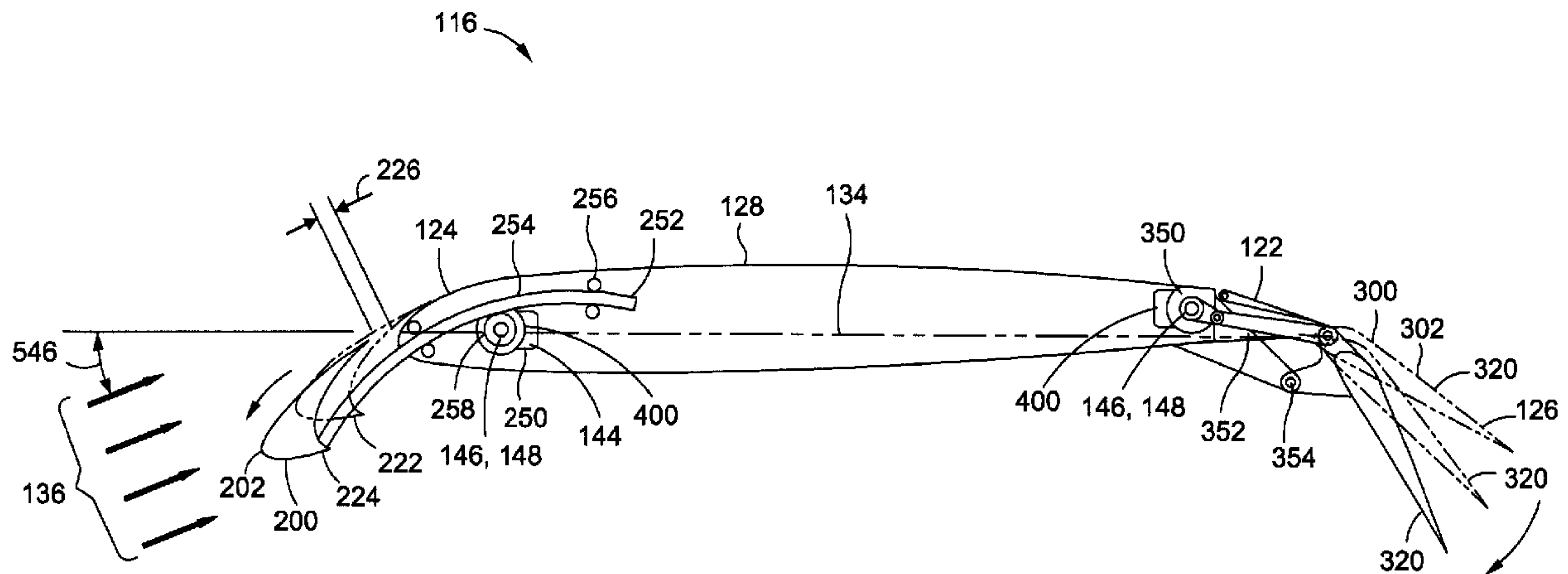




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(54) **Titre : INTERFACE DE COMMANDE POUR DISPOSITIFS DE BORD D'ATTAQUE ET DE BORD DE FUITE**
(54) **Title: CONTROL INTERFACE FOR LEADING AND TRAILING EDGE DEVICES**



(57) **Abrégé/Abstract:**

A system for controlling a high-lift device of an aircraft may include an interface for placement in a flight deck of an aircraft. The interface may include an edge control device for controlling a position of the high-lift device. The interface may be operable to select any of a plurality of control device positions. Each one of the plurality of control device positions may correspond to a different flight phase of the aircraft. The edge control device may be operable to engage, in response to a selection of a first control device position, a command mode for actuating the high-lift device in an automated manner based on the flight phase associated with the first control device position.

ABSTRACT

A system for controlling a high-lift device of an aircraft may include an interface for placement in a flight deck of an aircraft. The interface may include an edge control device for controlling a position of the high-lift device. The interface may be operable to
5 select any of a plurality of control device positions. Each one of the plurality of control device positions may correspond to a different flight phase of the aircraft. The edge control device may be operable to engage, in response to a selection of a first control device position, a command mode for actuating the high-lift device in an automated manner based on the flight phase associated with the first control device position.

CONTROL INTERFACE FOR LEADING AND TRAILING EDGE DEVICES

FIELD

The present disclosure relates generally to flight controls and, more particularly, to an interface for controlling the leading edge and trailing edge devices of an aircraft wing.

5

BACKGROUND

Aircraft such as commercial airliners typically include control surfaces or devices mounted on the wings to improve the aerodynamic performance of the aircraft. Such control surfaces include wing leading edge devices and wing trailing edge devices, which may be extended and/or deflected during different phases of flight to alter the lift and/or drag characteristics of the wings. For example, commercial airliners typically include leading edge slats and trailing edge flaps which may be extended and retracted during takeoff, approach, landing, and other flight phases to alter the wing lift characteristics.

