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(54) **DEPLOYABLE AIRFOIL ASSEMBLY FOR AIRCRAFT**

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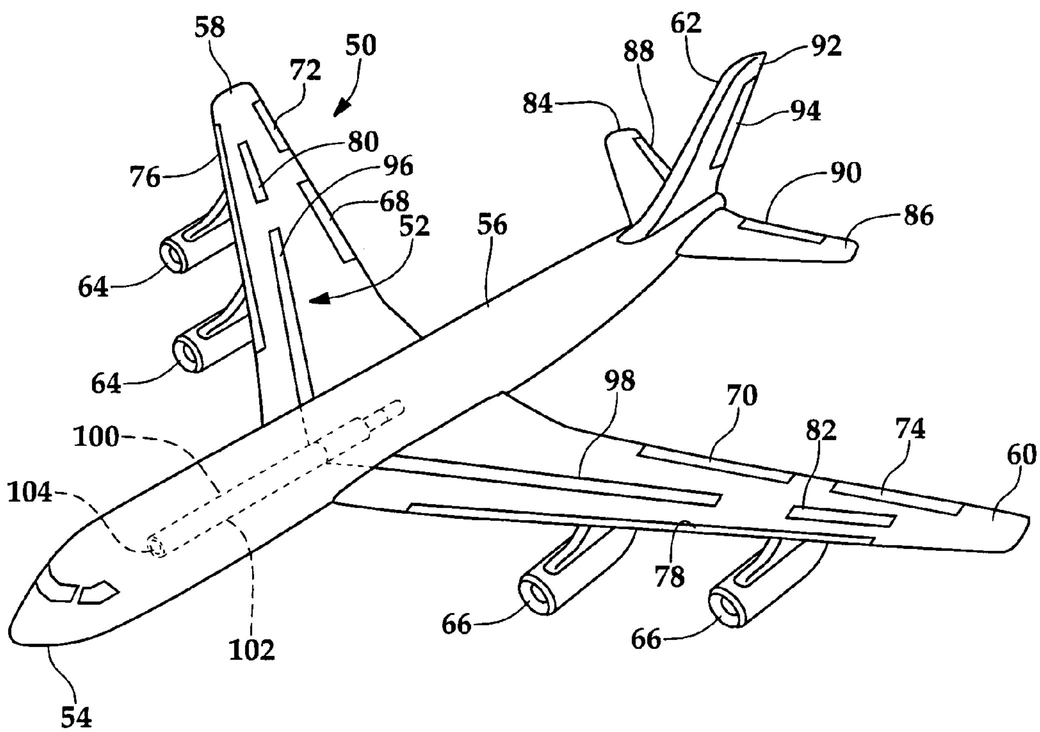
(57) **ABSTRACT**

A deployable airfoil assembly is disclosed that provides for selectively augmenting lift surface area of an aircraft. In one embodiment, a fixed wing is mounted to the aircraft. An auxiliary wing is moveably coupled to the fixed wing and actuatable between a retracted position and an extended position. In the retracted position, the auxiliary wing is housed within the fixed wing and, in the extended position, the auxiliary wing is positioned above the fixed wing such that a venturi passageway is defined between the auxiliary wing and the fixed wing. A sail is deployable along a length of the auxiliary wing from a boom associated with the aircraft.



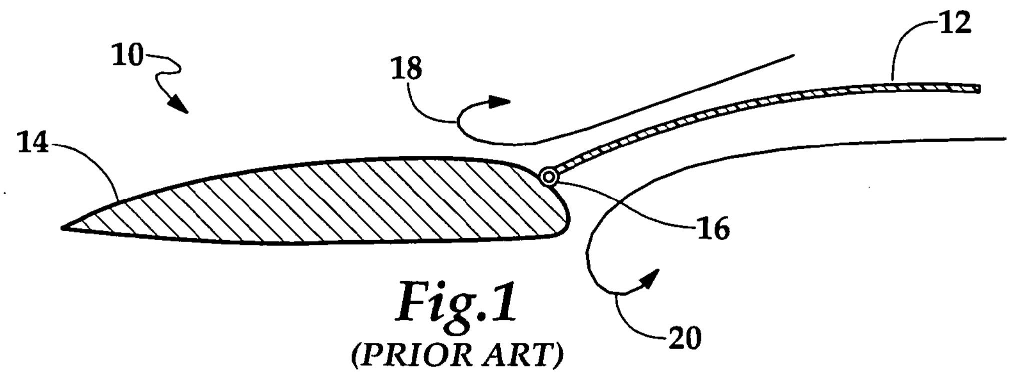


Fig.1
(PRIOR ART)

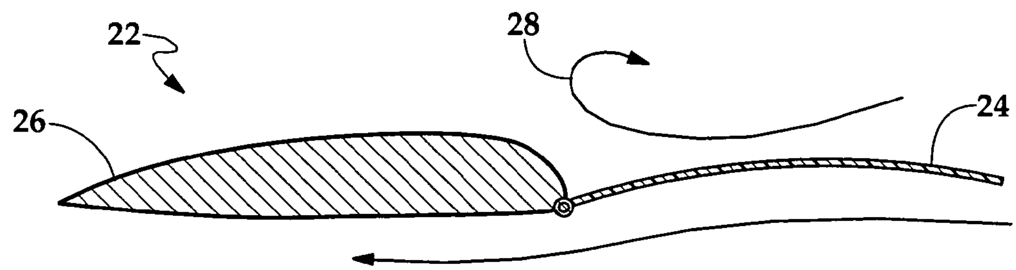


Fig.2
(PRIOR ART)

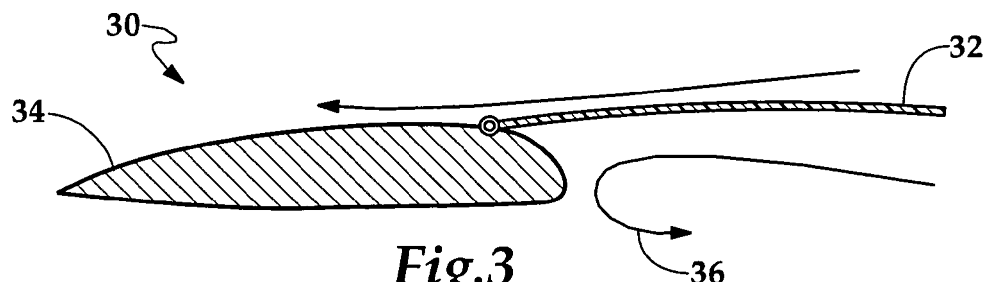


Fig.3
(PRIOR ART)

