United States Patent

[11] 3,612,446

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[45] Patented **Oct. 12, 1971**

[54] **MEANS AND METHOD FOR PREVENTING THE FORMATION OF AUDIBLE FREQUENCIES IN FLUIDS PASSING OVER AN AIRFOIL SECTION**
8 Claims, 6 Drawing Figs.

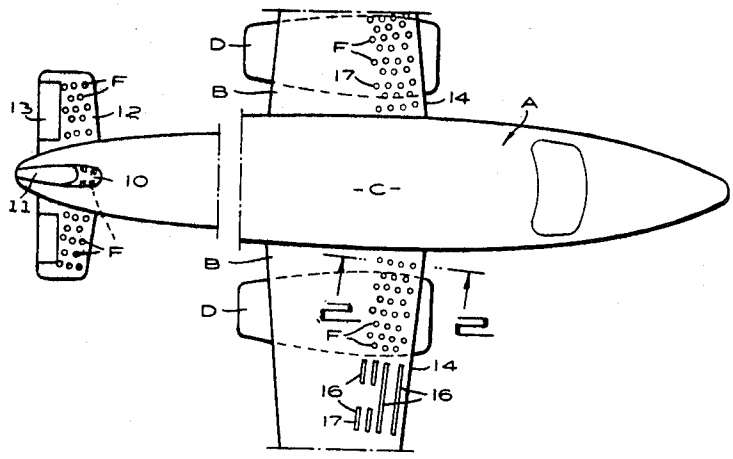
[52] **U.S. Cl.** ..... **244/35,** 244/1 N
[51] **Int. Cl.** **B64c 3/04**
[50] **Field of Search** ..... 244/35, 130, 1 N, 41; 181/35, 40, .5

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Primary Examiner—Milton Buchler
Assistant Examiner—C. A. Rutledge
Attorney—Joseph F. Cole

ABSTRACT: Means and method for preventing the formation of audible frequencies in fluids passing over an airfoil section in which the potential audible frequencies are converted into inaudible frequencies at the source of the fluid disturbance with the airfoil section.



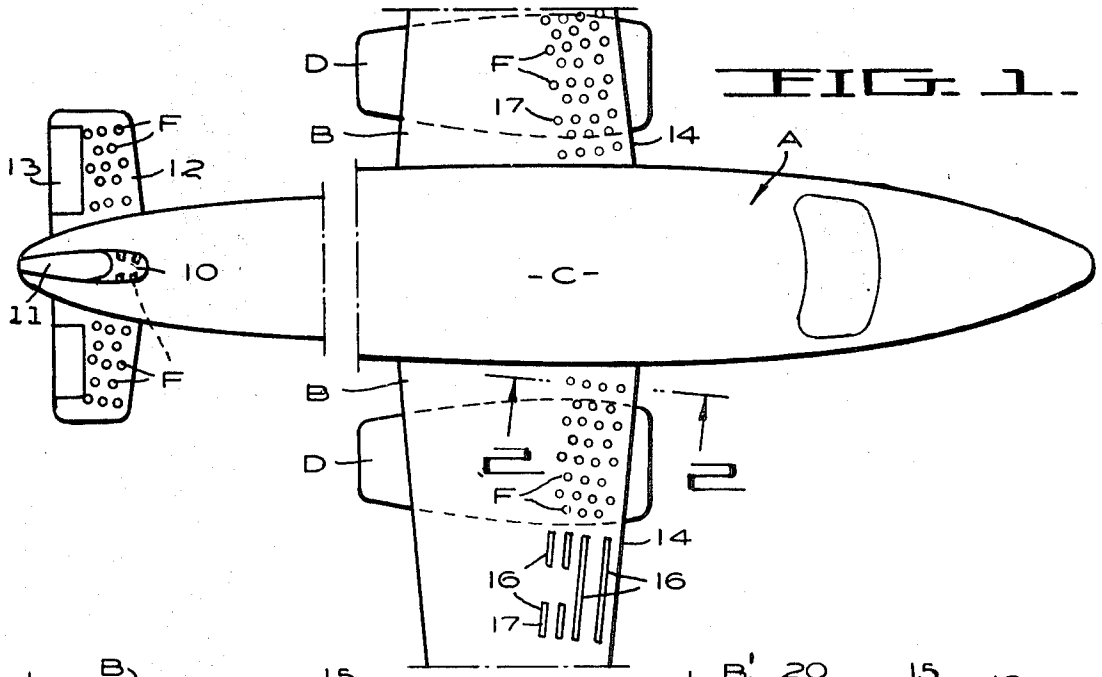


FIG. 1.

