United States Patent

Blatt et al.

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[54] SILENCER WITH FREQUENCY SEPARATING AND MODULATING BAFFLE

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[52] **U.S. Cl.** ..... **181/56,** 181/60, 181/61, 181/63, 181/70, 181/36 A, 181/71

[51] **Int. Cl.** **F01n 1/10,** F01n 7/16, F01n 7/18

[58] **Field of Search** ..... 181/60, 68, 70, 71, 56, 36 A, 181/42, 50, 61–63, 46

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[57] **ABSTRACT**

An air exhaust silencer comprises a housing having an inlet and an outlet with opposed porous dome shaped noise reducing members and a porous frequency separating and modulating baffle disposed within and between said noise reducing members, contoured and of such undulating shape and form extending into at least one of said dome shaped members so as to have a total surface area in excess of the cross sectional area of opening between said dome shaped members, for reducing and modifying high pressure sound frequencies and reducing back pressure.

6 Claims, 5 Drawing Figures

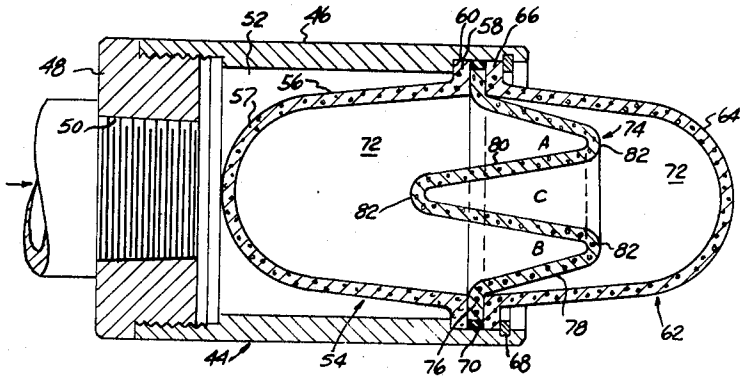


FIG. 1

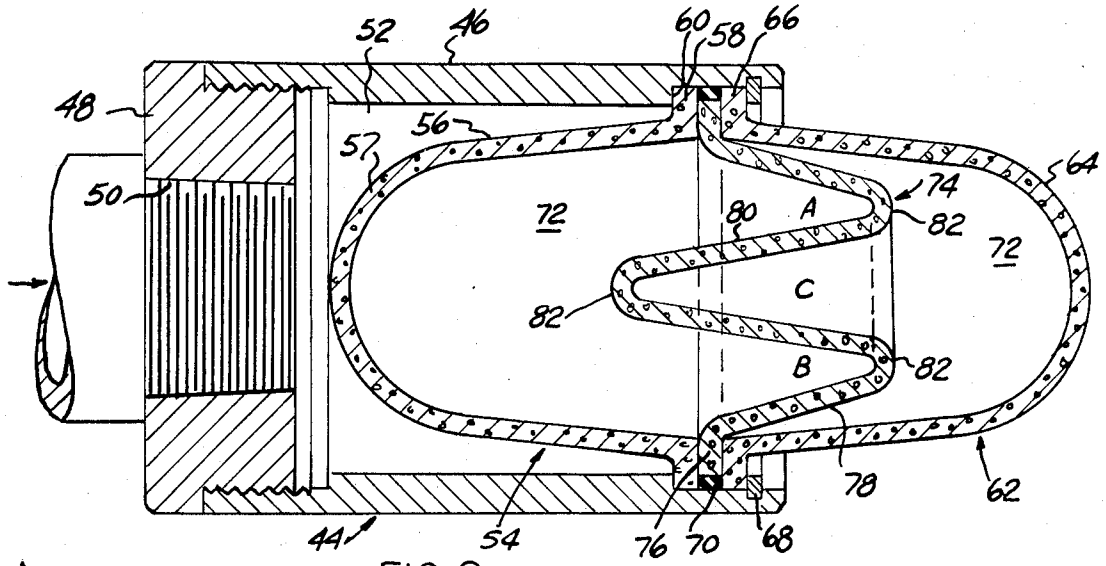
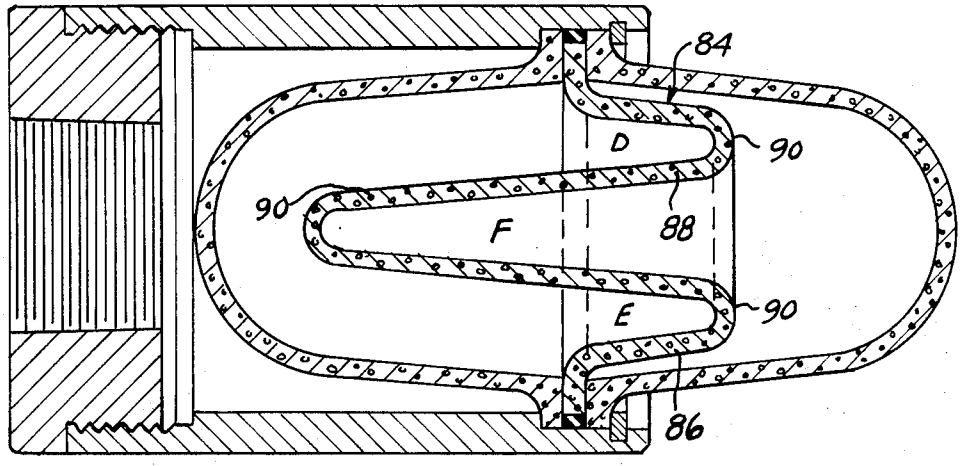