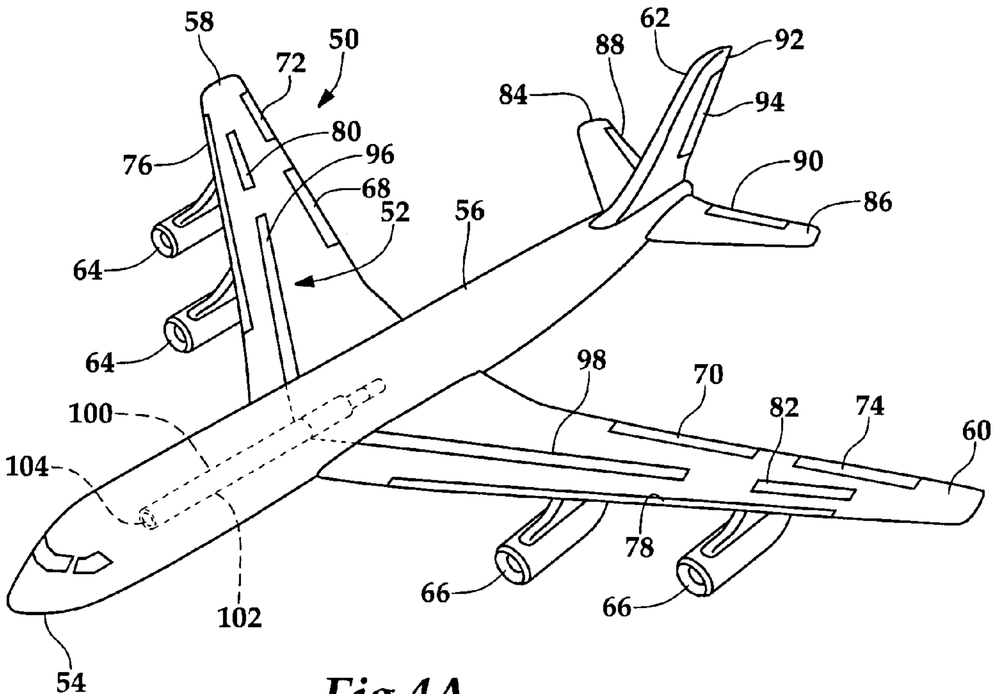

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Fig.4A

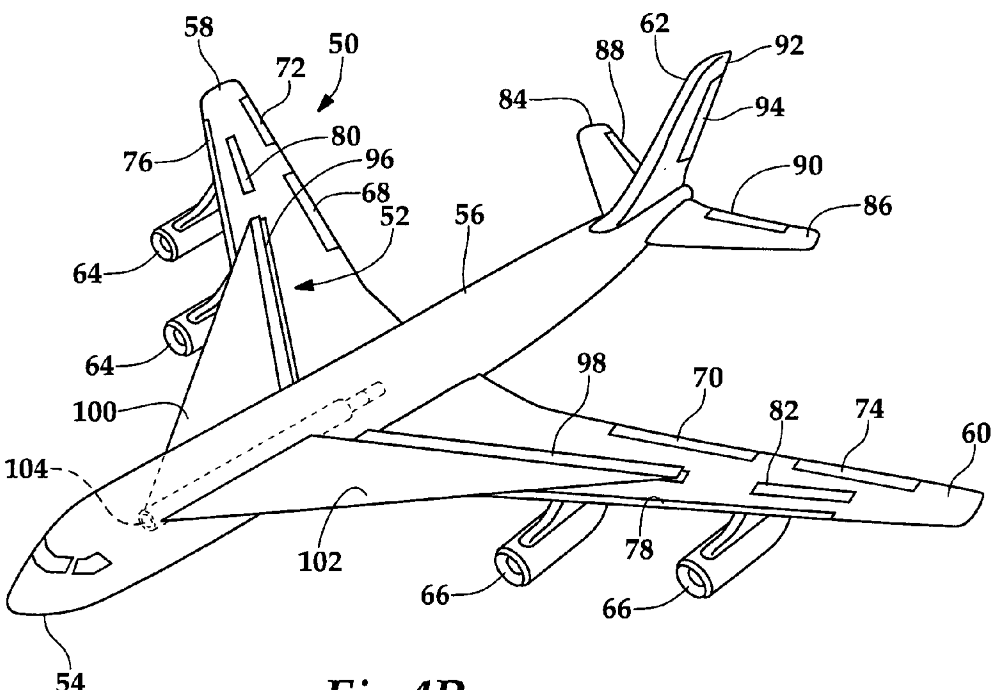
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Fig.4B