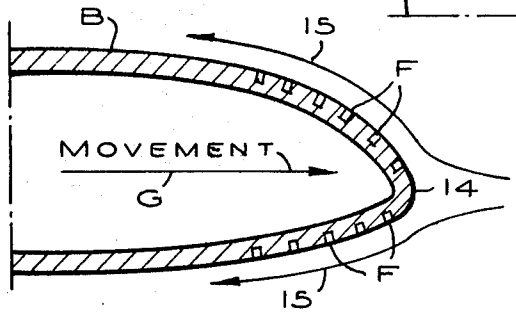


FIG. 2.

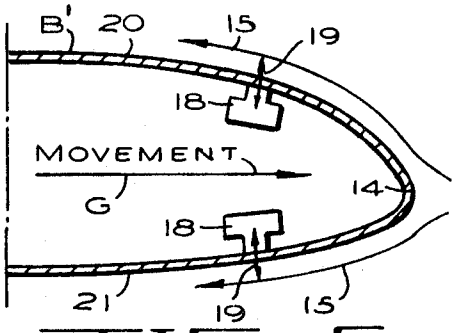


FIG. 6.

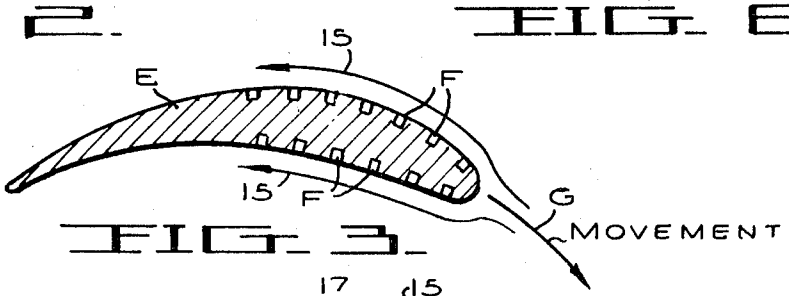


FIG. 3.

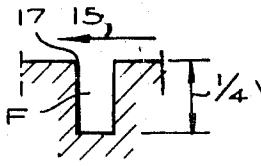


FIG. 4.

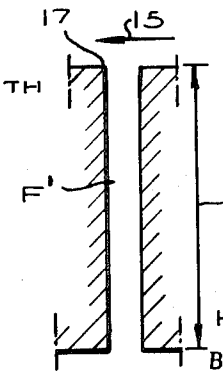


FIG. 5.

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MEANS AND METHOD FOR PREVENTING THE FORMATION OF AUDIBLE FREQUENCIES IN FLUIDS PASSING OVER AN AIRFOIL SECTION

SUMMARY

As the cardinal object of this invention, it is proposed to provide means and method for preventing the formation of audible frequencies in fluids passing oven an airfoil section. This is accomplished by the conversion of potential audible frequencies into inaudible frequencies at the source of fluid disturbance with the airfoil section.

More specifically stated, the conversion is accomplished by two different approaches: (1) providing organ pipe configurations in the surface of the airfoil section that contacts the fluids, with the fluids passing over edges of the configurations to produce standing waves in the configurations that impart their frequencies to the fluids; or (2) by vibrating the surface of the airfoil section that contacts the fluids, with the vibrations imparting their frequencies to the fluids in the inaudible frequency range.

Other objects and advantages will appear as the specification proceeds, and the novel features will be pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWING

For a better understanding of the invention, reference should be made to the accompanying drawing, forming part of this specification, in which:

FIG. 1 is a fragmentary top plan view of an aircraft with organ pipe configurations formed therein;

FIG. 2 is a transverse sectional view taken through a wing of the aircraft along the plane 2—2 of FIG. 1;

FIG. 3 is a transverse sectional view taken through an airfoil section defining a blade;

FIGS. 4 and 5 are diagrammatic views showing waves produced in a cavity and in a pipe, respectively; and

FIG. 6 is a section through an airfoil section in which oscillators, or the like, are used to vibrate the surface thereof that contacts the fluids.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Research work in the area of reducing noise created by turbulent gases, such as combustion gases moving at high velocity and at frequencies in the audible range, i.e. below 20,000 cycles per second, bypassing said gases over the lip of an organ pipe of such length as will create a frequency above 20,000 cycles per second, has resulted in an additional approach to the noise problem, whereby the conversion of the potential audible frequency takes place at the source of the gas or air disturbance, rather than converting the frequency of the gas from audible into inaudible as it leaves the engine and is entering the atmosphere.