FIG. 2



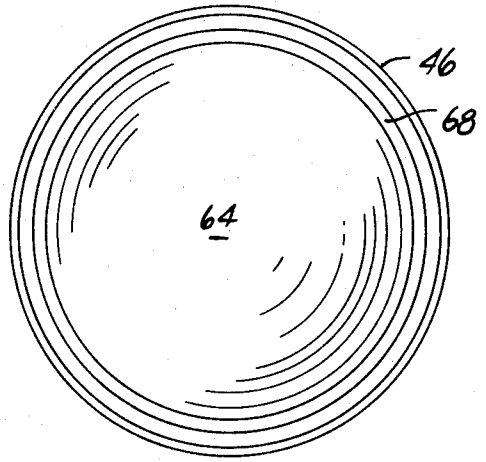


FIG. 5

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FIG. 3

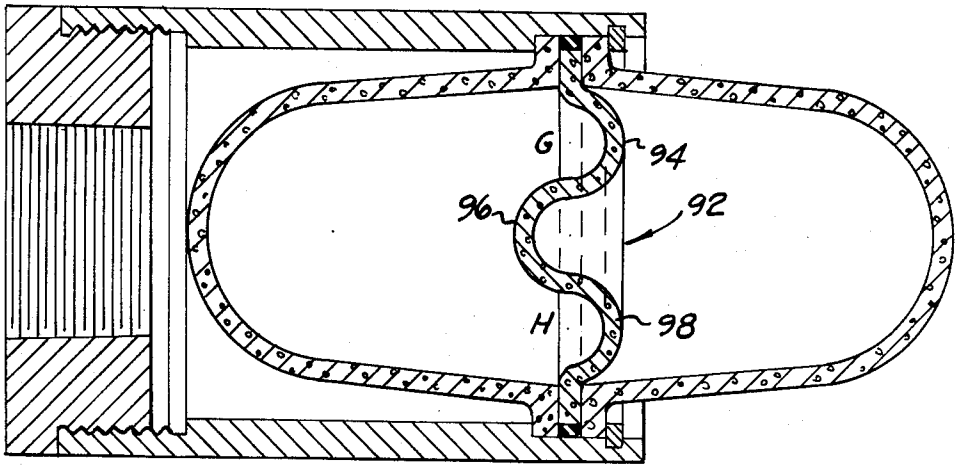
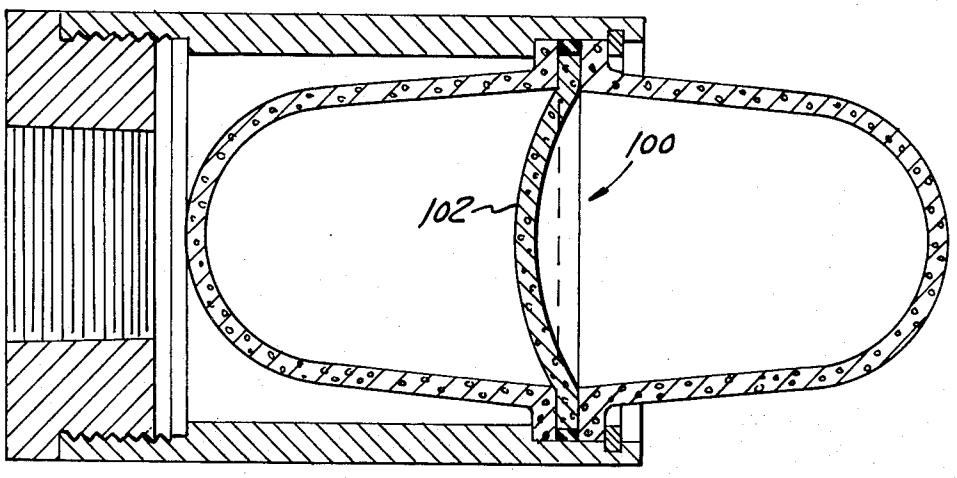


FIG. 4



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SILENCER WITH FREQUENCY SEPARATING AND MODULATING BAFFLE

RELATED INVENTION

The present invention is an improvement over the exhaust silencer shown in copending patent application Ser. No. 81,051 filed Oct. 15, 1970.