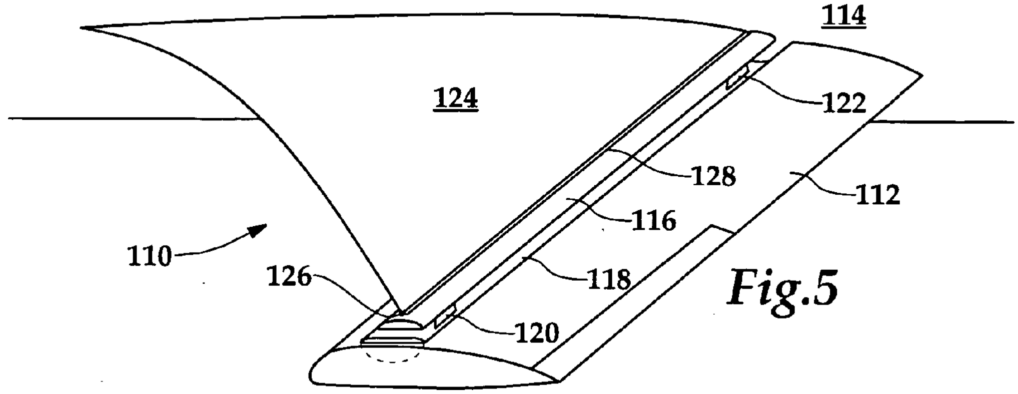

Fig.5

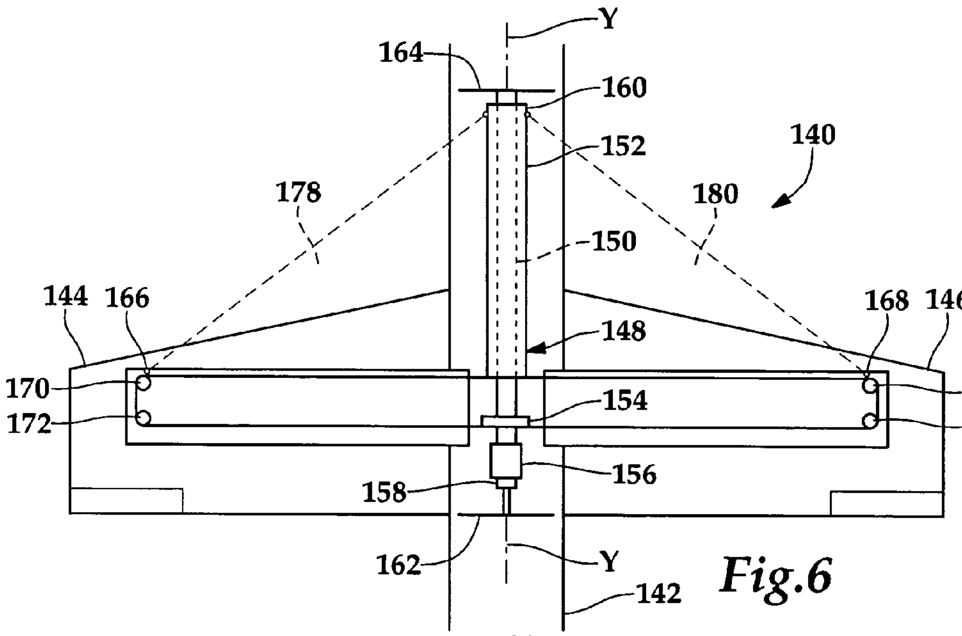

Fig.6

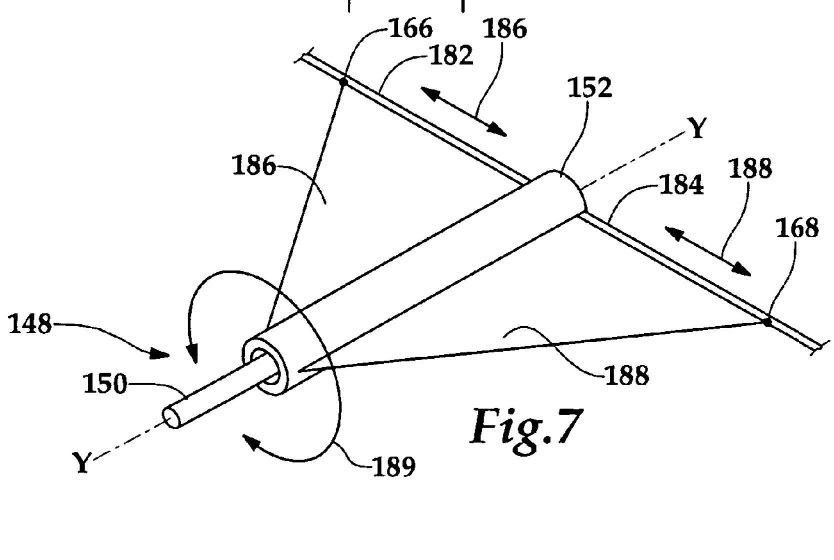

Fig.7

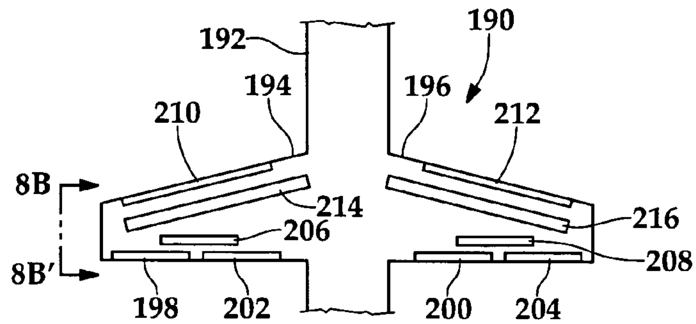

Fig.8A

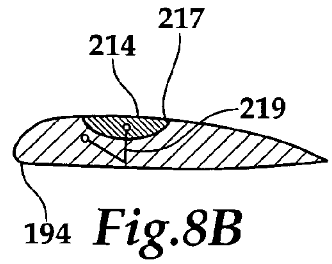

Fig.8B

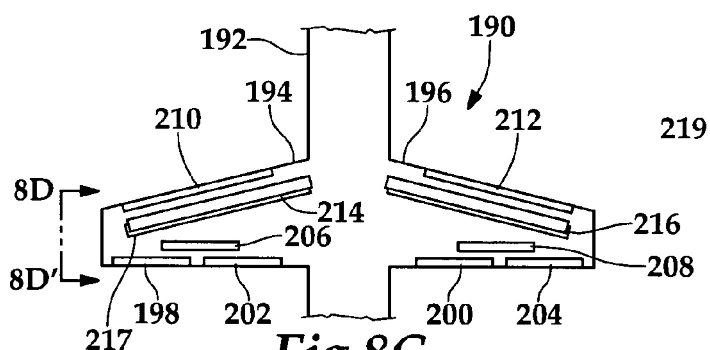

Fig.8C

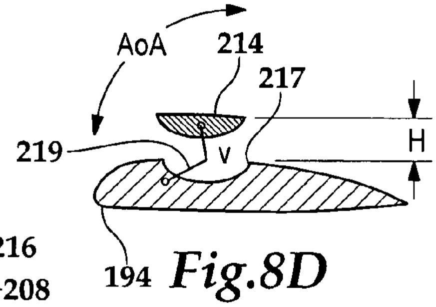

Fig.8D

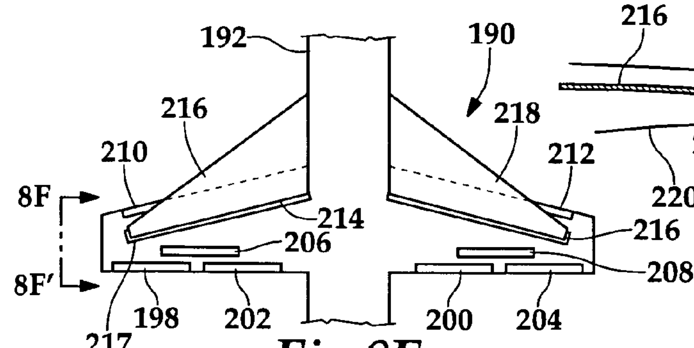

Fig.8E

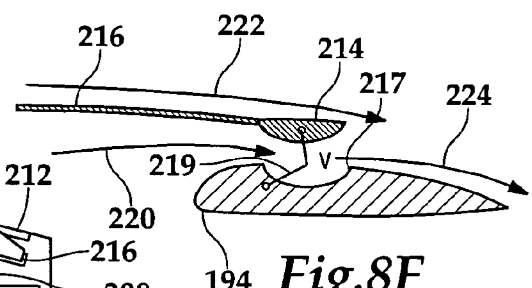

Fig.8F

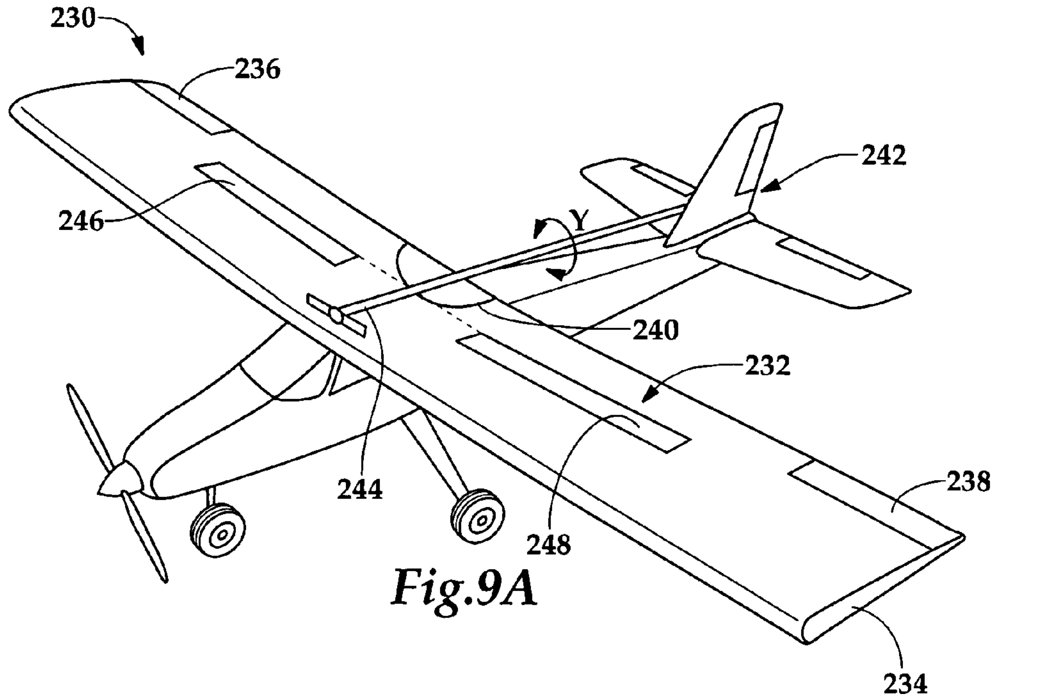
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Fig.9A

