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NASA CASE NO. LAR 13400-1

PRINT FIG. 1

PAT. APPL. IN-02 157379

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Serial No.: 07/806,066
12/13/91 LaRC

SWEPT WING ATTACHMENT LINE CONTAMINATION FENCE

Awards Abstract

NASA Case No. LAR 13400-1

The present invention is a device for controlling attachment line contamination on an airfoil. A fence is installed on the leading edge of the airfoil in the freestream direction perpendicular to the airfoil, outboard of the fuselage boundary layer. The inboard side of the fence arrests the spanwise movement of the turbulent boundary layer while the laminar boundary layer on the outboard side of the fence eliminates any further turbulent contamination of the attachment line.

The novelty of this invention is found in the placement of geometrically simple device on the leading edge of a swept wing in a location which provides control of attachment line contamination over a wide range of angles of attack.

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SWEPT WING ATTACHMENT LINE CONTAMINATION FENCE

Origin of the Invention

Technical Field of the Invention

The present invention relates in general to controlling airflow across an airfoil and more specifically to controlling attachment line contamination on swept wings.

Background of the Invention

The control of attachment line contamination has practical applications on swept wings incorporating natural laminar flow or laminar flow control for reduction of viscous drag. Attachment line contamination can destroy laminar flow on swept wings of production airplanes or on swept surfaces being used for boundary-layer research purposes.

The method previously considered for control of attachment line contamination is the Gaster bump (U.S. Pat. No. 3,288,399). The Gaster bump operates on the principle of creating a new boundary-layer stagnation point on the attachment line. Thus, the turbulent attachment line flow is stopped and a laminar boundary layer starts on the bump and persists along the attachment line in the spanwise direction. The Gaster bump is only effective over a limited range of angles of attack. For example, a Gaster bump which works at an angle of attack for low altitude, high-speed cruising

conditions may not work at the higher angle of attack required for slower cruise or climb speeds at higher altitudes. This problem arises because of the change in attachment line location on the leading edge with changes in angle of attack.

Thus it is an object of the present invention to provide a device for controlling attachment line contamination.

It is another object of this invention to control attachment line contamination over the entire range of angles of attack for an aircraft.

It is another object of this invention to control attachment line contamination on swept wing aircraft.

It is yet another object of the present invention to accomplish the foregoing objects in a simple manner.

Additional objects and advantages of the present invention are apparent from the drawings and specification which follow.

Summary of the Invention

According to the present invention, the foregoing and additional objects are obtained by providing a device for passively controlling attachment line contamination on an airfoil. A fence is installed on the leading edge of the airfoil in the freestream direction perpendicular to the airfoil, outboard of the fuselage boundary layer. In this location, the inboard side of the fence arrests the spanwise movement of the turbulent boundary layer while the laminar boundary layer on the outboard side of the fence eliminates any further turbulent contamination of the attachment line. The height of the fence is larger than the thickness of the attachment line boundary layer and the fence may be wedge-shaped or a single plate angled from the freestream direction towards the fuselage.

Brief Description of the Drawings

Figure 1 is a partial plan view of a swept wing aircraft,

Figure 2 is a cross-sectional view of a fence attached to the leading edge of an airfoil taken along line II-II of figure 1, and

Figure 3 is a cross-sectional view of a fence taken along line III-III of figure 2.

Detailed Description of the Invention

Figure 1 shows an airfoil 10 attached to an aircraft fuselage 12. A wedge-shaped fence 14 is attached to the leading edge of the airfoil 10 outboard of the fuselage boundary layer 16. As is shown in figure 2, the fence 14 continues along the lower surface of the airfoil 10 to provide attachment line contamination control over a wide range of angles of attack. The height of the fence 14 is between 0.25 and 1.00 inches for swept-wing aircraft at cruise unit Reynolds numbers between 1×10^6/ft and 3×10^6/ft. A fence 14 in this height range exceeds the thickness of the attachment line boundary layer 18 which is shown in figure 3. The wedge half angle 20 must be great enough to provide for a positive angle of incidence 26 to the local flow 22 and usually ranges from 10° to 45° when installed on swept-wing aircraft (sweep angle 24 of 15° to 35°). If the sweep angle 24 is increased, the wedge half angle 20 is increased.

