United States Patent [19]

Scharton

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[54] **VORTEX TURBULENCE NOISE GENERATION SUPPRESSOR**

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[73] Assignee: **Bolt Beranek and Newman Inc.,** Cambridge, Mass.

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[21] Appl. No.: **381,000**

Related U.S. Application Data

[63] Continuation of Ser. No. 217,369, Jan. 12, 1972, abandoned.

[52] **U.S. Cl.** ..... **181/46;** 181/33 HB

[51] **Int. Cl.**[2] **F01N 1/00**

[58] **Field of Search** .. 181/46, 56, 60, 33 H, 33 HA, 181/33 HB, 33 HC, 33 HD

[56] **References Cited**

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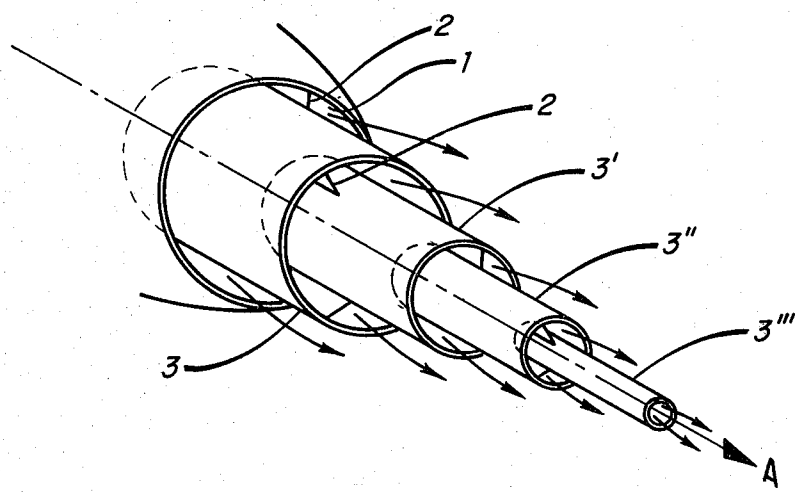
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Attorney, Agent, or Firm—Rines Rines; Shapiro and Shapiro

[57] **ABSTRACT**

This disclosure deals with structures for suppressing a substantial percentage of noise that normally is attendant upon vortex generation from jet engines, blown flaps, turbine outlets and the like, involving successive tubular sections of successively reduced width disposed longitudinally, preferably along a common axis.