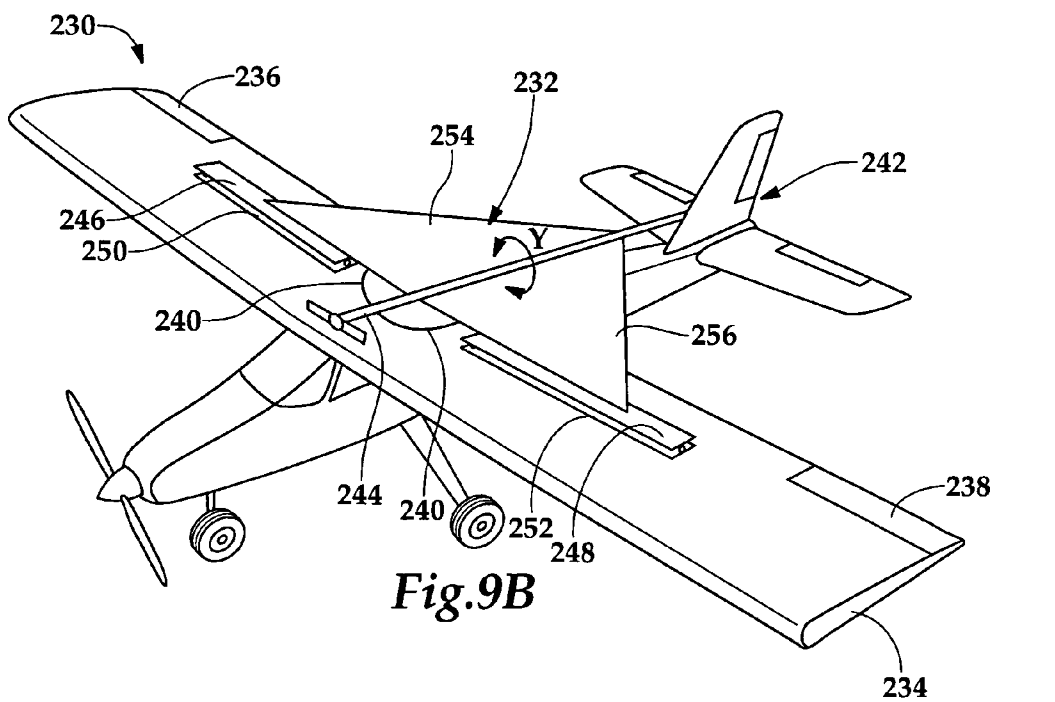
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Fig.9B

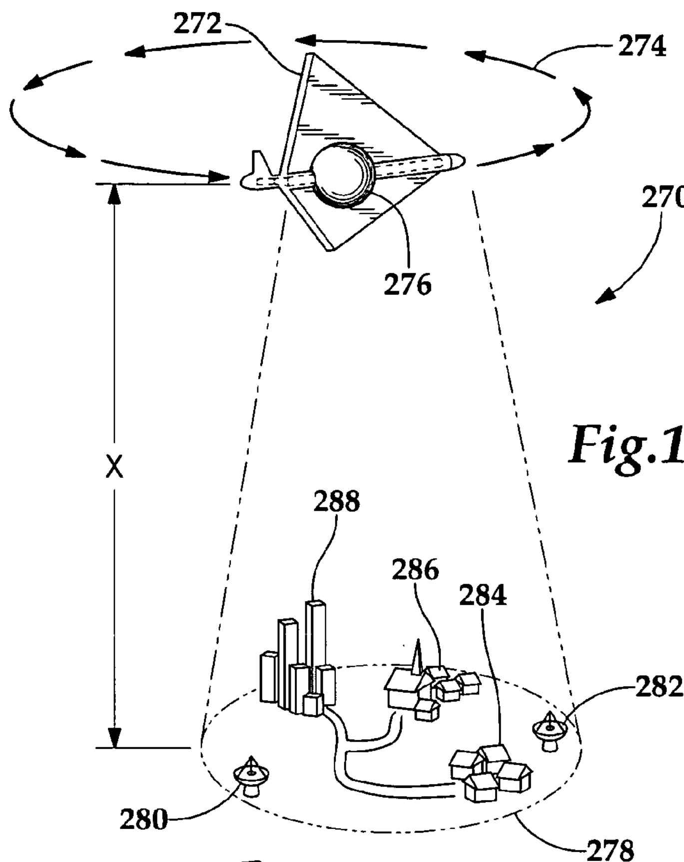

Fig.10A

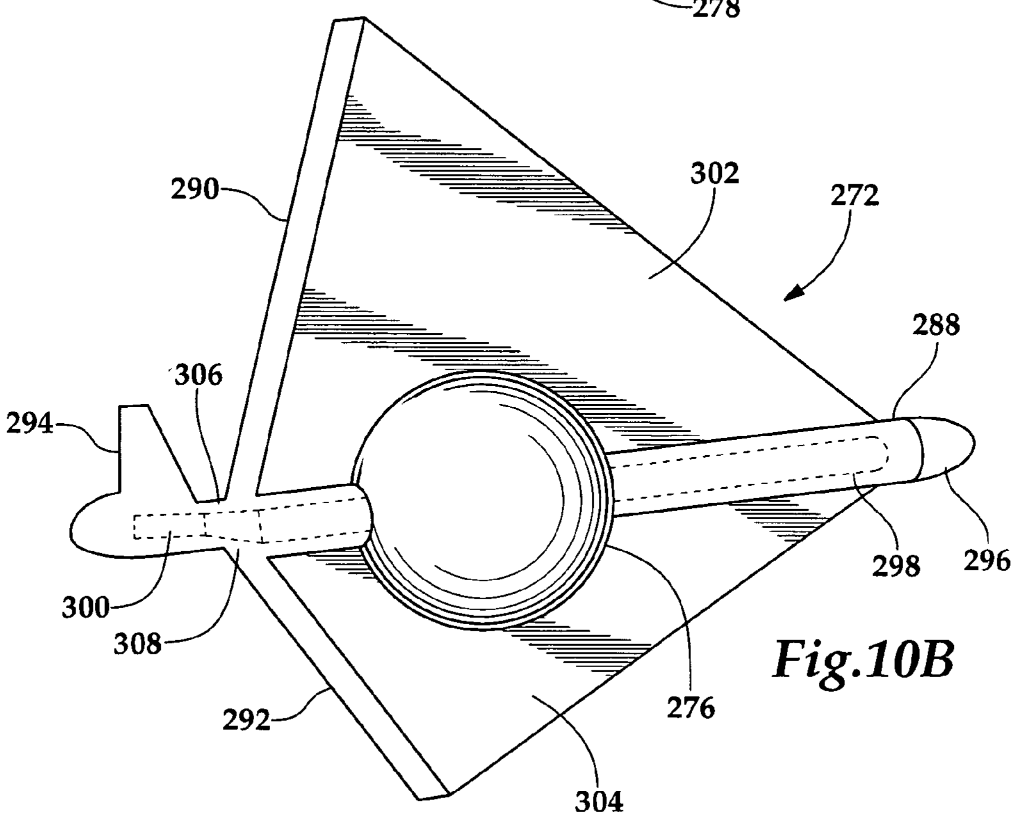

Fig.10B

DEPLOYABLE AIRFOIL ASSEMBLY FOR AIRCRAFT

TECHNICAL FIELD OF THE INVENTION

[0001] This invention relates, in general, to aircraft wing structures and, in particular, to a deployable airfoil assembly for a fixed wing aircraft that augments the lift surface area of the aircraft.