During certain flight phases, the flight crew typically performs a large number of tasks during a relatively short period of time. For example, during the approach phase and landing phase of a flight, the flight crew may perform multiple tasks for reconfiguring the aircraft in preparation for landing. Such reconfiguration tasks may include periodically altering the engine thrust setting, arming the spoilers, lowering the landing gear, and other tasks. In addition, the flight crew may need to review instrument landing charts, assess weather conditions at the destination airport, adjust the altimeter, communicate with air traffic control, and continuously monitor the operation of various systems.

Furthermore, during approach and landing, the flight crew may need to make multiple crew-commanded adjustments to the position of the leading and trailing edge devices. The repositioning of the leading and trailing edge devices are typically performed at specific airspeed trigger points. In addition, the positions of the leading and trailing edge devices may be adjusted based on pilot judgment in consideration of maximum operating speeds (e.g., flap placard speeds), instructions from air traffic control, and other considerations.

Conventional aircraft typically allow for extending the leading and trailing edge devices to a limited number of settings for a given flight phase. For example, during takeoff, conventional aircraft may allow for extending the flaps only to a single flap setting, such as a

takeoff setting of Flaps 15. Such a takeoff setting may be based on a maximum takeoff weight aircraft with engines operating at maximum takeoff thrust and departing from a standard length runway at sea level. However, the aircraft may have an actual takeoff weight that may be less than the maximum takeoff weight such that the Flaps 15 setting may result in operating the
5 engines at an unnecessarily high thrust setting which may contribute to engine wear and generate excessive engine noise. In addition, positioning the flaps at a flap setting of Flaps 15 may generate a climb rate that is above or below what may be desired and/or required for obstacle or engine-out climb requirements.

As such, there may be a need for improved system and methods for adjusting the
10 position of leading and/or trailing edge devices of aircraft.

SUMMARY

The present disclosure describes examples of systems and methods for controlling high-lift devices (e.g., leading and/or trailing edge devices) of an aircraft.

In one embodiment, there is provided a system for controlling a high-lift device of
15 an aircraft. A high-lift device includes a leading edge device or a trailing edge device. The system includes an interface for placement in a flight deck of an aircraft. The interface is configured to receive an input from a flight crew and/or provide feedback to the flight crew. The interface includes a first edge control device for controlling a position of a high-lift device of the aircraft and operable to select any of a plurality of control device positions, each one of the
20 plurality of control device positions associated with a different flight phase of the aircraft. The first edge control device is further operable to engage, in response to a selection of a first control device position, a command mode for actuating the high-lift device in an automated manner based on the flight phase associated with the first control device position. The system further includes a flight control computer communicatively coupled to the interface and configured to
25 compute a high-lift device setting for the high-lift device and an actuation system configured to automatically actuate the high-lift device to the computed high-lift device setting if the command mode is engaged. The interface further includes a second edge control device operable to select a desired setting for the high-lift device different from the computed high-lift

device setting without movement of the first edge control device from the first control device position.

5 In another embodiment, there is provided a method of operating a high-lift device of an aircraft. The high-lift device includes a leading edge device or a trailing edge device. The method involves positioning a first edge control device of an aircraft in a first control device position of a plurality of control device positions. Each of the plurality of control device positions are associated with a flight phase of the aircraft. The method further involves engaging a command mode in response to the positioning of the edge control device in the first control device position, computing a high-lift device setting, and automatically actuating the high-lift
10 device to the computed high-lift device setting while the command mode is engaged. The method further involves positioning a second edge control device in a desired setting for the high-lift device, wherein the desired setting is different from the computed high-lift device setting and no movement of the first edge control device from the first control device position is required.

15 In another embodiment, there is provided a system for controlling a high-lift device of an aircraft. The system involves an interface for placement in a flight deck of the aircraft. The interface includes a first edge control device for controlling a position of the high-lift device of the aircraft. The first edge control device is operable to select any of a plurality of control device positions. Each one of the plurality of control device positions are associated with a flight phase
20 of the aircraft and corresponding to a different standard device setting for the high-lift device. The first edge control device is further operable to engage, in response to a selection of a first control device position of the plurality of control device positions, a command mode for actuating the high-lift device in an automated manner based on the flight phase associated with the first control device position. The system further includes a flight control computer
25 communicatively coupled to the interface and configured to compute an optimum device setting for the high-lift device based on aircraft state data, the computed optimum device setting including a setting that is different than a standard device setting associated with a control device position. The interface further includes a second edge control device for further controlling the position of the high-lift device. The second edge control device is operable to
30 select a desired setting different from the computed optimum device setting for the high-lift device without movement of the first edge control device. The system further includes a device

actuation system communicatively coupled to the flight control computer and operatively coupled to the high-lift device and configured to: continuously periodically and automatically adjust the high-lift device to a series of the computed optimum device settings based on the aircraft state data including at least altitude, airspeed, and weight if the command mode is engaged; and adjust the high-lift device to the desired setting different from the computed optimum device setting if second edge control device is actuated.