To illustrate: While I have been able to convert the gases moving in the audible frequency range by passing them over the lip of a suitable organ pipe, as they are leaving the engine, I now propose that the organ pipe configuration be located at the source or point of fluid (gas or liquid) disturbance. This may be readily understood by referring to the accompanying drawing.

In FIG. 1, I show an aircraft designate generally at A having wings B projecting laterally from the fuselage C, with jet engines D arranged to advance the aircraft. As shown in FIG. 2, the wings B define airfoil sections. Also, in FIG. 1, the fin 10 and rudder 11 define an airfoil section; and, likewise, the stabilizer 12 and elevator 13 define an airfoil section. In FIG. 3, a blade E of the engine D has been disclosed, and it defines an airfoil section.

The source of fluid disturbance previously mentioned is usually an airfoil configuration or section, such as the intake compressor blades of the engine D; the power producing or high velocity gas deflecting blades; the leading edges 14 of the wings B and empennage (tail) surfaces in the case of speeds

over Mach 1; or the speed of sound, thus resulting in sonic boom.

If such points of origin, or source of fluid disturbance, i.e., the surface of the airfoil section that contacts the air or gases (flow indicated by arrows 15 in FIGS. 2 and 6), is covered with suitable organ pipe configurations F, the fluid will be put into motion at frequencies imparted by the organ pipe configurations F, rather than being converted at a later time as in previous research on ultrasonic silencers for engines.

In order for any invention to be practical, the physical parameters of the proposed changes to existing components should be within engineering limits so brief reference will be made to what is needed in organ pipe sizes to obtain inaudible frequencies. Since the length of a closed organ pipe (see FIG. 4) is one-quarter of the wave length generated by that pipe, and since the basic formula involved is L equals D over N, where L is wavelength and D is distance traveled by the sound in one second, and N is the number of vibrations per second, we can readily determine the length of pipe needed.

Keeping in mind that the speed of sound varies with the altitude—the range is 1,100 feet per second at sea level, or 760 miles per hour, and is 660 miles per hour at 30,000 feet elevation to give two points of reference—in order to obtain a frequency of 20,000 cycles per second, we need a closed organ pipe 0.165 inch deep at sea level and at 30,000 feet this depth becomes 0.144 inch. To get 30,000 cycles per second this pipe depth becomes 0.110 inch at sea level and 0.095 inch at 30,000 feet. For 40,000 cycles per second we need 0.082 inch and at 30,000 feet the figure is 0.072 inch. At still higher frequencies—100,000 cycles per second is no longer considered high—the length or depth would be still shorter so we could readily, from a physical angle, install the equivalent of an organ pip configuration F in such airfoil sections (such as the wings B or blade E), or members as turbine intake or compressor blades; turbine exhaust or power blades; wing and empennage leading edge surfaces where the audible range waves known as sonic boom are formed.

These organ pipe configurations F can be in the form of small holes in the air contact surface of the blades E, or leading edge or the wind B or empennage (or for that matter any fluid disturbing surface), or they may be grooves or slots 16 (see FIG. 1)—continuous or intermittent—in said surfaces. Holes, of course, have no rotational directional axis, but grooves or slots would run at right angles to the direction of movement G of the airfoil section (see FIGS. 2, 3 and 6), that is, the passing of the air or fluid would be across the grooves or slots 16.

Since an organ pipe works on the basis of a standing wave existing in the pipe (FIG. 5) or cavity (FIG. 4), we do not have air or gases going into and out of the pipe cavity. The standing wave does, however, impart its frequency to an air or gas passing over the lip 17 of the pipe opening. Hence there is no turbulence created to impair the efficiency of the airfoil section, or member involved. Strength of the air foil section, be it an engine blade or leading surface, need not be impaired since solid material often cannot disperse and attenuate strain forces as well as nonsolid members.