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to sound absorbing devices and more in particular to a noise subduing device to maintain a specific noise level within acceptable limits.

Almost universally, every thing, substance or matter moving provides or produces noise at varying frequencies and at different noise levels which may range from a low frequency whisper to high frequency squeals.

Any consistent sound at whatever noise level is, in most cases, annoying to the human ear, although the sound level may not be as high as to produce a health hazard. However, in connection with machinery, whether it be mechanical, electrical or fluid power operated or by combustion, noises are produced which, in instances, exceed a safe level, particularly at high frequencies.

It is known in the industry that the federal government established industrial safety standards by the provision of the Walsh-Healey Act which was amended on May 8, 1969, in regard to occupational noise exposure, setting a standard providing that a person may not work more than 8 hours at a maximum 90 dBA (90 decibels measured on the A-scale of a sound level meter).

Many noises produced in a plant or similar working place, are considerably higher than 90 dBA. Most of these noises are not merely pure tones, but in most cases are a combination of sounds and may range from a low frequency roar to a high frequency squeal. Obviously, combined frequencies require differentiating of materials inside the silencer to stop or absorb those frequencies or separate those frequencies in order that they not be added or combined with one another to produce a sound level unacceptable or unhealthful to human beings. Another factor to be considered is the power level of the sound field. Thus, if a great deal of noise is being produced at different frequencies, or the level of power is high, it would require extremely large and complicated silencers to reduce the noise to within a tolerance acceptable to a human being at a certain distance from the origin of the sound.

As mentioned before, sound is producted by matters or substances flowing or moving through the air or through another substance and the noise level of the sound is dependent on the pressure and speed of movement of the moving substance and the relative resistance of the matter or other substance through which the moving substance passes. Thus, air flowing through the orifice or venturi of an exhaust valve at relatively high speed and pressure, creates a high frequency squealing sound, whereas, for instance, the sound produced inside of air operated tools is much more subdued, but this sound is combined with the noise created by the working parts of the tool. Thus, these two examples require different types of sound absorbing material for effective silencing to within a safe level.

Considerable difficulties are experienced in moderating or absorbing these sounds created by the exhaust of pneumatic valves, motors and other air operated tools in the industry. Noise is also produced by the sound of mechanical movement of the working parts of the tools coupled with other frequencies caused by air vibrations as air travels through a particular valve or pneumatic motor.

It is known to the men skilled in the art of noise reduction or absorbtion that, when the daily noise exposure is comprised of two or more periods of noise, the different level and combined effect should be considered rather than the individual effect of each.

Most air tool and/or air valve applications, where a great deal of air flow is present, require the design of silencer chambers to be of utmost consideration so as not to create excessive back pressure within the tool or valve which will cause a slowdown in the cycle of the operation time.

Accordingly, the present invention provides an improved air exhaust silencer construction adapted to effectively reduce high noise levels to a safe level not exceeding 90 dBA.

The definition of the word "sound" depends on the point of view adopted. Subjectively, it may be regarded as a variation in a normal atmospheric pressure caused by vibrations or other pressure disturbances that are transmitted to the human hearing mechanism causing a knowing sensation. The variation in a normal atmospheric pressure that is a part of the sound wave may be characterized by the rate in which such as the standard musical tone "a" occurs when a pressure change through a complete cycle is 440 times per second.

The apparent loudness that we attribute to a sound varies not only with the sound pressure but also with the frequency or pitch of the sound. The frequency being of a wave length which is within the frequency of the human ear is classified as sound.

Scientists and engineers have investigated many aspects of man's reaction to sound. The human ability to distinguish sound has been established between the frequency of 20 to 20,000 hertz. Most individuals can hear tones in the frequency range of 200 to 10,000 hertz, even though the levels are low. Within this frequency range, if the sound pressure level is above 90 decibels, the Walsh-Healey Act as amended for occupational noise hazards, limits the individual's working time to 8 hours at 90 decibels. Also, the law sets forth curves between 100 and 8,000 hertz as being the frequency most likely to be injurous or affect the human hearing. The upper limit at which we can hear airborne sounds depend on the condition of our hearing and the intensity of the sound. The upper limit is somewhere between 16,000 and 20,000 hertz.