BACKGROUND OF THE INVENTION

[0002] Short takeoff and landing, abbreviated STOL, refers to the ability of an aircraft to clear a 50-foot (15 meter) obstacle within 1500 feet (450 meters) of commencing takeoff, or in landing, to stop within 1500 feet (450 meters) after passing over a 50-foot (15 meter) obstacle. It is desirable under certain conditions for fixed-wing aircraft to be able to perform STOL operations at relatively low air speeds, for example, 20 to 30 knots (37-55 km/hr) indicated air speed. This requires either a high ratio of power to aircraft weight or high ratio of wing area to aircraft weight. Slats and flaps are the primary means for increasing the wing area of conventional aircraft. Typically, slats and flaps change the camber as well as increase the effective lift area of the wing. Increased wing area and changes in camber generally yield a greater lifting force on the wing, thereby reducing stall speed.

[0003] Another existing solution is described in U.S. Pat. No. 6,241,195 which issued in the name of Fred A. Wagner, III, (hereinafter "the '195 patent"). The '195 patent discloses a retractable airfoil assembly that augments the wing surface area of an aircraft enabling it fly without stalling at reduced speeds during takeoff and landing. The operation of the retractable airfoil assembly of the '195 patent is illustrated in prior art FIGS. **1-3**.

[0004] With reference to FIG. **1**, a prior art airfoil assembly **10** includes a flexible sail **12** that is retractably deployed along a airplane wing **14** via a track located at a leading edge **16**. The flexible sail **12** and the airplane wing **14** form a continuous airfoil. In operation, stall zones **18** and **20** are created at the junction of the flexible sail **12** and the airplane wing **14** due to the difference in thickness therebetween. The stall zones **18** and **20** cause drag and less than optimum performance.

[0005] Referring now to FIG. **2**, a prior art airfoil assembly **22** is illustrated having a flexible sail **24** interfacing a bottom surface of an airplane wing **26**. Similar to FIG. **1**, a stall zone **28** is created at the junction of the flexible sail **24** and the airplane wing **26** due to the difference in relative thicknesses of the wings at the junction. Referring now to FIG. **3**, likewise, in a prior art airfoil assembly **30**, in which an airfoil **32** is connected to an upper surface of an airplane wing **34**, a stall zone **36** develops. Accordingly, regardless of the point of connection between the airfoil and the airplane wing, performance is not optimized due the presence of stall zones and related drag. Hence, a need exists for improvements to airfoil assemblies which augment the surface area of an aircraft without creating stall zones and drag.

SUMMARY OF THE INVENTION

[0006] A deployable airfoil assembly is disclosed that provides for selectively augmenting lift surface area of an aircraft. In one embodiment, a fixed wing is mounted to the aircraft. An auxiliary wing is moveably coupled to the fixed wing and actuatable between a retracted position and an extended position. In the retracted position, the auxiliary wing is housed within the fixed wing and, in the extended position, the auxiliary wing is positioned above the fixed wing such that a venturi passageway is defined between the auxiliary wing and the fixed wing. A sail is deployable along a length of the auxiliary wing from a boom associated with the aircraft.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] For a more complete understanding of the features and advantages of the present invention, reference is now made to the detailed description of the invention along with the accompanying figures in which corresponding numerals in the different figures refer to corresponding parts and in which:

[0008] FIG. **1** is side cross-sectional view of a prior art airfoil assembly having an airfoil connected in a leading edge embodiment;

[0009] FIG. **2** is a side cross-sectional view of a prior art airfoil assembly having an airfoil connected in a bottom surface embodiment;

[0010] FIG. **3** is a side cross-sectional view of a prior art airfoil assembly having an airfoil connected in an upper surface embodiment;

[0011] FIG. **4**A is a front perspective view of one embodiment of an aircraft having a deployable airfoil assembly;

[0012] FIG. **4**B is a front perspective view of the aircraft of FIG. **4**A wherein the deployable airfoil assembly is in a fully deployed configuration;

[0013] FIG. **5** is a perspective view of one embodiment of a deployable airfoil assembly;

[0014] FIG. **6** is a top plan view of one embodiment of a depolyable airfoil assembly;

[0015] FIG. **7** is a perspective view, partly broken away, of one embodiment of the boom of FIG. **6** including the static support tube, rotatable drum, and pair of flexible sails;

[0016] FIG. **8**A is a top plan view of one embodiment of an aircraft utilizing the deployable airfoil assembly in a fully retracted configuration;

[0017] FIG. **8**B is a side view of the aircraft along line **8**B-**8**B' of FIG. **8**A;

[0018] FIG. **8**C is a top plan view of the aircraft utilizing the deployable airfoil assembly in a partially deployed configuration;

[0019] FIG. **8**D is a side view of the aircraft along line **8**D-**8**D' of FIG. **8**C;

[0020] FIG. **8**E is a top plan view of the aircraft utilizing the deployable airfoil assembly in a fully deployed configuration;

[0021] FIG. **8**F is a side view of the aircraft along line **8**F-**8**F' of FIG. **8**E;

[0022] FIG. 9A is a front perspective view of another embodiment of an aircraft having a deployable airfoil assembly;

[0023] FIG. 9B is a front perspective view of the aircraft of FIG. 9A wherein the deployable airfoil assembly is in a fully deployed configuration;

[0024] FIG. 10A is a schematic illustration of one embodiment of an orbiting platform utilizing a depolyable airfoil assembly; and

[0025] FIG. 10B is a perspective view of the underside of the orbiting platform of FIG. 10A.

DETAILED DESCRIPTION OF THE INVENTION

[0026] While the making and using of various embodiments of the present invention are discussed in detail below, it should be appreciated that the present invention provides many applicable inventive concepts which can be embodied in a wide variety of specific contexts. The specific embodiments discussed herein are merely illustrative of specific ways to make and use the invention, and do not delimit the scope of the present invention.

[0027] Referring initially to FIG. 4A, therein is depicted one embodiment of an aircraft **50** having a deployable airfoil assembly **52**. The aircraft **50** includes a cockpit **54** that provides for command and control of the aircraft **50**. A fuselage **56** carries the aircraft's payload and fuel and connects the cockpit **54** with fixed wings **58** and **60** and a tail assembly **62**. As illustrated, jet engines **64** and **66** are positioned in pods under the fixed wings **58** and **60**, respectively, to provide thrust for the aircraft **50**. Flaps **68** and **70** are adjustable to alter lift and drag and ailerons **72** and **74** are adjustable to change roll. Additionally, slats **76** and **78** affect lift and spoilers **80** and **82** affect lift and drag. To control and maneuver the aircraft **50**, the tail assembly **62** includes horizontal stabilizers **84** and **86** having elevators **88** and **90**, respectively, to control pitch and a vertical stabilizer **92** having a rudder **94** to control yaw.