The flow of air or gas should pass over the edge or lip 17 of the organ pipe configuration at an angle that will attain maximum conversion to the frequency of the organ pipe configuration, and this result can be obtained in airfoil sections without changing the airfoil characteristics by having the hole or slot at the proper angle to the air flow pattern 15.

It should be pointed out that instead of having the inaudible frequencies generated by what might be termed "self induced" action of the air or gases flowing over the organ pipe configurations F, as in FIGS. 1 to 5, inclusive, we can also attain the desired end result by causing the surface, over which the air flows in contact, to be vibrated in the inaudible frequency range by a power source, such as an oscillator or the like 18, with the directions of the vibratory movements being indicated by the arrows 19 in FIG. 6. In other words, the upper and lower surfaces 20 and 21, respectively, of the airfoil

section B' become actuating diaphragms that impart their frequencies to the fluid (liquid or gas) that comes in contact with the diaphragms. At the inaudible frequencies, i.e., above 20,000 cycles per second, the movement of the metal involved is so small—due to the short wavelength—that the "metal movement" is well within the elastic limits of the metal so fatigue is not a factor.

Also, the frequencies could be at the lower limits, i.e., below 20 cycles per second. Open organ pipe configurations F' in FIG. 5 would be four times as long as the configurations F in FIG. 4, the latter showing a cavity, i.e., having a closed bottom.

The waves or vibrations imparted to the fluids contacting with the airfoil section are below or above the limits of the human ear, i.e., in the range between 20 and 20,000 cycles per second, respectively.

I claim:

1. The method for preventing the formation of audible frequencies in fluids passing over an airfoil section comprising the conversion of potential audible frequencies into inaudible frequencies at the source of the fluid disturbance with the airfoil section, i.e., at the leading portion of said section, and in which the conversion is accomplished by providing organ pipe configurations in the surface of the airfoil surface that contacts the fluids, with the fluids passing over edges of the configurations to produce standing waves in the configurations that impart their frequencies to the fluids.

2. The method for preventing the formation of audible frequencies in fluids passing over an airfoil section, as set forth in claim 1; and in which the waves impart their frequencies below or above the limits of the human ear, i.e., in the range between 20 and **20,000** cycles per second, respectively.

3. The method for preventing the formation of audible frequencies in fluids passing over an airfoil section comprising the conversion of potential audible frequencies into inaudible frequencies at the source of the fluid disturbance with the airfoil section, i.e., at the lead portion of said section; and in which the conversion is accomplished by vibrating the surface of the airfoil section that contacts the fluids, with the vibrations imparting their frequencies to the fluids in the inaudible frequency range.

4. The method for preventing the formation of audible frequencies in fluids passing over an airfoil section, as set forth in claim 3; and in which the vibrations are below or above the limits of the human ear, i.e., in the range between 20 and 20,000 cycles per second, respectively.

5. An airfoil section movable through fluids and having a surface over which the fluids pass, the surface having means for converting potential audible frequencies into inaudible frequencies at the source of the fluid disturbance with the airfoil section, i.e., at the leading portion of said section, and in which the conversion is accomplished by organ pipe configurations in the surface of the airfoil section that contacts the fluids, with the fluids passing over edges of the configurations to produce standing waves in the configurations that impart their frequencies to the fluids.

6. The combination, as set forth in claim 5; and in which the waves impart their frequencies below or above the limits of the human ear, i.e., in the range between 20 and **20,000** cycles per second, respectively.

7. An airfoil section movable through fluids and having a surface over the fluids pass, the surface over the fluids pass, the surface having means for converting potential audible frequencies into inaudible frequencies at the source of fluid disturbance with the air foil section, i.e., at the leading portion of said section; and in which oscillators, or the like, are provided for vibrating the surface of the airfoil section that contacts the fluids, with the vibrations being in the inaudible frequency range.

8. The combination, as set forth in claim 7; and in which the vibrations impart their frequencies below or above the limits of the human ear, i.e., in the range between 20 and 20,000 cycles per second, respectively.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,612,446 Dated October 12, 1971

Inventor(s) Herbert A. Lebert

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 41, "wind" should read --wing--.

Column 4, line 25, delete "the surface over the fluids pass,".

Signed and sealed this 4th day of April 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents