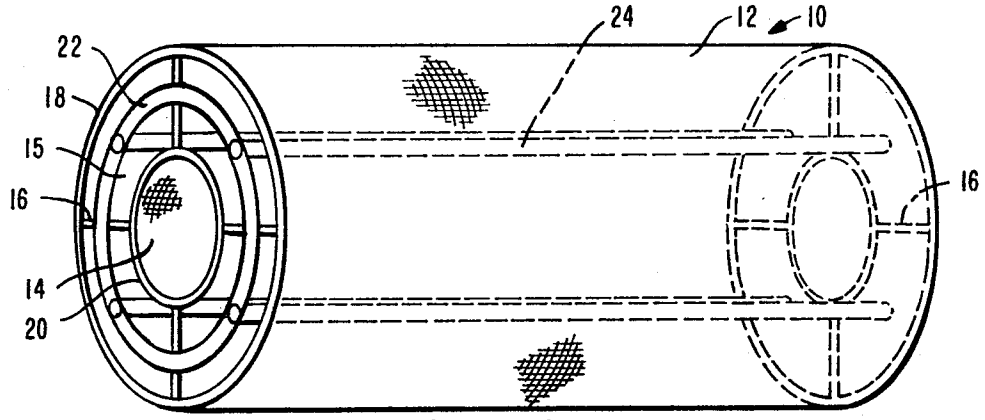


FIG.—1

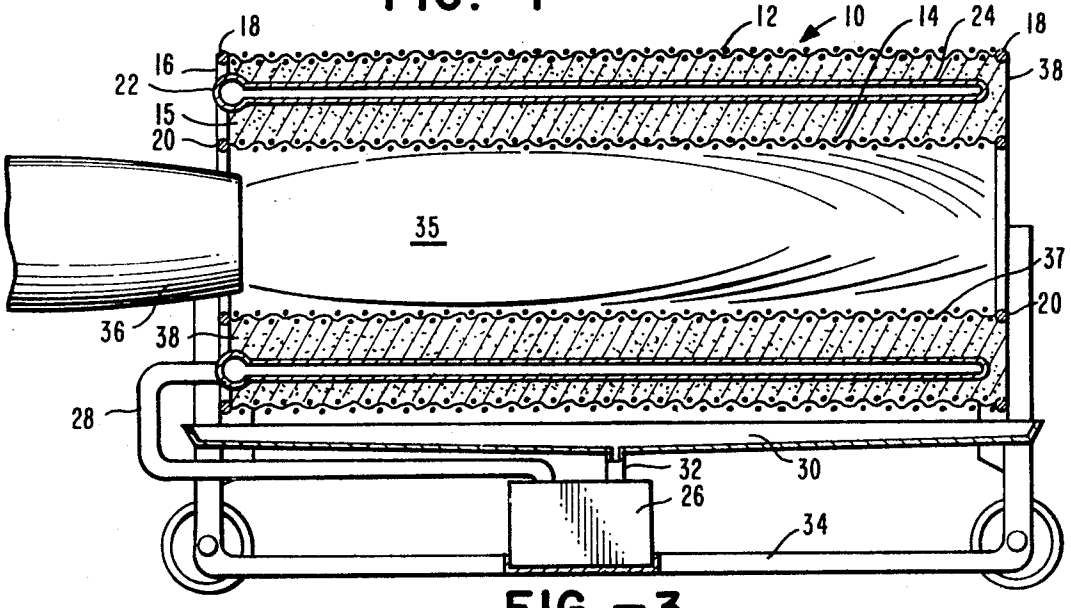


FIG.—3

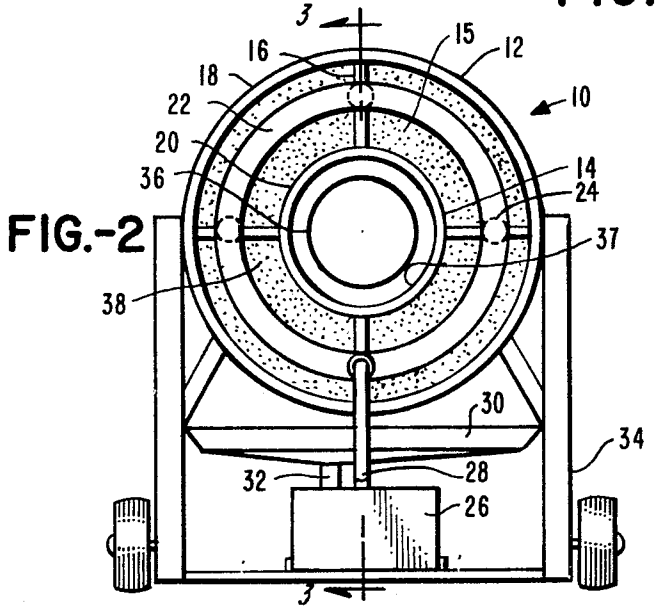


FIG.-2

INVENTOR.
DONALD N. YATES, JR.

BY Bruce A. Jagger
Beehler & Arant
ATTORNEYS

MEANS AND METHOD FOR NOISE SUPPRESSION

The present invention provides a noise suppressor which is adapted to surround a high-velocity stream of noise-radiating gas with a noise-attenuating foamed liquid.

Previously, considerable difficulty had been experienced in accomplishing the muffling or suppression of the noise radiating from the exhaust of a jet engine. The high level of the jet engine noise near airports with major airline overhaul stations has become a serious health problem and a source of considerable annoyance to the residents of adjacent neighborhoods.

The disadvantages of prior devices have been overcome by the present invention which provides for surrounding a high-velocity, unconfined stream of gas, such as the exhaust from a jet engine, for a distance equal to several times the diameter of the stream of gas at its origin with an apparatus capable of supporting a blanket of noise-attenuating foamed liquid. Preferably, the inner wall of the blanket is spaced well away from the moving, high-velocity stream so as to prevent a rapid consumption of foam by direct physical contact with the moving stream. The maximum attenuation of noise is accomplished when the high-velocity stream of gas is surrounded by the blanket of liquid foam for an axial length at least equal to the diameter of the stream at its origin and preferably for an axial length greater than three times the diameter of the stream at its origin. The characteristics of the foam, such as shear strength, thermal stability, and particularly bubble size, are regulated to predetermined values so as to obtain the maximum attenuation of noise. In the drawings there is illustrated:

FIG. 1 is a perspective schematic view of a structure for holding a foam blanket radially spaced around a stream of noise-radiating gas;

FIG. 2 is a schematic front elevation of a self-contained noise suppressor; and

FIG. 3 is a cross-sectional view taken along line 3—3 of FIG. 2. Referring particularly to the drawings, there is illustrated a noise suppressor **10**, in which a liquid foam blanket holder structure is provided. The liquid foam blanket holder structure includes outer foam barrier **12** which is generally cylindrical and composed of a liquid pervious material and a perforate inner foam barrier **14** which is mounted internally of and coaxially with outer foam barrier **12**. An annular space **15** is defined between the inner wall of outer foam barrier **12** and the outer wall of perforate inner foam barrier **14**. A support spider **16** is provided to support foam barriers **12** and **14** in operative coaxial relationship to one another. Support spider **16** is attached to and extends between outer support rings **18** and inner support rings **20**. Support rings **18** and **20** define the configurations of foam barriers **12** and **14**. Support rings **18** and **20** provide structural rigidity in combination with support spider **16** to the respective foam barriers **12** and **14**. Outer foam barrier **12** is generally composed of perforate metallic screen or liquid pervious cloth material, and perforate inner foam barrier **14** is preferably composed of perforate metallic screen.