[0028] The deployable airfoil assembly **52** includes auxiliary wings **96** and **98** moveably coupled to the fixed wings **58** and **60**, respectively, and actuatable between a retracted position and an extended position. As depicted, in the retracted position, the auxiliary wings **96** and **98** are housed within the fixed wings **58** and **60**, which together may be referred to as an auxiliary wing structure. In particular, in one implementation, the auxiliary wings **96** and **98** are flush with the fixed wings **58** and **60** in order to create a continuous, aerodynamic wing and minimize the presence of drag. Dynamic wings or sails **100** and **102** are furled about a boom **104** that is associated with the aircraft **50** and positioned in the fuselage **56**. It should be appreciated that for some types of aircraft a single furling boom or boom positioned in the center of the fuselage will not be appropriate. In these instances, two booms may be utilized such that one is positioned on each side of the fuselage proximate to each fixed wing.

[0029] FIG. 4B depicts the aircraft **50** of FIG. 4A in a fully deployed configuration. In the extended position, the auxiliary wings **96** and **98** are positioned above the fixed wings **58** and **60** such that a venturi passageway is defined between the auxiliary wings **96** and **98** and the fixed wings **58** and **60**. Additionally, the sails **100** and **102** are deployed along a length of the auxiliary wings **96** and **98** from the boom **104**. In addition to unwrapping the sails **100** and **102** from a furled or retracted position to an unfurled or extended position, the boom **104** returns the sails **100** and **102** from the unfurled to the furled position. As will be explained in further detail hereinbelow, the dynamic and auxiliary wing arrangement optimizes performance of the aircraft by eliminating stall zones and related drag. The deployable airfoil assembly presented herein is not heavy, however. It is relatively light, which is critical on weight sensitive, fully loaded aircraft.

[0030] More specifically, the retractable airfoil assembly constructed in accordance with the teachings presented herein provides significant flight benefits. When the auxiliary wings are fully extended and the sails are completely deployed, the wing area is increased, thereby resulting in increased lift. The increased lift enables the aircraft to takeoff at slower speeds without stalling. The slower speed requirements on takeoff translate into short landing rolls. Further, slower landing speeds result in less wear and tear on the undercarriage components, such as tires, landing gear, and struts, of the aircraft. Moreover, takeoff roll may be reduced since the aircraft can rotate at slower speed, thus reducing requirements for longer runways. This is particularly important as real estate demands force new airports to consider shorter runways. The aircraft is also able to climb at slower speeds and at greater climb angles. Such abilities are useful in noise sensitive areas or where the glide path adjacent the end of the runway is obstructed.

[0031] FIG. 5 depicts one embodiment of a deployable airfoil assembly **110** in a fully deployed configuration. A fixed wing **112** is coupled to a fuselage **114** of an aircraft. An auxiliary wing **116** is housed within a compartment or recess **118** of the fixed wing **112** and extendable therefrom by the actuation of pedestals **120** and **122**. The auxiliary wing **116** may comprise aluminum or an aluminum alloy, for example. Once the auxiliary wing **116** is positioned, a sail **124** is deployed from the fuselage **114**. The sail **124** may comprise a cloth fabric construction that is reinforced with MYLAR®, KEVLAR®, or nylon filaments, for example. A guide cable **126** which commutes laterally along trailing edge track **128** extends and retracts the sail **124** and maintains tension in the sail **124** during deployment and recovery. It should be appreciated that the edge track may be positioned at the trailing edge, leading edge or at an intermediate edge of the auxiliary wing.

[0032] It should be appreciated that although the sail **124** is illustrated as completely deployed, the deployable airfoil assembly described herein may be partially deployed in particular implementations. Regardless of whether the sails of the deployable airfoil assembly are partially or completely deployed, the deployable airfoil assembly selectively augments the surface area of an aircraft without creating stall zones or drag. In particular, the arrangement of both auxiliary wings and sails overcomes the limitations of '195 patent as presented in the Background hereinabove.

[0033] FIG. 6 depicts one embodiment of an aircraft **140** utilizing a depolyable airfoil assembly. The aircraft **140** includes a fuselage **142** and fixed wings **144** and **146**. A boom **148** includes a static tube **150** concentrically mounted within an outer winding tube or furling drum **152**. Additionally, the retractable airfoil assembly **140** includes a spring-biased cable drum **154**, a drive motor **156**, and bearings **158** and **160**. An aft portion of the static tube **150** is attached at a connection **162** to the fuselage **142** or, in another embodiment, the base of the tail assembly. The forward portion of the static tube **150** is attached at a connection **164** to the fuselage **142** also or, in the another embodiment, a main wing spar of a fixed wing. In one embodiment, the furling drum **152** is tubular and is supported for rotation on the static tube **150** by the bearings **158** and **160**. The static tube **150** provides stable support for the furling drum **152** and sails. The furling drum **152** is radially spaced from the static tube **150** and is rotatable clockwise and counterclockwise about the Y axis on the bearings **158** and **160**.

[**0034**] The furling drum **152** is rotatably driven by the drive motor **156**, which is located on a forward section of the static tube **150**. It should be appreciated, however, that the drive motor **156** may be positioned in other locations. For example, the drive motor may be offset from the furling drum **152**. In one implementation, the drive motor **156** is a reversible dc electric motor but may be driven by other means, for example, a hydraulic motor or pneumatic motor or manually by a hand crank.

[**0035**] Operating to provide a sail drive apparatus, opposite end portions of a drive cable are attached to and are wound around about the spring-biased cable drum **154**. In addition to rotating the furling drum **152**, the drive motor **156** also unreels the flexible drive cable from the spring-biased cable drum **154**. The sail drive cable end portions are connected to the sails at cable connections **166** and **168**, respectively, and maintain tension in the sails during retractions (furling) and extension (unfurling). The drive cable is guided around pulleys **170** and **172** that are located on the fixed wing **144** and pulleys **174** and **176** that are located on the fixed wing **146**. In one implementation, as will be described in further detail hereinbelow, the drive cable is guided in tracks. The placement and number of pulleys utilized may change with different wing types. The drive cable arrangement may include a flexible heavy gauge cable or a chain with drive sprockets, for example. The flexible drive cable and spring-biased cable drum maintain tension in the sails during recovery and deployment. The tension applied by the drive cable maintains the sails in a flat airfoil configuration when the sails are extended. When unfurled, the sails occupy areas **178** and **180** to augment the surface area of the aircraft.

[**0036**] FIG. **7** depicts one embodiment of the boom **148** that further illustrates the static support tube **150** and rotatable drum **152** arrangement illustrated in FIG. **6**. In particular, this figure further depicts guide tracks **182** and **184** that may be disposed along the auxiliary wing structures. Flexible sails **186** and **188** are movably coupled to the guide tracks **182** and **184** by cable connections **166** and **188**, which move laterally through guide tracks **182** and **184** as illustrated by arrows **186** and **188**, respectively. Further the flexible sails **186** and **188** are wrapped on over the other in overlapping relating around the furling drum **152**. The sails **186** and **188** are unfurled from the furling drum **152** by clockwise or counterclockwise movement about the static support tube **150** as illustrated by arrow **189**. Additional general details regarding track assemblies for guiding sails may be found in the following patent: U.S. Pat. No. 6,241,195 which issued in the name of Fred A. Wagner, III, which is hereby incorporated by reference for all purposes.

