US005873549A

United States Patent [19]

Lane et al.

[11] Patent Number: 5,873,549

[45] Date of Patent: Feb. 23, 1999

[54] **VEHICLE ROTATION AND CONTROL MECHANISM**

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[21] Appl. No.: **719,457**

[22] Filed: **Sep. 25, 1996**

[51] **Int. Cl.**[6] **F42B 10/14**; F42B 10/50; F42B 15/01; B64G 1/62

[52] **U.S. Cl.** ..... **244/160**; 244/138 A; 244/139; 244/63; 244/3.28; 102/384; 102/388

[58] **Field of Search** ..... 244/3.28, 3.29, 244/138 A, 138 R, 139, 160, 164, 63; 102/384, 385, 388

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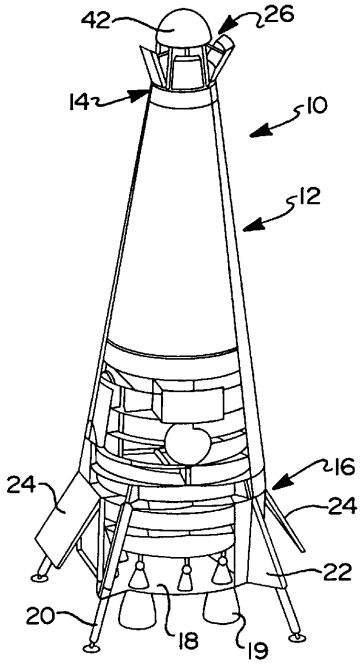
[57] **ABSTRACT**

A nose assembly and method for controlling the rotation and stabilizing the orientation of a vehicle during landing maneuvers. The vehicle includes a nose assembly that is coupled to an airframe thereof and that has a frame and flap assembly. The flap assembly includes an actuating means and a flap coupled to the frame such that the actuating means moves the flap from and between a fully retracted position and a fully extended position in response to a guidance signal received from a flight control computer. In a preferred embodiment of the present invention, the flap assembly includes a plurality of flaps each coupled to the nose assembly frame and an actuating means that selectively positions the plurality of flaps in response to a signal. The method for rotating a vehicle from a nose-forward orientation to a base-forward orientation includes the steps of orientating the vehicle in nose-forward flight, rotating the vehicle in a first direction, and selectively actuating one of a first and second flap from a retracted position toward an extended position to generate a damping moment tending to position the vehicle in a base-forward orientation.