In another embodiment, there is provided an aircraft. The aircraft includes a wing including at least one of a leading edge device and a trailing edge device. The aircraft further includes an edge control system including a first edge control device positionable in one of a plurality of control device positions. Each one of the control device positions correspond to a flight phase of an aircraft and a different standard device setting for at least one of the leading edge device and the trailing edge device. The aircraft further includes a flight control computer communicatively coupled to the edge control system and configured to compute an optimum device setting based on aircraft state data for at least one of the leading edge device and trailing edge device. The computed optimum device setting includes a setting that is different than a standard device setting associated with a control device position. The edge control system further includes a second edge control device operable to select a desired setting different from the computed optimum device setting for at least one of the leading edge device and the trailing edge device without movement of the first edge control device. The first edge control device is configured to command a device actuation system to adjust at least one of the leading edge device and the trailing edge device in a continuous periodic and automated manner to a series of the optimum device settings based on the aircraft state data including at least altitude, airspeed, and weight. The second edge control device is configured to command the device actuation system to adjust at least one of the leading edge device and the trailing edge device to the desired setting. The device actuation system is configured to adjust at least one of the leading edge device and the trailing edge device in deflection angle increments that are smaller than the angle between the standard device settings.

In another embodiment, there is provided a method of operating a high-lift device of an aircraft. The method involves positioning a first edge control device of the aircraft in a first control device position of a plurality of control device positions. Each of the plurality of control device positions are associated with a flight phase of the aircraft and correspond to a different

standard device setting for the high-lift device. The method further involves engaging a command mode in response to the positioning of the first edge control device in the first control device position and computing an optimum device setting for the high-lift device based on aircraft state data. The computed optimum device setting includes a setting that is different than
5 a standard device setting associated with a control device position. The method further involves continuously periodically and automatically adjusting the high-lift device to a series of the computed optimum device settings based on the aircraft state data including at least altitude, airspeed, and weight in deflection angle increments that are smaller than the angle between the standard device settings while the command mode is engaged. The method further involves
10 using a second edge control device, commanding the high-lift device to a desired device setting different from the computed optimum device setting while the first edge control device remains in the first control device position.

The features and functions that have been discussed can be achieved independently in various embodiments of the present disclosure or may be combined in yet
15 other embodiments, further details of which can be seen with reference to the following description and drawings below.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features of the present disclosure will become more apparent upon reference to the drawings wherein like numbers refer to like parts throughout and wherein:

20 Figure 1 is a top view of an aircraft;

Figure 2 is a diagrammatic view of an embodiment of an edge control system having an edge control device (e.g., flap control lever) in a cruise position (e.g., UP) for controlling one more leading edge devices and/or trailing edge devices in a variable camber mode;

25 Figure 3 is a sectional view of a wing illustrating upward and downward deflection of a leading edge slat and a trailing edge flap in the variable camber mode when the edge control device is in the cruise position;

Figure 4 is a diagrammatic plan view of a leading edge of a wing and schematically illustrating an inboard slat and an outboard slat in a retracted position;

Figure 5 is a diagrammatic plan view of the leading edge of the wing of Figure 4 illustrating the inboard slat and outboard slat actuated in unison;

5 Figure 6 is a diagrammatic plan view of the leading edge of the wing of Figure 4 illustrating the inboard slat actuated independently of the outboard slat;

Figure 7 is a diagrammatic plan view of the leading edge of the wing of Figure 4 illustrating the outboard slat actuated independently of the inboard slat;

10 Figure 8 shows several graphs illustrating the actuation of the leading edge devices and trailing edge devices in a variable camber mode when the edge control device is in the cruise position;

Figure 9 is a diagrammatic view of an embodiment of the edge control system with the edge control device in a hold position for actuating a leading edge device to a sealed position;

Figure 10 is a sectional view of a wing illustrating positioning of a leading edge
5 slat in the sealed position when the edge control device is in the hold position;

Figure 11 is a diagrammatic view of an embodiment of the edge control system with the edge control device in a climb/approach position for automatically extending and retracting one or more trailing edge devices according to a respective extension sequence and retraction sequence;

10 Figure 12 is a sectional view of a wing illustrating the positioning of a leading edge slat in the sealed position and the automated extension of the trailing edge flap according to an extension sequence when the edge control device is the climb/approach position;

Figure 13 shows several graphs illustrating the automated extension of the slats
15 and flaps as a function of Mach number and altitude when the edge control device is the climb/approach position;

Figure 14 is a diagrammatic view of an embodiment of the edge control system with the edge control device in a takeoff/go-around position for positioning one or more trailing edge devices at an optimized flap setting for an aircraft on takeoff;

20 Figure 15 is a sectional view of a wing illustrating the positioning of a trailing edge flap at the optimized flap setting when the edge control device is the takeoff/go-around position and the aircraft in on takeoff;

Figure 16 is a diagrammatic view of an embodiment of the edge control system with the edge control device in the landing position for extending one or more trailing edge
25 devices according to an extension sequence during landing and for determining an autogap condition for one or more leading edge devices;