8 Claims, 4 Drawing Figures



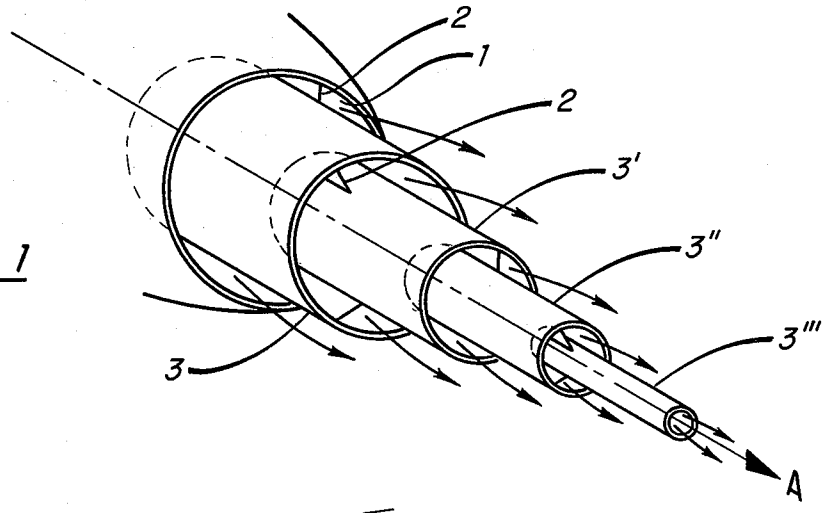


FIG. 1

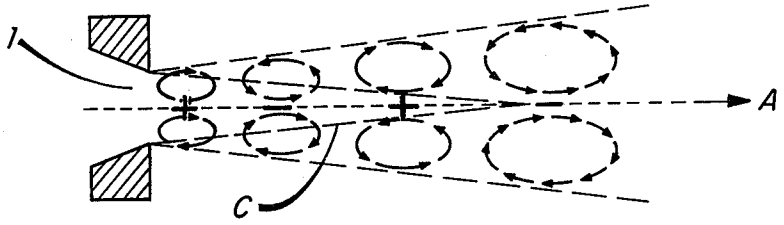


FIG. 2

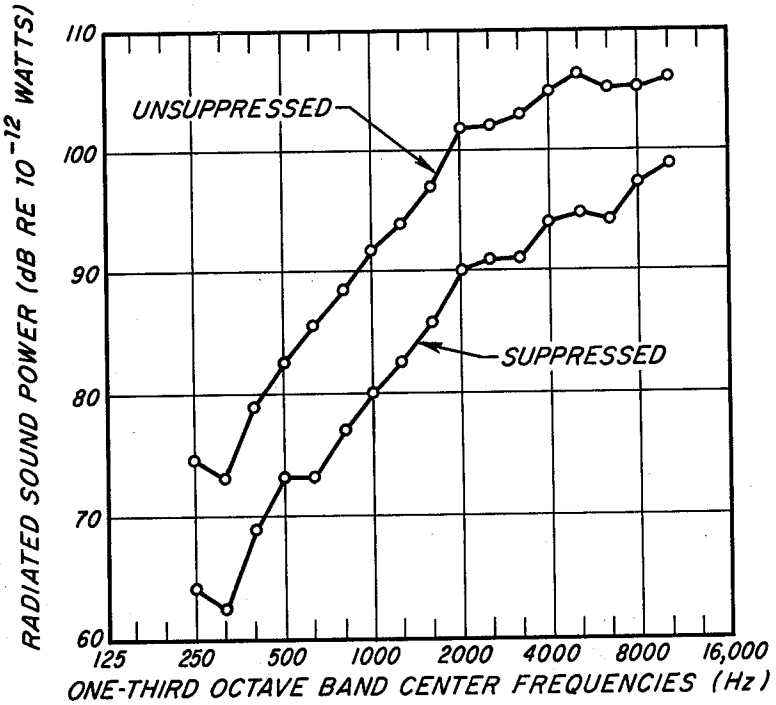


FIG. 3

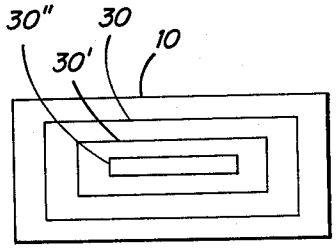


FIG. 4

VORTEX TURBULENCE NOISE GENERATION SUPPRESSOR

This is a continuation application of Ser. No. 217,369, filed Jan. 12, 1972, now abandoned.

The present invention relates to the suppression of the generation of noise in exhaust outlets such as jet engines, blownflap structures for producing additional lift in aircraft, turbines and similar systems, all having vortex-type exhausts, generically referred to herein as jet outlets.

Numerous types of passive and dynamic noise suppressors have been proposed through the years for reducing the generation of noise in fluid flow systems, such as, for example, those associated with vehicular engines and the like as described, for example, in U.S. Letters Pat. No. 2,893,508, issued July 7, 1959 to Clayton H. Allen and Jordan J. Baruch and assigned to Bolt Beranek and Newman Inc., the assignee of the present invention. Particular problems, however, exist in connection with the noise generated in the production of vortices associated with jet outlets of the beforementioned types, as discussed, as an illustration, in an article by G. S. Beavers et al. entitled "Vortex Growth in Jets," appearing in the Journal of Fluid Mechanics, Vol. 44, Part I, 1970. Attempts have been made to overcome this problem by multi-tube devices that, for example, break up the jet into small uncorrelated jet outlets, as described by G. S. Schairer et al. in AIAA Paper No. 68–1023, "Perspective of SST Aircraft Noise Problem," October, 1968, particularly FIG. 30. Such devices, however, are complex and involve breaking the jet circumferentially, which has been found actually not to be necessary to the purposes of the present invention. In accordance with a discovery underlying the present invention, to the contrary, it has been found that the base pressure drag inherent in such multi-element suppressors may be eliminated with a much simpler design that only breaks up the jet radially.

An object of the invention, accordingly, is to provide a new and improved noise-generation suppressor for a jet outlet that is not subject to such pressure drag problems and that obviates the disadvantages of complex circumferential dividing structures, effecting vortex noise-generation suppression, rather, with a far more simple and effective construction.

A further object is to provide a novel noise suppressor of more general applicability, as well.

Other and further objects will be described hereinafter and are more particularly pointed out in the appended claims. In summary, however, from one of its aspects, the invention contemplates a noise generation suppressor for a jet outlet and the like having, in combination, a plurality of hollow tubular members mounted upon the outlet and extending therefrom along a common longitudinal axis, the successive tubular members being of successively reduced transverse cross dimension or width at successive longitudinally spaced positions from the outlet along the axis.