A foam-distributing manifold **22** is provided on noise suppressor **10** and is connected to foam discharge headers **24** so that foam is supplied to foam discharge headers **24** through foam-distributing manifold **22**. Foam discharge headers **24** are positioned in operative association with annular space **15** so as to discharge and uniformly distribute foam **38** in annular space **15**. A foam generator **26** is operatively connected to foam-distributing manifold **22** by means of manifold feed line **28**. Foam generator **26** is adapted to supply a continuous stream of liquid foam to foam-distributing manifold **22** at a rate sufficient to replace any foam lost or consumed during the operation of noise suppressor **10**. A tray **30** is mounted on carriage **34** in a position to receive and collect any liquid draining off of foam **38**. Tray **30** is provided with a liquid return line **32** which conducts the liquid which collects in tray **30** into foam generator **26** for regeneration and recycle to foam-distributing manifold **22**. The liquid draining-off foam **38** passes through liquid pervious outer foam barrier **12** and falls into tray **30** under the action of gravity. Carriage **34** is designed to be movable and adjustable as to height so that it can be easily moved to a desired location and adjusted to the required height to accommodate the requirements for noise suppression at various locations and at various heights above the supporting surface.

A jet engine exit cone **36** is illustrated particularly in FIGS. **2** and **3**. The outlet of exit cone **36** is the origin of exhaust **35** which is discharged from exit cone **36** as an unconfined high-velocity, noise-radiating stream of gas. When noise suppressor **10** is positioned in operative association adjacent the origin of exhaust **35** at the outlet of exit cone **36**, as illustrated particularly in FIG. **3**, the exhaust **35** passes through passageway **37**. Passageway **37** extends axially through noise suppressor **10** and is defined by the inner wall of perforate inner foam barrier **14**.

The foam-generating system comprising the foam generator **26**, the foam-distributing manifold **22**, and the foam discharge headers **24** is preferably so regulated that the bubble size of the foam **38** is smaller than the perforations in inner foam barrier **14**.

In operation the foam **38** is generally supplied continuously to the foam discharge headers **24** and extends slightly past perforate inner foam barrier **14** into passageway **37**. The foam, in addition to attenuating the noise, serves to cool the structure and particularly perforate inner foam barrier **14**.

The use of the term diameter throughout this specification and the appended claims is not intended to infer that the element to which it is applied has a circular cross section. The term diameter is used herein broadly to denote an average lateral dimension but not necessarily one that is constant throughout the periphery of the element to which this term is applied.

The noise suppressor of this invention needs only a minimum amount of structure to supply and maintain a noise-attenuating liquid foam blanket around an unconfined noise-radiating, high-velocity stream of gas. The perforate inner foam barrier **14** is preferably the minimum structure required to define passageway **37** axially through foam **38**. The axial length of passageway **37** should be at least equal to the diameter of the unconfined high-velocity stream of gas at its origin and preferably at least five times this diameter. Passageway **37** may be shaped to fit the stream of gas as desired. If the stream of gas is expanding at a very rapid rate, the diameter of passageway **37** may be increased so that the walls of passageway **37** are expanded radially outwardly to accommodate the expanding stream of gas. Preferably, the diameter of passageway **37** is greater than the diameter of the stream of gas at least at its origin. When the stream of gas is an exhaust from the jet engine, the diameter of passageway **37** is at least equal to the diameter of the exhaust and may be several times the diameter of the exhaust. Preferably, the diameter of passageway **37** is from about two to three times the diameter of the exhaust at the outlet of the jet engine and is at least large enough to prevent the blanket of foam from being destroyed at a rate which is greater than that at which it can be generated.

The thickness of the liquid foam blanket should preferably be at least one-quarter the diameter of passageway **37**, and in any event it should be thick enough so that it absorbs the majority of the acoustical power radiated to it.

The length of passageway **37** is established at such a value that it surrounds the high-velocity stream of gas for the period of time during which the majority of acoustic energy is radiated from the stream. This length is dependent upon the nature of the stream of gas and the total amount of acoustic energy which it is desired to absorb.

The foam-generating equipment is conventional in its design and operation and includes a water or other liquid supply, a foaming agent tank and metering device, and an air aspirator. The conventional components of the foam supply system are not illustrated in detail in the drawings.

The structure required to support the liquid foam blanket in operative association with the noise-radiating stream of gas is reduced to a bare minimum and is preferably composed primarily of deformable materials having little or no resilience. Using this structure, the maximum amount of radiated acoustical power is transmitted directly to the foam rather than to the supporting structure. Also, less foam is required to cool the supporting structure because it has a relatively small mass compared to the size of the foam blanket. The lightweight foam blanket-supporting structure is also economical to construct and maintain. The compactness and lightweight features of the foam blanket-supporting structure make it readily portable to and from various locations of use and convenient to store when not in use.