Figure 17 is a sectional view of a wing illustrating the extension of a leading edge slat from a sealed position to a gapped position and the extending of a trailing edge flap according to an extension schedule when the edge control device is in the landing position;

30 Figure 18 is a diagrammatic view of an embodiment of the edge control system when the edge control device is moved from the landing position to the takeoff/go-around position for positioning one or more trailing edge devices at an optimized flap setting for an aircraft performing a go-around operation following an aborted landing;

Figure 19 is a sectional view of a wing illustrating the positioning of a trailing edge flap at the optimized flap setting for a go-around operation when the edge control device is moved from the landing position to the takeoff/go-around position;

Figure 20 is a block diagram illustrating an embodiment of the edge control system 500;

Figures 21A-21B are illustrations of an embodiment of an indicator for indicating a position of a high-lift device;

Figure 22 is a flow chart illustrating one or more operations that may be included in a method of operating high-lift devices of an aircraft; and

Figure 23 illustrates a flight profile of an aircraft and the positioning of the edge control device (e.g., flap control lever) during different flight phases.

DETAILED DESCRIPTION

Referring now to the drawings wherein the showings are for purposes of illustrating preferred and various embodiments of the disclosure, shown in Figure 1 is a top view of an aircraft 100 having a fuselage 102 and a pair of wings 116. Each wing 116 may be attached to the fuselage 102 and may extend from a wing root 130 to a wing tip 132. The aircraft 100 may include an empennage including a horizontal tail 108 and an elevator 110, and a vertical tail 112 and a rudder 114. The aircraft 100 may further include one or more propulsion units 104 which may be mounted to the wings 116, to the empennage, to the fuselage, or to other structure of the aircraft 100.

As shown in Figure 1, the aircraft 100 may include one or more leading edge devices 200 and one or more trailing edge devices 300 which may be extended and/or retracted to alter the lift characteristics of the wings 116. For example, the aircraft 100 may include leading edge devices 200 configured as slats 202 mounted to the leading edge 124 of the wings 116. However, the leading edge devices 200 may be provided in alternative configurations such as Krueger flaps or other configurations, and are not limited to slats 202. The leading edge devices 200 may include one or more inboard leading edge devices 200 and one or more outboard leading edge devices 200 such as inboard slats 204 and outboard slats 206, respectively.

The wings 116 may also include trailing edge devices 300 located at the trailing edge 126 of each wing 116. The trailing edge device 300 may be implemented as flaps 302 or other trailing edge device configurations. Similar to the leading edge devices 200, the trailing edge devices 300 may include inboard devices 140 and outboard devices 142. For

example, the inboard devices **140** may include one or more inboard flaps **304** and/or an inboard roll-control flap **302** device configured as a flaperon **118** (e.g., a combination flap-aileron). The outboard devices **142** may include one or more outboard flaps **306** and/or an outboard roll-control flap **302** device such as an aileron **120**. The trailing edge devices **300**
 5 may be provided in other configurations including, but not limited to, elevons and other trailing edge device configurations. The aircraft **100** may also include one or more spoilers **122** on each wing **116**, which may be used for generating aerodynamic drag and/or reducing wing lift.

In Figure 2, shown is a diagrammatic view of an embodiment of a system **500** for
 10 controlling high-lift devices of the aircraft (e.g., leading edge devices **200** and trailing edge devices **300**). The system **500** may interchangeably be referred to herein as edge control system **500** and may include an edge control interface **502** for controlling the leading edge devices **200** and/or the trailing edge devices **300** during different phases of flight. The edge control interface **502** may be placed in a flight deck **138** of an aircraft **100** and may include an
 15 edge control device **504** such as a flap lever **506**. The edge control device **504** may be movable in a forward-and-aft direction. However, the edge control device **504** may be provided in alternative embodiments for controlling the leading edge devices **200** and/or trailing edge devices **300**, and is not limited to a flap lever **506**. For example, the edge control device **504** may be implemented as a rotary switch, a touchpad, or others. The edge
 20 control device **504** may be operable to select any of a plurality of control device positions **510**. Each one of the control device positions **510** may correspond to a different flight phase **544** of the aircraft **100**. For example, in the case of a flap lever, the flap lever **506** may be movable to a plurality of flap lever positions, as shown in the Figure 2.

When a control device position **510** is selected, a command mode may be engaged
 25 which may cause the edge control system **500** to command a device actuation system **144** (e.g., a slat actuation system **250** and/or a flap actuation system **350**) to actuate at least one of the high-lift devices (e.g., leading edge devices **200** and/or trailing edge devices **300**) in an automated manner based on the control device position **510** and corresponding flight phase **544** associated with the control device position **510**. The edge control device **504** may
 30 include one or more mechanical gates **508** to prevent movement of the edge control device **504** unless the edge control device **504** is lifted, depressed, or otherwise manipulated to move the edge control device **504** past the mechanical gate **508** as a means to prevent inadvertent retraction of the leading edge devices **200** and/or trailing edge devices **300**.