The attachment line fence 14 operates on the principle that the inboard side of the fence arrests the spanwise movement of the turbulent boundary layer and the laminar boundary layer on the outboard side of the fence eliminates any further turbulent contamination of the attachment line. The boundary layer on the outboard side of the fence is made laminar by providing for a small positive angle of incidence 26 between the outboard side of the fence and the local freestream velocity vector 22.

What is claimed is:

SWEPT WING ATTACHMENT LINE CONTAMINATION FENCE

Abstract of the Disclosure

A device for controlling attachment line contamination on an airfoil. A fence is installed on the leading edge of the airfoil in the freestream direction perpendicular to the airfoil, outboard of the fuselage boundary layer. The inboard side of the fence arrests the spanwise movement of the turbulent boundary layer while the laminar boundary layer on the outboard side of the fence eliminates any further turbulent contamination of the attachment line.

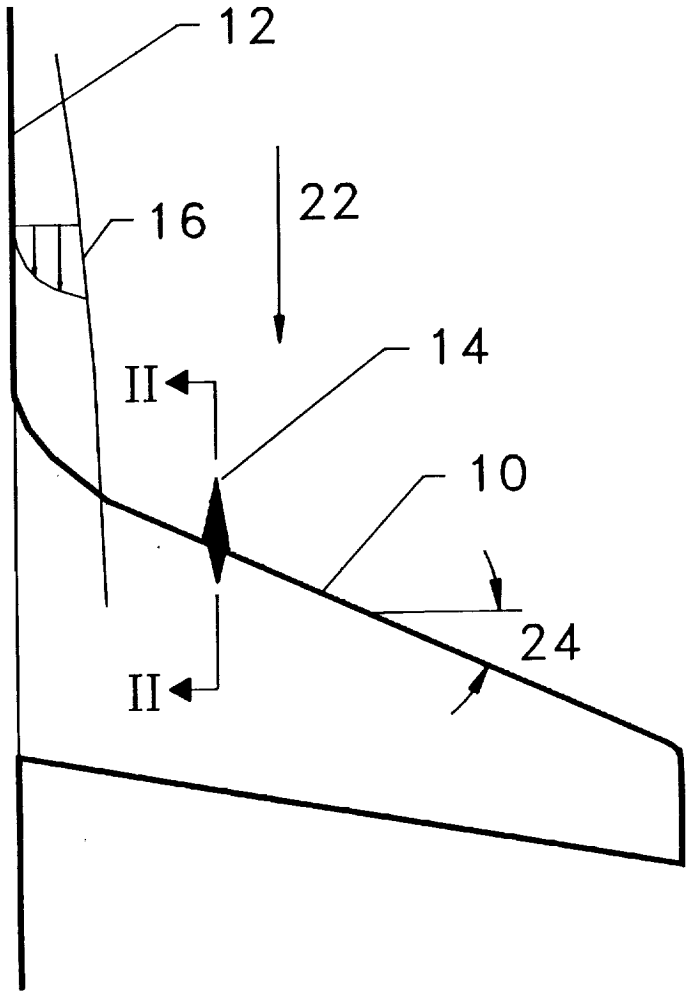

FIG. 1

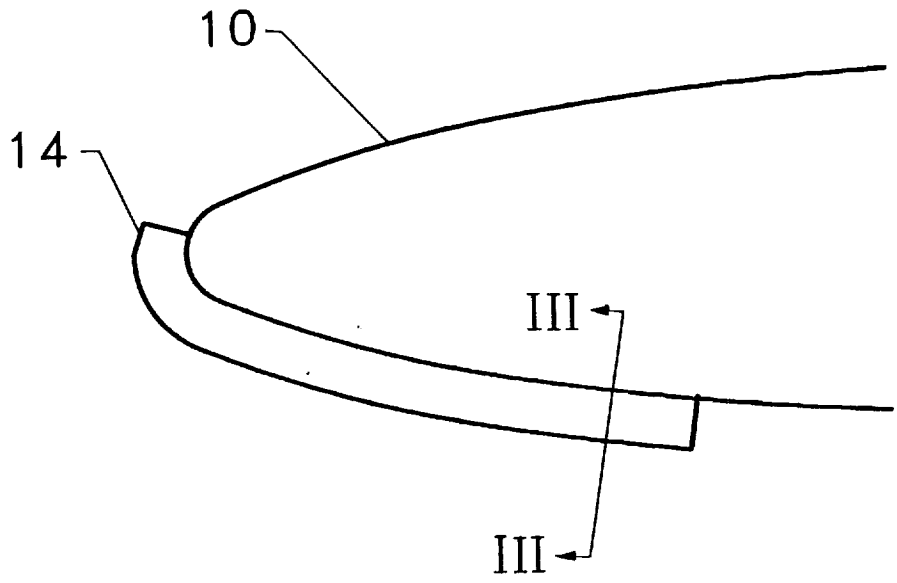

FIG. 2

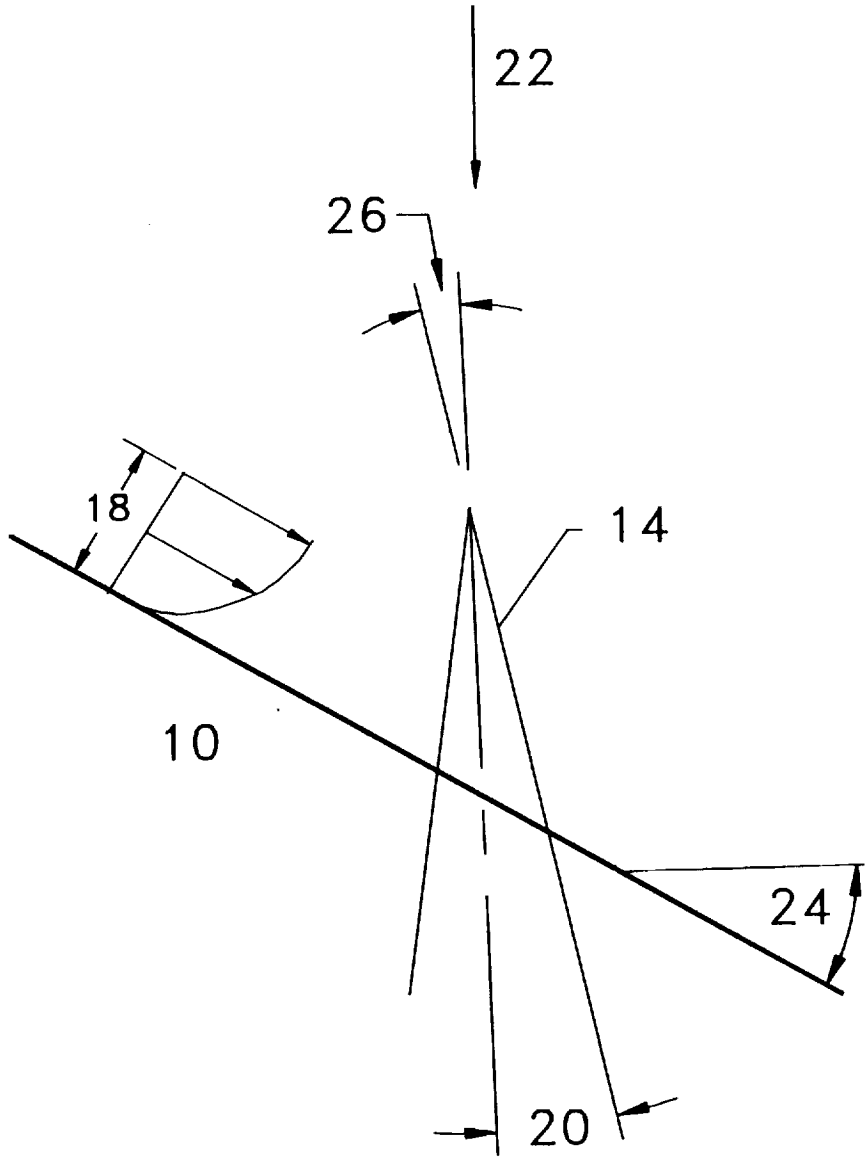

FIG.3