The invention will now be described with reference to the accompanying drawing, FIG. 1 of which is an isometric schematic view of a preferred form of the invention as applied to cylindrical jet outlets;

FIG. 2 is a longitudinal section illustrating vortex generation;

FIG. 3 is a graph of experimentally obtained results; and

FIG. 4 is an end view of a rectangular geometry modification.

Referring to the drawings, a jet outlet 1, as from a jet engine or the like, is shown having mounted thereon by means of ribs or other brackets 2, successive cylindrical hollow vanes or tubular members 3, 3′, 3″, 3‴, etc., each of successively reduced transverse cross-dimension, width or diameter, and each disposed at successive longitudinally spaced positions rearward of the outlet 1 along the common longitudinal axis A. The successive longitudinal disposition of the coaxial members 3, 3′, 3″, 3‴ and their tapered cross-dimensioning is selected to fall within the inner converging tapered conical potential core C of FIG. 2, containing successive regions +, −, +, −, etc. surrounding which successive oppositely rotating vortices are generated from such jet outlets, with the members 3, 3′, 3″, 3‴ radially breaking-up the vortex patterns. The successively reduced transverse width or diameter of the successive coaxially mounted members, thus shaped to conform to the rate of convergence of the potential core C of the vortices, prevents large-scale vortices from being formed and produces, rather, a set of small, annular uncorrelated jets. This has been found to suppress much of the noise generated by the large-scale vortex generation.

In certain applications, including that later-described in connection with the performance illustrated in FIG. 3, the length of the successive members 3, 3′, 3″, 3‴ is made substantially equal, with each member overlapping a part of the preceding member; and the supporting brackets 2 may be disposed at different circumferential locations or spacings for the successive members, as shown.

Other parallel sheet configurations than successively reduced-dimension circular cylindrical tubular members may also be employed, where appropriate, including parallel rectangular plate members, schematically shown at 30, 30′, 30″, etc. in connection with a rectangular outlet in FIG. 4. In all cases, however, the invention is concerned with preventing or suppressing noise generation in the first instance, as distinguished from absorbing already generated sound.

Comparing the radiated sound power with frequency for an experimental jet nozzle of five-eighths inch inside diameter, as used in a turbine nozzle, with tubular members 3, 3′, 3″, 3‴ of the type shown in FIG. 1, down to one-sixteenth inch for the smallest diameter and over a longitudinal distance of about 2 inches, noise reduction of the order of 10 decibels was obtained ("Suppressed" curve in FIG. 3) over a broad frequency band extending from 250 to 10,000 Hz. From experience with scaling techniques in this field, it has been determined that similar substantial improvement can be obtained with much larger structures, as well as smaller structures. These tests show, moreover, that these novel results can be accomplished with relatively small thrust lost; namely, that due primarily to friction drag.

Where the jet outlet takes a different geometrical configuration, such as other geometrically configured outlets, as in the before-mentioned blown flap structures for adding wing lift in some aircraft, the tubular or plate members may assume corresponding geometrical configurations; but with the same constructional features and relative positioning and dimensioning before-discussed.

Further modifications will also occur to those skilled in this art and all such are considered to fall within the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A noise generation suppressor for breaking up the exhaust of a jet outlet into a plurality of streams while minimizing flow-dividing drag, having, in combination, means including a plurality of successive longitudinally extending passages of successively smaller cross-dimension for dividing said exhaust into a plurality of streams and for breaking up the vortex pattern of said exhaust, each of said passages having an inlet at one end and an outlet at the opposite end, each inlet being located adjacent the outlet of the preceding passage and remote from the inlet of the preceding passage, and each passage being substantially freely open and devoid of transverse sub-division along said cross-dimension throughout most of its length.

2. A noise generation suppressor as claimed in claim 1 and in which said passages are of about equal length.

3. A noise generation suppressor as claimed in claim 1 and in which each of said passages overlaps only a portion of the preceding passage.

4. A noise generation suppressor as claimed in claim 1 and in which said passages have substantially cylindrical cross-section.

5. A noise generation suppressor as claimed in claim 1 and in which said passages have substantially rectangular cross-section.

6. A noise generation suppressor as claimed in claim 1 and in which said passages comprise plate members.

7. A noise generation suppressor as claimed in claim 1 and in which said passage outlets are rectangular slits.

8. A noise generation suppressor as claimed in claim 1 and in which said jet outlet has associated therewith a converging potential core and in which said passages are located within the converging potential core.

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