20 Claims, 3 Drawing Sheets



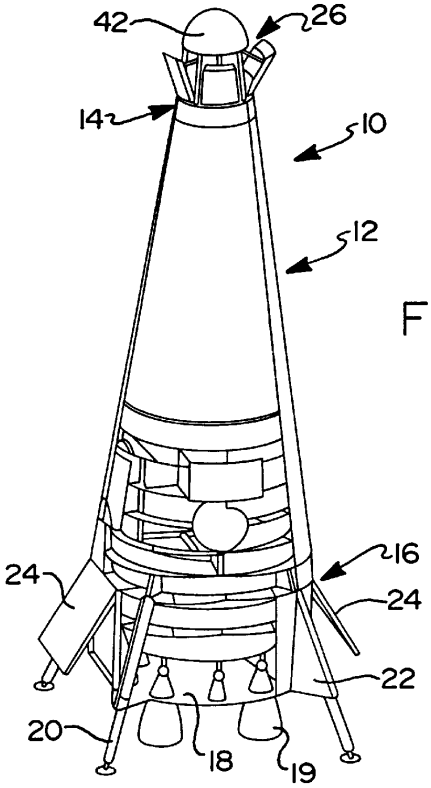


FIG 1

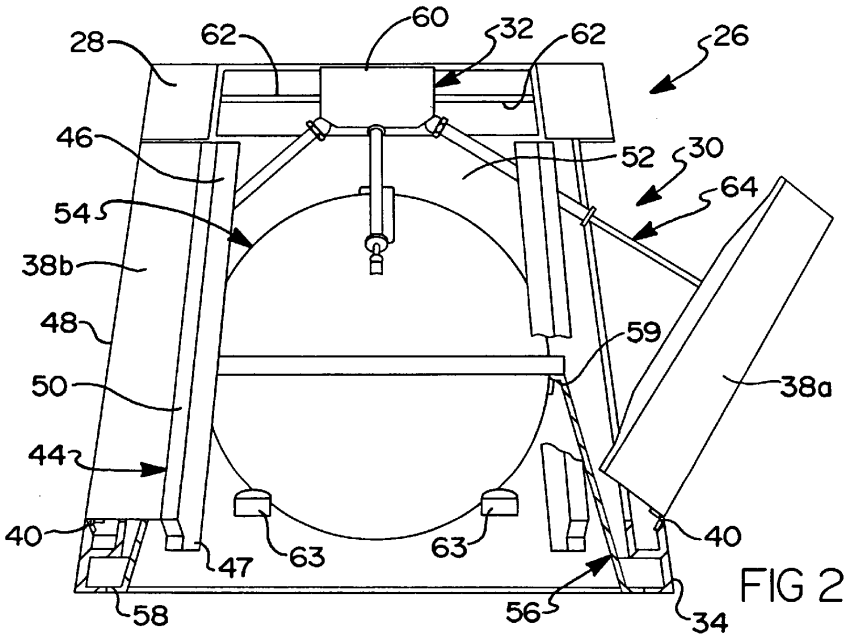


FIG 2

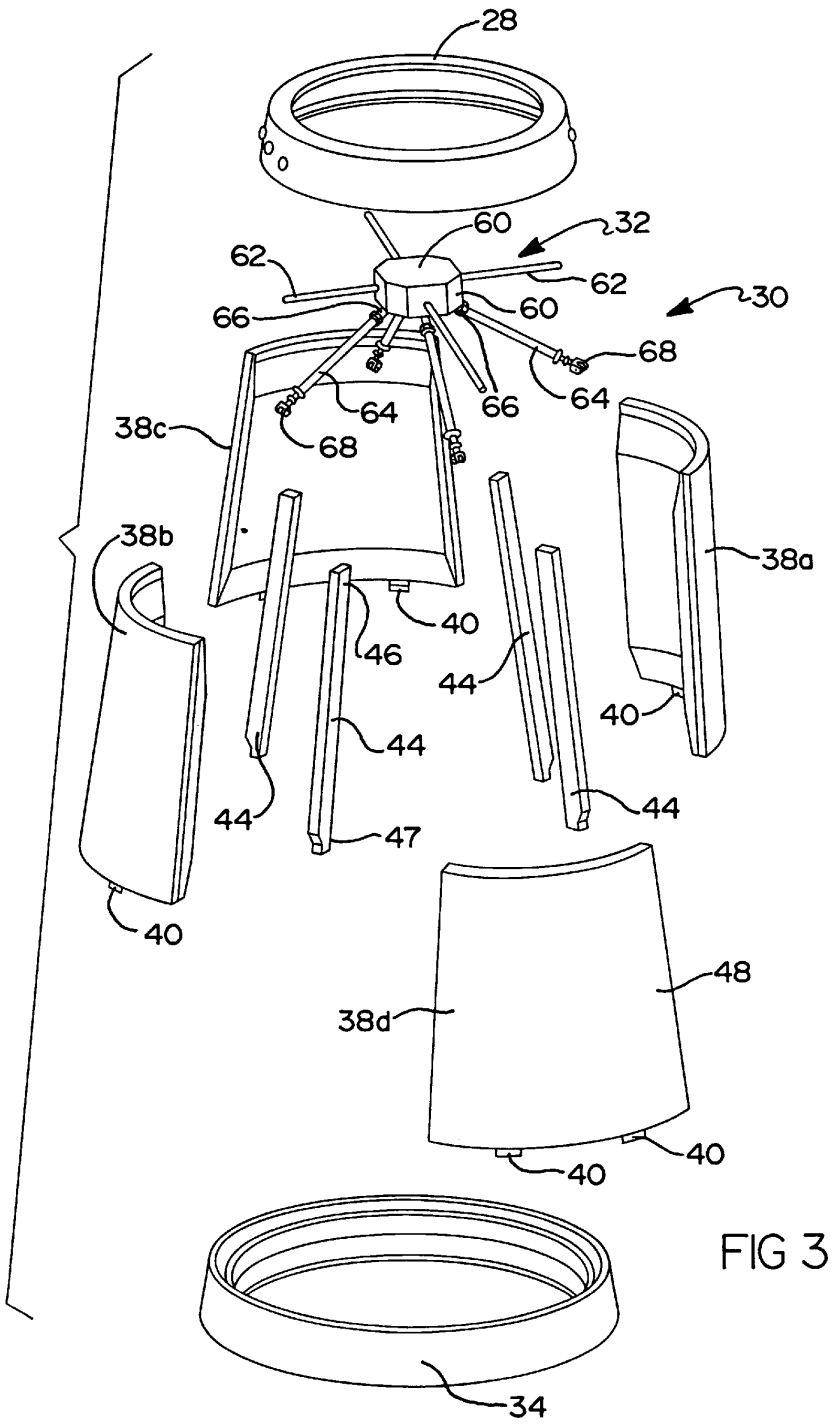


FIG 3

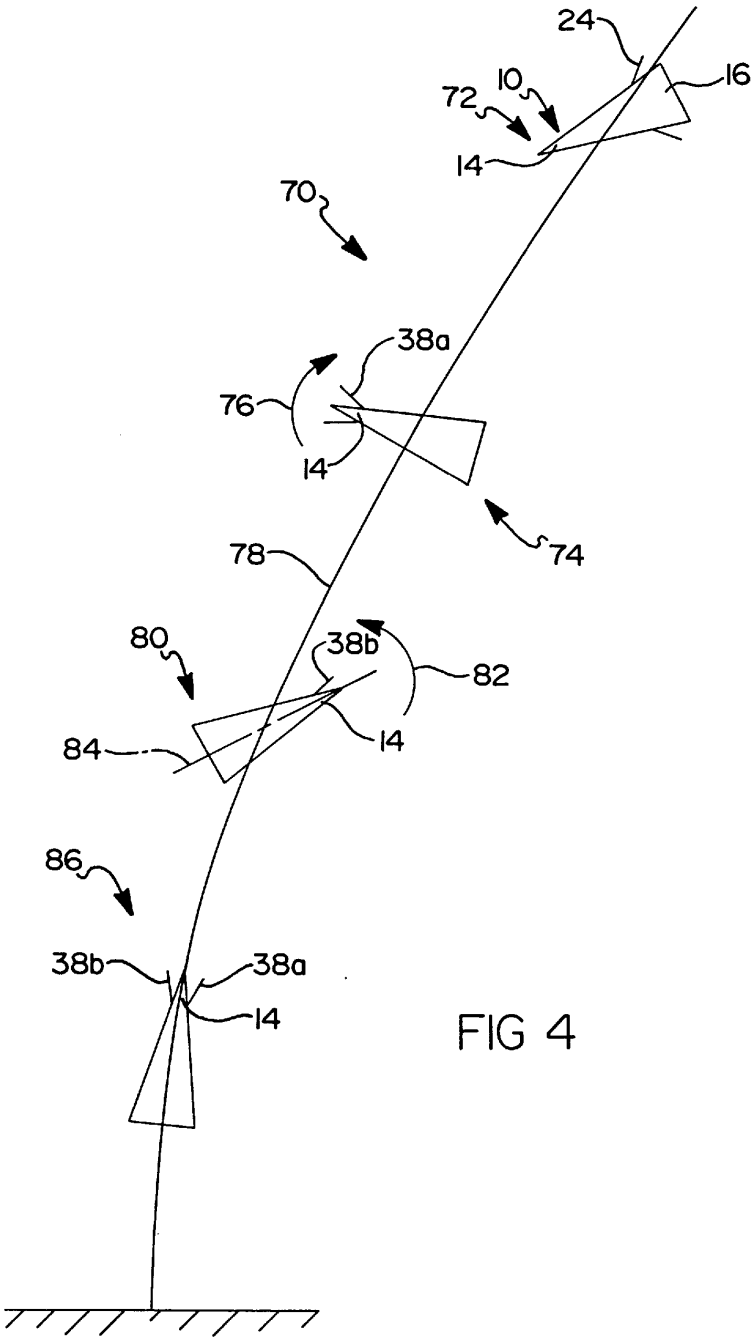


FIG 4

VEHICLE ROTATION AND CONTROL MECHANISM

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates generally to a direction control assembly for an aerospace vehicle and, more particularly, to a flap assembly at the forebody of a reusable launch vehicle for rotating and stabilizing the vehicle during entry and pre-landing maneuvers.

2. Discussion

Reusable launch vehicles used to deploy satellites in a predetermined orbit about the earth include single stage to orbit ("SSTO") vehicles that are designed to perform their intended operation and return to earth without jettisoning any portions of the vehicle. Accordingly, SSTO vehicles do not include discardable booster rockets or fuel tanks. Rather, the fuel supply elements of SSTO vehicles are retained throughout the flight thereby increasing the need to minimize fuel consumption in order to decrease the unusable weight carried into orbit. The present invention addresses these concerns by providing a vehicle rotation and control mechanism that reduces propellant acquisition subsystems and the propellant required to properly position the vehicle for landing.