[**0037**] FIGS. **8**A and **8**B depict one embodiment of an aircraft **190** utilizing the deployable airfoil assembly described herein in a fully retracted configuration. The aircraft **190**, which is only partially presented, includes a fuselage **192** and fixed wings **194** and **196** coupled thereto. The fixed wings **194** and **196** include ailerons **198** and **200**, flaps **202** and **204**, spoilers **206** and **208**, and slats **210** and **212**. Auxiliary wings **214** and **216** are in a retracted position and housed within recesses, such as recess **217**, of the fixed wings **194** and **196**. In one embodiment, the auxiliary wings **214** and **216** are placed slightly fore or aft of the point where the airflow separates on the upper surface of the fixed wing. As best seen in FIG. **8**B, a scissor hinge **219** connects the auxiliary wing **214** to the fixed wing **194**.

[**0038**] FIGS. **8**C and **8**D depict the aircraft utilizing the deployable airfoil assembly in a partially deployed configuration. As illustrated, hinges, such as the scissor hinge **219**, actuate the auxiliary wings **214** and **216** from the retracted position to an extended position wherein the auxiliary wings **214** and **216** are positioned above the fixed wings **194** and **196**, respectively, to create venturi passageways, such as venturi passageway V, between the auxiliary wings **214** and **216** and the fixed wings **194** and **196**.

[**0039**] As best seen in FIG. **8**D, the scissor hinge **219** permits the auxiliary wing **214** to be adjusted with respect to height H above the fixed wing **194** and angle of attack AoA. By changing the height H and angle of attack AoA of the auxiliary wing **214** the venturi passageway V may altered. It should be appreciated that height H and angle of attack AoA are adjusted and optimized in accordance with the drag and compressibility experienced at different velocities. In general, in order to maintain laminar airflow attached to the fixed wings, larger venturi passageways are required at slower speeds and narrower venturi passageways are required at higher speeds.

[**0040**] FIGS. **8**E and **8**F depict the aircraft **190** utilizing the deployable airfoil assembly in a fully deployed configuration. Sails **216** and **218** are deployed along lengths of the auxiliary wings **194** and **196**, respectively, from a boom associated with the aircraft **190**, thereby selectively augmenting the lift surface area of the aircraft **190**. In one implementation, the thicknesses of the auxiliary wings **194** and **196** and the sails **216** and **218** are more similar than the thicknesses the auxiliary wings **194** and **196** and the fixed wings **194** and **196**. In this implementation, the sails **216** and **218** compress and accelerate the airflow through the spaces, such as venturi V, defined between the fixed wings **194** and **196** and the auxiliary wings **214** and **216**, respectively. By compressing and accelerating the airflow as depicted by arrows **220**, **222**, and **224**, the sails **216** and **218** resemble guiding vanes that prevent the creation of stall zones and drag.

[**0041**] In operation, an aircraft may utilize the deployable airfoil assembly described herein during takeoff and landing. By way of example, the deployable airfoil assembly may be actuated before a takeoff sequence or before a landing sequence to augment the lift surface area of the aircraft and hold airflow to the wing to enable takeoff and landing operations at reduced speeds and with improved climbing rates. For example, when installed on a Cessna **172**, the deployable airfoil assembly permits takeoff and landing operations at 20-30 knots (about 27-55 kilometers/hour) and a rate of climb of 1200 feet per minute (about 365 meters/minute) at full power and 700 feet per minute (about 213 meters/minute) at 65 percent power. Following the takeoff or landing sequence, the deployable airfoil assembly may be retracted and cradled in the recess to allow for high speed cruising.

[0042] FIG. **9**A depicts a high wing aircraft **230** having a deployable airfoil assembly **232** in a fully retracted, furled configuration according to a trailing edge embodiment. The retractable airfoil assembly **232** includes a fixed wing **234** having ailerons **236** and **238** and an aerodynamic fairing **240**. The aircraft also includes a tail assembly **242**. A forward end portion of a support boom **244** is mounted on the fixed wing at a main wing spar just aft of a leading edge of the fixed wing. A rear end portion of the support boom **244** is mounted on the base of the tail assembly **242**. As previously described in FIG. **6**, the support boom **244** includes a furling drum that is rotatable clockwise and counter clockwise about the Y axis (longitudinal). As depicted, in the retracted position, auxiliary wings **246** and **248** are housed within recesses of the fixed wing.

[0043] FIG. **9**B depicts a front perspective view of the aircraft **230** of FIG. **9**A wherein the deployable airfoil assembly **232** is in a fully deployed configuration. In the extended position, the auxiliary wings **246** and **248** are extended above recesses **250** and **252**, respectively, and positioned above the fixed wing **234** such that a venturi passageway is defined between the auxiliary wings **246** and **248** and the fixed wing **234**. Additionally, the sails **254** and **256** are deployed along a length of the auxiliary wings **246** and **248** from the support boom **244**. As previously discussed, the height and angle of attack of the auxiliary wings may be adjusted in order to manipulate the venturi in response to a changing velocity or other flight requirements.

[0044] The sail **254** runs aft of the right side of the trailing edge from the auxiliary wing to the support boom **244** and extends diagonally aft to the base of the tail assembly **242**. Sail **256** is constructed in a mirror relationship. It should be appreciated that the deployable airfoil assembly described herein may be utilized in different configurations with a variety of aircrafts. By way of further example, the deployable airfoil assembly described herein may be utilized with a turbine-powered airliner as illustrated in FIGS. **4**A and **4**B, a high wing aircraft as illustrated in FIGS. **9**A and **9**B, and other types of aircraft including small and mid-sized aircraft manufactured by Cessna, corporate aircraft manufactured by Gulfstream Aerospace, or commercial aircraft manufactured by Boeing or Airbus, for example.

[0045] FIG. **10**A depicts one embodiment of an orbiting platform **270** utilizing a depolyable airfoil assembly **272**. The orbiting platform **270**, which may be a "drone", is in a controlled or pseudo-stationary position while orbiting along a path depicted by arrows **273** at an altitude x above the ground **274**. Preferably, the orbiting platform **270** is at a high altitude. For example, in one implementation, the orbiting platform **270** is at an altitude between 60,000 and 100,000 feet (18,288 and 30,480 meters).

[0046] Equipment **276** is coupled to the under-side of the orbiting platform **270** such that the equipment **276** is facing ground **274** and, in particular, region **275** which includes a remote communications station **280**, a city **282**, and towns **284** and **286**. As illustrated, the equipment **276** is communications equipment that is relaying communications signals between the remote communications station **280**, the city **282**, and the towns **284** and **286**.

[0047] It should be appreciated, however, that the equipment **276** may be other types of communications equipment, navigation equipment, or remote sensing equipment, for example. By way of further example, the communications equipment and navigation equipment may be suitable for personal communications, data messaging, direct broadcasting, and particular mobile applications where users require primarily regional coverage. The remote sensing equipment may be suitable for high resolution imaging, regional public services for agriculture, hydrology, fire protection, traffic monitoring, or disaster relief support, for example.

[0048] Referring now to FIG. **10**B, the orbiting platform **270** includes a deployable airfoil assembly **272** for selectively augmenting lift surface area of the orbiting platform **270**. A fuselage **288** includes wings **290** and **292** connected thereto. In one implementation, the fuselage **288** and the wings **290** and **292** form a T-frame wherein the wings **290** and **292** are of a similar thickness to the deployed sails so that lift and flight are not adversely affected. In an alternative embodiment, the orbiting platform is outfitted with the auxiliary wing arrangement discussed in detail hereinabove. As previously discussed, the equipment **276** is coupled to the fuselage **288**. The illustrated configuration, where the orbiting platform includes equipment **276**, is ideal for applications where the unique combination of altitude and controlled position over a certain area provides significant advantages over both terrestrial and space systems.