Psychologists have found that certain sound frequencies are more annoying and tiring to the human than other frequencies within the human range and it therefore becomes necessary for persons working on the ecology of sound to be able to lower or destroy the frequencies caused by the noise and jumble of sounds created by moving machinery, escaping exhaust air, etc., that may be encountered and now considered an occupational hazard.

Alternating sounds bear a closes resemblance to alternating electrical currents or light waves. Even though light travels at a fantastic speed of 186,000 miles per second while sound travels approximately 1,100 feet per second at sea level. There is analogy between the two which suggests the use of lenses of certain types to bend or change the frequency of the sound waves so that they may be destroyed or dispersed through the silencer not to be impinged on the human working within the effected area.

In copending application Ser. No. 81,051 filed Oct. 15, 1970, the frequency modulating baffle **74** does perform a function of blocking certain frequencies, yet its minimum cross sectional area is not the best conceivable design to change or filter out or cause interference of sound waves of a specific frequency within the range most affecting the human hearing mechanism.

Furthermore, it is readily seen that the cross sectional area of baffle **74** does not correspond or is not as great as the cross sectional area of either of the hemispherical chambers. If exhaust air pressure of 80 p.s.i. is released at port **50**, it would be restricted or cause a back pressure in the first chamber, restricting the exhaust time or slowing the air flow through the silencing unit.

To overcome this, it is an object of the invention to provide a design of several center lenses. This sound lens may be constructed with various angles or curves not only increasing the cross sectional area and reducing back pressure, but in such a manner when properly calculated will destroy a certain high pressure frequency affecting the human hearing mechanism with no apparent loss in air flow efficiency.

These and other objects will be seen from the following specification and claims in conjunction with the appended drawings:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal cross section through the present improved sound silencer with one form of frequency separating and modulating baffle.

FIG. 2 is a similar view of a modification thereof.

FIG. 3 is a similar view with another modification of the said baffle.

FIG. 4 is a similar view with still another form of baffle construction.

FIG. 5 is a right end view of any of the FIGS. 1 through 4.

The silencer 44 in FIG. 1 comprises a barrel type housing 46 closed at one end by a front end cap 48 having a threaded inlet opening 50 for attachment of the silencer to the noise or sound producing apparatus.

The interior of the housing 46 defines a chamber 52 in which is disposed a first dome shaped member 54 whose dome section 56 extends substantially the full length through the chamber. The open end of the dome shaped member 54 is directed away from the inlet opening 50 and is provided with a radial flange 58 by which the member 54 is retained in the housing 46 by abutment against inner radial shoulder 60 of the housing. Thus, the closed front end 57 of the dome shaped member 54 is disposed adjacent inlet opening 50 in axial alignment therewith.

The silencer 44 is provided with a second dome shaped member 62 which is identical to the first dome shaped member. The second dome shaped member is positioned in opposite direction to the first dome shaped member so that the closed dome portion 64 extends outwardly of the housing 46. The open end of the dome shaped member 62 is similarly provided with a radial flange 66 disposed within the rear end of the housing in abutting relationship against flange 58 of the inner dome shaped member. The second dome shaped member is retained in the rear end of the housing by means of a lock ring 68. A sealing member 70 is disposed between the adjoining flange portions 58 and 66 and the inner surface of the housing. The dome shaped members are preferably made of sintered bronze of a defined micron size suitable for the particular application in which the silencer is used.

The members 54 and 62 act as frequency distorters and, due to the expanded dome shaped portions, provide a greatly increased sound absorbing area with a minimum of material. The combined dome shaped members 54 and 62 provide a sound absorbing chamber 72 of a relatively large area which is divided by a baffle member 74 in the form of a plate retained between the adjoining flange portions 58 and 66. The baffle member 74 can be made of felt, screening, perforated metal, urethane, or other porous material, depending on the type of sound or noise to be absorbed. The baffle member 74 acts as a frequency variation separator to screen different sounds received by the silencer according to their frequency.

The present porous frequency separating and modulating baffle 74 is one illustration of a design for the destruction of certain specified frequencies having a relation to the cross sectional area between the hemispherical dome shaped sound silencing members 56 and 64.

The present baffle includes an annular retaining flange 76 interposed between flanges 58 and 66 and inwardly thereof is irregularly shaped and contoured with a series of curved and/or angularly related surfaces which extend into at least one if not both of the dome shaped members to thus produce a greatly enlarged surface area compared to the cross sectional area between the dome shaped members.