In Figure 2, the edge control device **504** may include any one or more of the control device positions **510**. For example, the control device positions **510** may include a cruise position **520** (e.g., a first control device position) designated as UP which may correspond to a cruise phase of flight, a hold position **522** (e.g., a second control device position) designated as HOLD which may correspond to a hold phase when the aircraft **100** is in a holding pattern, and a climb/approach position **524** (e.g., a third control device position) designated as CLB/APP which may correspond to a climb phase when the aircraft **100** is climbing after takeoff, or which may correspond to an approach phase such as when the aircraft **100** is descending from a cruising altitude in preparation for landing. The control device positions **510** may further include a takeoff/go-around position **526** (e.g., a fourth control device position) designated as TOGA which may correspond to a takeoff phase or a go-around operation initiated during an aborted landing. The control device positions **510** may also include a landing position **528** (e.g., a fifth control device position) designated as LAND which may correspond to a landing phase of the aircraft **100**. However, the edge control device **504** may include control device positions **510** in addition to or other than the control device positions **510** shown in Figure 2. Furthermore, the control device positions **510** may be designated by different nomenclature, and are not limited to the illustrated designations. In this regard, the control device positions **510** may be identified by any one of a variety of different labeling systems, and are not limited to the designations UP, HOLD, CLB/APP, TOGA, and LAND.

In Figure 2, when the edge control device **504** is in the cruise position **520** (e.g., a first control device position), the edge control system **500** may automatically command the device actuation system **144** to actuate one or more high-lift devices (e.g., one or more leading edge devices **200** and/or one or more trailing edge devices **300**) in a variable camber mode. For example, the edge control system **500** may command the device actuation system **144** to actuate one or more leading edge devices **200** and/or one or more trailing edge devices **300** in an upward direction **210**, **310** and a downward direction **212**, **312** relative to a retracted position **208**, **308** when the aircraft **100** is in a cruise phase of flight. The edge control device **504** may be communicatively coupled to a flight control computer **540** which may be configured to compute a setting for a high-lift device based upon aircraft state data **542**. The edge control system **500** may include one or more actuation systems **144** configured to automatically actuate one more high-lift device(s) to the high-lift device setting if a command mode is engaged. In some examples, the high-lift device setting may be an optimum device setting. For example, the flight control computer **540** may determine an

optimum slat setting **220** for the leading edge slats **202**, and/or an optimum flap setting **320** for the trailing edge flaps **302** based on aircraft state data **542**. The aircraft state data **542** may include, without limitation, aircraft gross weight, aircraft center of gravity, Mach number, airspeed, altitude, and other data.

5 When the edge control device **504** is in the cruise position **520**, the edge control system **500** may automatically command the slat actuation system **250** and/or the flap actuation system **350** to position the slats **202** and/or flaps **302** at the respective optimum slat setting **220** and optimum flap setting **320** as determined by the flight control computer **540** based upon the aircraft state data **542**. As described below, when the edge control device **504**
 10 is in the cruise position **520**, the leading edge devices **200** and/or trailing edge devices **300** may be actuated along an upward direction **210**, **310** and/or a downward direction **212**, **312** within relatively small deflection angles **216**, **316** relative to a retracted position **208**, **308**. Furthermore, the edge control system **500** may command the device actuation systems **144** to periodically reposition the leading edge devices **200** (e.g., the slats **202**) and/or trailing edge
 15 devices **300** (e.g., the flaps **302**) according to a slat positioning schedule and a flap positioning schedule when the edge control device **504** is in the cruise position **520** and the aircraft **100** is flying above a predetermined altitude and operating within a predetermined airspeed range or Mach number range.

Referring to Figure **3**, shown is a cross section of an aircraft wing **116** having a
 20 slat **202** mounted on the leading edge **124** of the wing **116**, and a flap **302** mounted on the trailing edge **126** of the wing **116**. The slat **202** and flap **302** are shown in solid lines in a retracted position **208**, **308**. Spoilers **122** may be mounted on a wing upper surface **128** and may partially overlap the forward edge of the flaps **302**. The spoilers **122** may be deployed to generate aerodynamic drag and/or reduce aerodynamic lift of the wings **116**. When the edge
 25 control device **504** is in the cruise position **520**, the slat **202** and flap **302** may be actuated in a variable camber mode in an upward direction **210**, **310** and downward direction **212**, **312** as shown in phantom lines in Figure **3**.

In Figure **3**, the leading edge devices **200** such as the slats **202** may be actuated by a slat actuation system **250**. The slats **202** may be coupled to an inboard torque tube **146** and
 30 an outboard torque tube **148** or other mechanical linkage. The inboard torque tube **146** on the leading edge **124** may be coupled to a centrally-located leading edge, power drive unit (PDU) (not shown). Each slat **202** may be supported by one or more carrier track assemblies **252** which may each include a guide track **254** supported by one or more guide rollers **256** mounted to the wing **116**. Each one of the torque tubes **146**, **148** may include a pinion gear

258 for engaging the guide track 254. Extension and retraction of the slats 202 may be effectuated by rotating the torque tubes 146, 148 using the PDU. Each PDU may operate in conjunction with a variable camber trim unit (VCTU). As described below, a VCTU 400 may be positioned between an inboard leading edge device 200 and an outboard leading edge device 200 on each wing 116 to allow for independent actuation of the inboard and outboard slats 204, 206.