[0049] A boom **298** having the sails wrapped therearound is positioned within the fuselage **288**. A vertical stabilizer **294** is positioned at the rear of the orbiting platform **270** and control equipment is positioned in a nose **296** of the orbiting platform **270**, which is unmanned in a preferred embodiment. Additional control and mechanical equipment including a fuel supply (e.g., batteries or gasoline) is positioned in the aft of the orbiting platform **270** as indicated by numeral **300**. Additionally, landing gear and rolling gear may be appropriately positioned in the fuselage **298**. It should be appreciated that other control and mechanical equipment arrangements are within the teachings of the present invention.

[0050] Guide tracks **302** and **304** are positioned along the wings **290** and **292**, respectively. Sails **306** and **308** are deployed from the boom **298** along the guide tracks **302** and **304** in a manner similar to that discussed in detail in FIGS. **5**-**7**. More specifically, the sails **306** and **308** are deployable and retractable to meet the immediate needs of the orbiting platform **270**. During flight at high altitudes, the depolyable sails of the present invention provide great amounts of wing area to ensure enough lift at the slow air speeds (e.g., 17 to 25 knots or 31 to 46 kilometers/hour) associated with controlled or pseudo-stationary positions. When ascending or descending through turbulent air, the depolyable sails may be partially or completely retracted as required. Further, when grounded, the deployable sails are retracted to provide for ease of handling. To provide for further ease of ground handling, the wings **290** and **292** are not necessarily fixed. The wings may be retractable at joints **310** and **312**.

[0051] While this invention has been described with reference to illustrative embodiments, this description is not intended to be construed in a limiting sense. Various modifications and combinations of the illustrative embodiments as well as other embodiments of the invention, will be apparent to persons skilled in the art upon reference to the description. It is, therefore, intended that the appended claims encompass any such modifications or embodiments.

What is claimed is:

1. A deployable airfoil assembly for selectively augmenting lift surface area of an aircraft, comprising:

a fixed wing mounted to the aircraft;

an auxiliary wing moveably coupled to the fixed wing and actuatable between a retracted position and an extended position, in the retracted position, the auxiliary wing being housed within the fixed wing and, in the extended position, the auxiliary wing being positioned above the fixed wing such that a venturi passageway is defined between the auxiliary wing and the fixed wing; and

a sail deployable along a length of the auxiliary wing from a boom associated with the aircraft.

2. The deployable airfoil assembly as recited in claim 1, wherein the auxiliary wing further comprises a recess operable to accommodate the auxiliary wing in the retracted position.

3. The deployable airfoil assembly as recited in claim 1, further comprising a set of hinges that moveably couples the auxiliary wing to the fixed wing, the set of hinges for actuating the auxiliary wing between the retracted and extended positions.

4. The deployable airfoil assembly as recited in claim 1, further comprising a pedestal that moveably couples the auxiliary wing to the fixed wing, the pedestal for actuating the auxiliary wing between the retracted and extended positions.

5. The deployable airfoil assembly as recited in claim 1, wherein the auxiliary wing is adjustable with respect to height.

6. The deployable airfoil assembly as recited in claim 1, wherein the auxiliary wing is adjustable with respect to angle of attack.

7. A method for selectively augmenting lift surface area of an aircraft, the method comprising:

housing an auxiliary wing in a retracted position in a recesses of a fixed wing, the fixed wing being mounted to the aircraft;

actuating the auxiliary wing from the retracted position to an extended position above the fixed wing to create a venturi passageway between the auxiliary wing and the fixed wing; and

deploying a sail along a length of the auxiliary wing from a boom associated with the aircraft, thereby selectively augmenting the lift surface area of the aircraft.

8. The method as recited in claim 7, further comprising initiating a takeoff sequence upon the deployment of the sail.

9. The method as recited in claim 7, further comprising initiating a landing sequence upon the deployment of the sail.

10. The method as recited in claim 7, further comprising adjusting the venturi passageway by changing the angle of attack associated with the auxiliary wing.

11. The method as recited in claim 7, further comprising adjusting the venturi passageway by changing the height associated with the auxiliary wing.

12. The method as recited in claim 7, further comprising, following a takeoff sequence:

retracting the sail into the boom; and

actuating the auxiliary wing from the extended position to the retracted position.

13. The method as recited in claim 7, further comprising, following a landing sequence:

retracting the sail into the boom; and

actuating the auxiliary wing from the extended position to the retracted position.

14. A system for selectively augmenting lift surface area of an aircraft, the system comprising:

a fixed wing mounted to the aircraft, the fixed wing having a recess for housing an auxiliary wing in a retracted position;

means for actuating the auxiliary wing from the retracted position to an extended position above the fixed wing to create a venturi passageway between the auxiliary wing and the fixed wing; and

means for deploying a sail along a length of the auxiliary wing from a boom associated with the aircraft.

15. The system as recited in claim 14, wherein the aircraft initiates a takeoff sequence upon the deployment of the sail.

16. The system as recited in claim 14, wherein the aircraft initiates a landing sequence upon the deployment of the sail.

17. The system as recited in claim 14, wherein the venturi passageway is adjusted by changing the angle of attack associated with the auxiliary wing.

18. The system as recited in claim 14, wherein the venturi passageway is adjusted by changing the height associated with the auxiliary wing.

19. The system as recited in claim 14, wherein the aircraft, following completion of a takeoff sequence, retracts the sail into the boom and actuates the auxiliary wing from the extended position to the retracted position.

20. The system as recited in claim 14, wherein the aircraft, following completion of a landing sequence, retracts the sail into the boom and actuates the auxiliary wing from the extended position to the retracted position.

21. A deployable airfoil assembly for selectively augmenting lift surface area of an aircraft of the type including a fixed wing structure comprising:

a furling drum mounted on the aircraft for rotation about a longitudinal axis;

an auxiliary wing structure moveable coupled to the fixed wing structure and actuatable between a retracted position and an extended position, in the retracted position, the auxiliary wing structure being housed within the fixed wing structure and, in the extended position, the auxiliary wing structure being positioned above the fixed wing structure such that a venturi passageway is defined between the auxiliary wing structure and the fixed wing structure;

a guide track disposed along the auxiliary wing structure;

first and second flexible sails movably coupled to the guide track and wrapped on over the other in overlapping relation around the furling drum; and

a sail drive apparatus attached to the sails for moving the sails along the guide tracks.

22. The assembly as recited in claim 21, wherein the sail drive apparatus comprises a rotatable cable drum and a drive cable would about the retractable cable drum, the drive cable including a first end portion and a second end portion attached to the first sail and the second sail, respectively.

23. The assembly as recited in claim 21, further comprising a rotary drive motor in mechanical communication with the furling drum for rotating it clockwise and counterclockwise.

24. A deployable airfoil assembly for selectively augmenting lift surface area of an orbiting platform, comprising:

a fuselage;

first and second wings coupled to the fuselage;

first and second guide tracks positioned along the first and second wings respectively; and

first and second sails deployable along the first and second guide tracks, the first and second sails being deployed from a boom associated with the aircraft.

25. The deployable airfoil assembly as recited in claim 24, further comprising equipment mounted to the fuselage, the equipment being selected from the group consisting of communications equipment, navigation equipment, and remote sensing equipment.

26. The deployable airfoil assembly as recited in claim 24, wherein the first and second wings are retractable for storage.

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