Vertically landing SSTO vehicles commonly include a conically shaped airframe configured for stable flight in a nose-forward orientation. However, since the vehicle is vertically landed in a rearward or tail-first orientation a rotation of the vehicle during the landing sequence is required. Currently, SSTO vehicles of this class perform the rotation maneuver through the use of engine power. More specifically, the maneuver includes starting several of the main engines, retracting entry flaps so that the vehicle pitches up to initiate rotation, and selectively throttling up the engines to arrest rotation and place the vehicle into the desired base-first orientation. In order to minimize the quantity of propellant consumed by the engines between the rotation and touch down phases of the landing procedure, this rotation maneuver is generally conducted at a relatively low altitude. While this procedure is viable, a considerable amount of propellant is used during the starting and operation of the engines and the propellant feed system becomes heavy and complex. Further, the relatively low altitude compresses landing functions into a shorter timeline.

SUMMARY OF THE INVENTION

The present invention provides a nose assembly and method for controlling the rotation and stabilizing the orientation of an aerospace vehicle during landing maneuvers. The vehicle includes a nose assembly that is coupled to an airframe and that has a frame and flap assembly. The flap assembly includes an actuating means and a flap coupled to the frame such that the actuating means moves the flap from and between a fully retracted position and a fully extended position in response to a guidance signal received from the flight control computer. In a preferred embodiment of the present invention, the flap assembly includes four of flaps each coupled to the nose assembly frame and an actuating means that selectively positions each flap in response to a signal. A method for rotating the vehicle from a nose-forward orientation to a base-forward orientation according to the present invention includes the steps of orientating the vehicle in nose-forward flight, rotating the vehicle in a first direction, and selectively actuating one of a first and second flap to an extended position to generate a damping moment tending to position the vehicle in a base-forward orientation.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings, in which:

FIG. **1** is a perspective view of a reusable launch vehicle in accordance with the present invention;

FIG. **2** is a front partial sectional view of the nose cone of the vehicle shown in FIG. **1** with a flap removed for clarity;

FIG. **3** is an exploded perspective view of the nose cone shown in FIG. **2**; and

FIG. **4** is a schematic illustrating the orientation and nose flap position during the landing rotation sequence of the single stage to orbit vehicle shown in FIG. **1**.

DETAILED DESCRIPTION

The following description of the preferred embodiment of the present invention is merely exemplary in nature and is in not intended to limit the scope of the claimed invention. Moreover, while depicting the invention in a single stage to orbit ("SSTO") vehicle, the description is intended to adequately teach one skilled in the art to make and use the vehicle rotation and control mechanism and method described and claimed herein in a variety of aerospace vehicles.

As illustrated in FIG. **1** of the drawings, a vertically landing reusable launch vehicle **10** includes a generally conical shaped airframe **12** defining a forebody **14** and a thrust structure **16**. Thrust structure **16** includes a base **18** proximate to which landing gear **20**, fins **22**, and rear flaps **24** are coupled to airframe **12**. The forward portion of rear flaps **24** are pivotably connected to airframe **12** in a manner known in the art and an actuating mechanism (not shown) communicates with a flight control computer (not shown) and is coupled to rear flaps **24** to control the angular position thereof relative to airframe **12**. During normal, nose-first flight, the flight computer selectively positions rear flaps **24** to stabilize the flight path and orientation of vehicle **10**.

Forebody **14** of airframe **12** includes a nose cone **26** that is shown in FIGS. **2** and **3** to include a flap assembly **30** having a flap actuating apparatus **32** connected to an upper bulkhead ring **28**. Nose cone **26** further includes a lower bulkhead ring **34**, a plurality of flaps **38***a*, **38***b*, **38***c*, and **38***d* pivotably connected to lower ring **34** via hinge assemblies **40**, a cap **42** (FIG. **1**) securable to upper ring **28** in a manner known in the art, and stringers **44** having a first end **46** connected to upper bulkhead **28** and a second end **47** configured to cooperate with lower bulkhead **34**. Assembly **30** preferably includes four (4) circumferentially opposed and separately operable flaps that form flap pairs capable of providing opposing damping moments during vehicle flight. As best seen in FIG. **2**, flaps **38***a* and **38***b* illustrate one of the pair of opposed flaps wherein flap **38***a* is shown in a fully extended or fully pivoted position whereas flap **38***b* is fully retracted. In a manner known in the art, actuating apparatus **32** selectively positions flaps **38***a* and **38***b* at or between the fully extended and fully retracted positions in response to an input signal received from the vehicle's flight computer (not shown).

When constructed as described herein and as best seen in FIG. **2**, cap **42**, upper ring **28**, an outer surface **48** of flaps **38**, and a radially outer surface **50** of stringers **44** cooperate to define a relatively smooth and aerodynamic outer surface surrounding a cavity **52**. In the preferred embodiment, cavity **52** houses an auxiliary liquid oxygen tank **54** and actuating apparatus **32**. More particularly, a conical support **56** is

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