In Figure 3, the trailing edge device 300 is shown as a simple flap 302 supported on a drop hinge 354. However, the flap 302 may be provided in any one of a variety of different configurations and is not limited to a simple flap. For example, the flap 302 may be configured as a plain flap, a single-slotted flap, a multi-slotted Fowler flap, or any one of a variety of other trailing edge device 300 configurations that may be actuated by the device actuation system 144. The flap 302 may be actuated by a flap actuation system 350 using a trailing edge linkage assembly 352 that may be coupled to a torque tube 146, 148. The flap actuation system 350 may also include a centrally-located, trailing edge PDU (not shown), which may operate in conjunction with a VCTU 400 positioned between an inboard flap 304 and an outboard flap 306 on each wing 116 to allow for independent actuation of the inboard and outboard flaps 304, 306.

In Figure 3, when the edge control device 504 is in the cruise position 520, the edge control system 500 may automatically command the device actuation system 144 to adjust the position of the slats 202 and flaps 302 in relatively small deflection increments in an upward direction 210, 310 relative to the retracted position 208, 308, and/or in relatively small deflection increments in a downward direction 212, 312 relative to the retracted position 208, 308. The deflection increments may be no greater than approximately one (1) degree of actual slat angle or actual flap angle. However, the slats 202 and flaps 302 may be adjusted in increments of greater than one (1) degree of flap angle or slat angle. The slat actuation system 250 may be configured such that slat 202 movement is limited to within a slat deflection angle 216 of less than approximately three (3) degrees in each of the upward direction 210 and the downward direction 212 relative to the retracted position 208 of the slat 202. Likewise, the flap actuation system 350 may be configured such that flap 302 movement is limited to within a flap deflection angle 316 of less than approximately three (3) degrees in each of the upward direction 310 and the downward direction 312 relative to the retracted position 308 of the flap 302. The slat deflection angle 216 may be defined as the angle between a local wing chord line 134 and a local slat chord line 214. The slat chord line 214 may extend through a forward-most point on the slat 202 when the slat 202 is in the

retracted position **208**. Likewise, for the simple flap **302** illustrated in Figure 3, the flap deflection angle **316** may be defined as the angle between the local wing chord line **134** and a local flap chord line **314**. The local flap chord line **314** may be aligned with the local wing chord line **134** when the flap **302** is in the retracted position **308**.

5 Referring to Figure 4, shown is diagrammatic plan view of a leading edge **124** of the wing **116** illustrating differential deployment of the inboard and outboard leading edge devices **200**. In an embodiment, the propulsion unit centerline **106** may divide the inboard devices from the outboard devices. Although not shown, the inboard and outboard trailing edge devices **300** (e.g., inboard and outboard flaps **304**, **306** – Figure 1) may be differentially deployed in a manner
 10 similar to the below-described differential deployment of the inboard and outboard leading edge devices **200**. When the edge control device **504** is in the cruise position **520**, the edge control system **500** may automatically command the device actuation system **144** to differentially actuate the inboard devices **140** and outboard devices **142** in an upward direction **210**, **310** and downward direction **212**, **312** to alter the wing camber as a means to reduce aerodynamic drag and/or to
 15 optimize the distribution of aerodynamic lift along a spanwise direction of the wings **116**. Differential deployment may be effectuated by operating a PDU in conjunction with a VCTU **400** positioned between an inboard device **140** and outboard device **142**. The VCTU **400** may include a dedicated VCTU electric motor **402** that may include a speed sum gearbox (not shown) having a planetary gear arrangement allowing for differential rotation of the inboard torque tube **146**
 20 relative to the outboard torque tube **148**.

Figure 5 illustrates actuation of the inboard slat **204** and outboard slats **206** in unison with one another. Although not shown, the centrally-located PDU may be activated for rotating the inboard torque tube **146**. The VCTU **400** may transfer the rotation of the inboard torque tube **146** to the outboard torque tube **148** are actuated in unison. Figure 6 illustrates actuation of the inboard
 25 slat **204** independent of the outboard slats **206**. In such an arrangement, the VCTU **400** may be configured to prevent rotation of the outboard torque tube **148** while allowing the PDU to rotate the inboard torque tube **146**. Figure 7 illustrates actuation of the outboard slat **206** independent of the inboard slats **204**. In such an arrangement, the centrally-located PDU may be locked to prevent rotation of the inboard torque tube **146** while the VCTU electric motor **402** is activated to
 30 cause rotation of the outboard torque tube **148**.

Referring to Figure 8, shown are several graphs illustrating a non-limiting example of automatic actuation of the leading edge slats **202** and trailing edge flaps **302** in the variable camber

mode when the edge control device **504** (e.g., flap lever **506**) is in the cruise position **520** and the aircraft **100** is in cruise flight. With the variable camber mode enabled and the flap lever maintained in the same position (e.g., the cruise position **520**), the slats **202** and the flaps **302** may be periodically repositioned at their respective optimum device settings **220**, **320** as a function of aircraft state data **542**. The slats **202** and the flaps **302** may be positioned within the above-mentioned relatively small deflection angles **216**, **316** to optimize the wing camber according to a predetermined deflection schedule. The aircraft state data **542** may include altitude, Mach number, aircraft gross weight, and aircraft center of gravity which are shown plotted over time (e.g., in hours) in Figure 8. The graphs illustrate the slat deflection angles **216** of the inboard and outboard slats **204**, **206** and flaps **304**, **306** and the differential deployment thereof. When the edge control device **504** is in the cruise position **520**, the edge control system **500** may periodically (e.g., every 5 minutes, 10 minutes, etc.) reposition the slats **202** and flaps **302** according to weight-CG-altitude-airspeed scheduled surface deflection angles within the limits of the above described slat deflection angle **216** and flap deflection angle **316** for drag reduction and/or wing load alleviation.

Referring to Figure 9, shown is an embodiment of the edge control system **500** with the edge control device **504** in a hold position **522** (e.g., a second control device position). The edge control system **500** may be operable to engage, in response to the selection of a second control device position, a command mode for automatically commanding one or more leading edge devices to a sealed position **222**. In this regard, the device actuation system **144** may automatically position one or more leading edge devices **200** in the sealed position **222** when the edge control device **504** is moved to the hold position **522** and the aircraft **100** is in a holding phase. For example, when the aircraft **100** is descending for landing, instructions may be received from air traffic control to place the aircraft **100** in a holding pattern. The pilot or flight crew may move the edge control system **500** from the cruise position **520** to the hold position **522**.

Referring to Figure 10, shown is a sectional view of a wing **116** illustrating movement of a leading edge slat **202** to the sealed position **222**. The inboard slats **204** and the outboard slats **206** may be moved from an optimum slat setting **220** (i.e., in the variable camber mode) to the sealed position **222** in response to movement of the edge control device **504** from the cruise position **520** to the hold position **522**. The extension of the slats **202** from the retracted position **208** to the sealed position **222** may allow for a reduction in the airspeed of the aircraft **100** to reduce fuel

consumption and allow the aircraft **100** to remain within a designated airspace until further instructions are received from air traffic control to initiate an approach to an airport runway.

Referring to Figure **11**, shown is an embodiment of the edge control system **500** with the edge control device **504** moved to a climb/approach position **524**. The edge control system **500** may be configured to command the device actuation system **144** to automatically extend one or more of the trailing edge devices **300** according to an extension sequence when the edge control device **504** is moved to the climb/approach position **524** (e.g., from the cruise position **520** or from the hold position **522**) and the aircraft **100** is in an approach phase such as when the aircraft **100** is descending for a landing. The edge control system **500** may also be configured to command the device actuation system **144** to automatically retract one or more of the trailing edge devices **300** according to a retraction sequence when the edge control device **504** is moved to the climb/approach position **524** and the aircraft **100** is in a climbing phase such as after takeoff from a runway or during a go-around operation following an aborted landing.

Referring to Figure **12**, shown is sectional view of a wing **116** with the leading edge slat **202** moved from the retracted position **208** to the sealed position **222** when the edge control device **504** is moved from the cruise position **520** to the climb/approach position **524**. If the leading edge slat **202** is already in the retracted position **208** as a result of the edge control device **504** being in the hold position **522**, then the slat **202** may be maintained in the retracted position **208** when the edge control device **504** is moved from the hold position **522** to the climb/approach position **524**. In addition, shown in Figure **12** is the automated extension of the trailing edge flaps **302** from the retracted position to progressively deeper flap **302** settings according to a flap extension sequence.

The automated extension of the flaps **302** may reduce the number of tasks required by the flight crew. In addition, the flight control computer **540** (Figure **11**) may position the flaps **302** at optimum flap settings **320** based on continuously monitored aircraft state data **542** such as aircraft angle of attack, aircraft gross weight, acceleration, airspeed, altitude, and other aircraft parameters. The flight control computer **540** may be preprogrammed with data such as flap placard speeds to avoid exceeding the airspeed limitations of the flaps. When the aircraft **100** is climbing such as after departure from an airport runway, the edge control system **500** may command the flap actuation system **350** to periodically retract the flaps **302** according to a sequence of optimum flap settings **320** computed by the flight control computer **540** based on the aircraft state data **542**. When the aircraft **100** is descending, the edge control system **500** may command the flap actuation

system **350** to periodically extend the flaps **302** according to a sequence of optimum flap settings **320** computed by the flight control computer **540** based on the aircraft state data **542**.