Also this increased surface area for the transmission of medium therethrough is considerably large compared to the total interior surface area of the opposed dome shaped members. For illustration, and as an example in FIG. 1, the total surface area of the dome shaped members is 13.647 square inches. The surface area of the baffle member 74 is approximately 6.378 square inches.

It is noted with respect to FIG. 2 that the comparative surface area of the baffle member has been increased by modifying the proportions so as to have an area of approximate 8.470 square inches.

With respect to FIG. 1 the present baffle 74 includes an annular cone shaped portion 78 and coaxially thereof and forming in a continuation is the oppositely directed cone shaped portion 80 with the connecting continuous curved areas shown at 82. Thus, the baffle 74 defines the three chambers A, B, C to thus provide a surface area through which the medium must flow which is greatly increased with respect to the cross sectional area between the opposed cone shaped members.

Referring to FIG. 2 the construction is substantially the same except that the angular surfaces are different and therefore affect different frequencies. Here the frequency separating and modulating baffle 84 has an increased surface area as above described in view of the elongated annular converging surface portions 86 and the oppositely extending continuation or elongated cone shaped portion 88 with connecting curved portions 90 to thus define the differently shaped chambers D, E, and F.

A slightly modified curvature or form of frequency separating and modulating baffle is designated at 92, FIG. 3, which consists of a series of oppositely arranged or curved or undulating surfaces 94, 96 and 98, all interconnected to define the chambers G, H. and I.

It is noted with respect to FIGS. 1, 2 and 3 that the formed continuous portions of the baffle 74, 84 and 92 extend respectively into the corresponding dome shaped members to thus provide for increased surface area for the passage of the flow medium therethrough. In this particular construction shown in FIG. 3, the surface area is less than that shown in FIGS. 1 and 2 with the result that there is a greater resistance to flow and, accordingly, a higher back pressure developed than in the embodiments shown in FIGS. 1 and 2.

A modified form of baffle 100 is shown in FIG. 4 and wherein the central portion of said baffle is concave-convex at 102 and extends into one of the dome shaped members. Here again, back pressure created due to this surface area is greater than that created in FIG. 3 or in any of the other illustrations, FIGS. 1 and 2, where greatly increased surface areas are provided due to the curved and angular lens like or irregular contoured surfaces.

The present irregularly shaped frequency modulating baffle may thus be designed for the destruction of certain predetermined frequencies that may be produced within a particular chamber having a plurality of different noise sources when it is desired to destroy or reduce these without creating back pressure or in providing for modified back pressure in accordance with the particular design of baffle.

The foregoing illustrations, FIGS. 1 through 4, merely show several preferred embodiments of the irregularly shaped sound or frequency separating and modulating baffle and wherein the total surface area is substantially increased due to its irregular shape.

While sintered bronze has been referred to in the illustrative embodiments of the invention, other materials which would be regarded as equivalent thereto include sintered steel, porous porcelain or stone or porous plastic materials.

Having described the invention, reference should now be had to the following claims:

1. A silencer adapted to reduce the combined noise level of a flow medium and working mechanism normally above 90 decibels to a sum total value below 90 decibels comprising:

a housing having an inlet for passage of said flow medium into said housing and an outlet;

opposed dome shaped porous first and second noise reducing members with their open ends in abutting relation, forming a chamber in between them;

said first noise reducing member having surfaces disposed adjacent said inlet for passage of said flow medium into said chamber, and said second noise reducing member having surfaces extending from the housing outlet defining an outlet for passage of said flow medium from said chamber to atmosphere, so that the noise level of said flow medium as it passes through said first and second noise reducing members is substantially reduced, and

a porous frequency separating and modulating baffle disposed between said first and second dome shaped members within said chamber, having an annular flange retained between abutting outer portions of said dome shaped members, and inwardly of said flange irregularly shaped contoured portions extending into at least one of said dome shaped members and having a total surface area greater than the maximum cross sectional area between said dome shaped members for reducing and modifying high pressure frequencies and reducing back pressure.

2. In the silencer of claim 1, the contoured portion of said frequency modulating baffle including a pair of continuous concentric oppositely arranged coned shaped members extending into both dome shaped members.

3. In the silencer of claim 1, the contoured portion of said frequency modulating baffle including an outer annular converging portion at its smallest diameter terminating in an oppositely arranged cone shaped portion.

4. In the silencer of claim 1, the contoured portion of said frequency modulating baffle including a series of continuous undulating curved and angularly related surfaces.

5. In the silencer of claim 1, the contoured portion of said frequency modulating baffle including a series of continuous oppositely arranged concave-convex portions.

6. In the silencer of claim 1, the contoured portion of said frequency modulating baffle including a central concave-convex portion.

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