The foam used in the suppression of noise is preferably one having high strength and high density. The characteristics and properties of a wide variety of foams are well known. One suitable foam has been found to be that produced from an intimate admixture of protein and water. The bubble size of the foam is controlled principally by three factors, the nature of the foaming material, the pressure at which it is discharged, and the apparatus technique of aspiration. Procedures for the regulation of bubble size in foam are well known. It has been found that foam containing bubbles of a particular size will absorb a greater amount of radiated noise of a certain frequency than it will of radiated noise at other frequencies. There is a relationship between bubble size and frequency. It is possible to determine the optimum bubble size or range of sizes for a particular application by determining the amount of acoustical energy absorbed by the foam at different bubble sizes. This may be conveniently accomplished by measuring the increase or decrease in decibels as the bubble size in a liquid foam blanket surrounding a gas stream of constant acoustical output is varied.

The cleaning of the noise suppressor of this invention is very easy and simple to accomplish. Cleaning may be accomplished with clean water, and the water pervious nature of the foam barriers **12** and **14**, respectively, renders it unnecessary to disassemble any part of the noise suppressor to accomplish complete cleaning. No toxic or corrosive special solvents need be used.

As will be understood by those skilled in the art, what has been described are preferred embodiments in which modifications and changes may be made without departing from the spirit and scope of the accompanying claims.

What I claim is:

1. A noise suppressor comprising:

an outer foam barrier;

an inner perforate foam barrier positioned within said outer barrier and spaced from the wall of said outer foam barrier;

a radially enclosed axially extending passageway defined by the inner wall of said inner barrier, said passageway extending axially completely through said noise suppressor; and

means for substantially filling the space between said inner and outer barriers with foamed liquid.

22. A noise suppressor of claim **1** wherein said inner and outer foam barriers are generally cylindrical and are mounted on a movable supporting structure.

3. A noise suppressor of claim **1** wherein the outer foam barrier is a liquid pervious cylindrical member and the perforate inner foam barrier is a cylindrical member positioned concentrically within said outer foam barrier, the means for substantially filling the annular space between said inner and outer barriers with foamed liquid including a foam discharge header adapted to discharge liquid foam uniformly throughout said annular space, said header being connected to a means for providing liquid foam, a liquid collection tray positioned to receive liquid passing through the wall of said liquid pervious outer foam barrier, said noise suppressor being mounted on a movable supporting structure.

4. A noise suppressor comprising:

means for radially surrounding an unconfined noise-radiating stream of high-velocity gas with a blanket of liquid foam from a location adjacent the origin of said stream of gas for an axial distance at least equal to the diameter of said stream of gas at its origin.

5. A noise suppressor of claim **4** including perforate means defining an axial passageway, said passageway being adapted to receive said stream of gas, said passageway having a diameter at least twice as great as the diameter of the stream of high-velocity gas at the origin of said stream.

6. A noise suppressor of claim **4** including perforate means defining an axial passageway, said passageway being adapted to receive said stream of gas, and means for generating said blanket of liquid foam including means for regulating the size of the bubbles in said foam to predetermined values which are less than the size of the perforations in said perforate means.

7. A process of suppressing noise comprising:

radially surrounding an unconfined stream of high-velocity gas with a blanket of foamed liquid, said blanket extending axially rearward from a location adjacent the origin of the unconfined stream of gas for a distance at least as great as the diameter of the unconfined stream of gas at its origin, providing an axial passage for said stream of gas through said blanket of foamed liquid.

8. A process of claim **7** including regulating the size of the bubbles in said foamed liquid blanket to predetermined values.

9. A process of claim **7** wherein the unconfined stream of high-velocity gas is the exhaust from a jet engine and the inner diameter of the axial passageway in the blanket of foam is established at a value at least one and one-half times greater than the diameter of said exhaust at the point where said exhaust is ejected from said jet engine.

10. A process of suppressing noise according to claim **7** including continuously maintaining the blanket of foamed liquid radially around said unconfined stream of high-velocity gas for a predetermined period of time.