Referring to Figure **13**, shown are several graphs illustrating the automated extension of the slats **202** and flaps **302** as a function of aircraft state data **542** when the edge control device **504** is moved to the climb/approach position **524** and the aircraft **100** is descending during an approach phase. The aircraft state data **542** may include altitude and Mach number which is shown plotted over time in Figure **13**. Also shown is the automated extension of the slats **202** from a retracted position **208** to a sealed position **222** at approximately the **78**-minute mark on the graphs, and the sequence of extension of the flaps **302** shortly after the **78**-minute mark. From the **75**-minute mark to the **78**-minute mark, the graphs show the inboard slats **204** and flaps **302** in dashed lines and the outboard slats **206** and flaps **302** in solid lines to illustrate the differential deployment of the slats **202** and flaps **302** according to the automated extension sequence during descent of the aircraft **100**.

Referring to Figure **14**, shown is an embodiment of the edge control system **500** with the edge control device **504** moved to a takeoff/go-around position **526**. The edge control system **500** may be configured to command the device actuation system **144** to position one or more of the trailing edge devices **300** at an optimum flap setting **320** when the edge control device **504** is moved to the takeoff/go-around position **526** and the aircraft **100** is in a takeoff phase. The edge control system **500** may include a flight control computer **540** for computing the optimum flap setting **320** based on aircraft state data **542** and/or airport information **548**. The aircraft state data **542** and/or airport information **548** may be preloaded into the flight control computer **540** and/or entered into the flight control computer **540** by the flight crew or by an airline dispatcher or other personnel. The flight control computer **540** may compute the optimum flap setting **320** prior to takeoff and/or at any time during a flight.

In Figure **14**, the aircraft state data **542** may include aircraft gross weight, aircraft center of gravity, takeoff thrust of the propulsion units, and other aircraft state data **542** representing the state of the aircraft **100**. Airport information **548** may include airport parameters **550** and/or airport atmospheric data **552**. Airport parameters **550** may include generally static or non-changing data regarding an airport. For example, airport parameters **550** may include runway length, local terrain information, obstacle definition such as obstacle height and location relative to the runway, airport elevation, and other parameters. Airport atmospheric data **552** may include data representative of the meteorological conditions at the airport and may include barometric pressure, outside air temperature, wind speed, wind direction, wind gust information, and other atmospheric data **552**.

In Figure 14, the edge control system 500 may include a display window 514 for displaying the value (e.g., a numerical value) of the optimum flap setting 320 as a visual indication to the flight crew. The display window 514 may be located below the flap 302 control lever or in any other location that is visible by the flight crew such as on a main display (not shown) of the flight control instrumentation (not shown). The optimum flap setting 320 displayed in the display window 514 may change with real-time changes in the aircraft state data 542 and/or real-time changes in airport information 548. The display window 514 may also display a desired flap setting 322 that may be selected by the flight crew as described below.

In Figure 14, the edge control system 500 may include a variable-trailing-edge-position switch 512 which may function as a second edge control device or supplemental input device for the high-lift devices. In this regard, the second edge control device (e.g., the variable-trailing-edge-position switch 512) may enable selection by the flight crew of a desired setting for the high-lift devices different from the computed high-lift device setting without requiring movement of the first edge control device (e.g., a flap lever 506) from the first control device position (e.g., from a cruise position 520). In some examples, the desired setting may be a desired flap setting 322 based on the optimum flap setting 320 computed by the flight control computer 540. The variable-trailing-edge-position switch 512 may be operative when the edge control device 504 is in the takeoff/go-around position 526. However, the variable-trailing-edge-position switch 512 may be operative when the edge control device 504 is in control device positions 510 other than the takeoff/go-around position 526. The variable-trailing-edge-position switch 512 may provide the flight crew with the means to adjust or fine tune the optimum flap setting 320 to a desired flap setting 322 that may be different than the optimum flap setting 320. For example, moving the edge control device 504 into the takeoff/go-around position 526 may cause the flaps 302 to be automatically commanded to an optimum flap deflection angle 316 of twenty (20) degrees as computed by the flight control computer 540. The flight crew may manually rotate the variable-trailing-edge-position switch 512 to change the flap setting from an optimum flap deflection angle 316 of twenty (20) degrees to a desired flap deflection angle 316 of eighteen (18) degrees.

Although shown as a rotary dial having a digital display window 514, the variable-trailing-edge-position switch 512 may be configured as an analog dial having flap setting values arranged in a circular pattern around the variable-trailing-edge-position switch 512. Alternately, the variable-trailing-edge-position switch 512 may be configured as a push-

button device, as a mechanical slider, or in other configurations. The variable-trailing-edge-position switch **512** may be configured to position the flaps **302** or other trailing edge devices **300** within a predetermined flap setting range. For example, when the edge control device **504** is in the takeoff/go-around position **526**, the variable-trailing-edge-position switch **512**
 5 may be limited to selecting a flap deflection angle **316** of between approximately **5-20** degrees, or some other flap **302** setting range.

In Figure **14**, the variable-trailing-edge-position switch **512** may include a plurality of switch positions. The difference between two adjacent switch positions may correspond to a flap deflection increment for adjusting the position of the flaps **302** as indicated above. For example, moving the variable-trailing-edge-position switch **512** from
 10 **17** (not show) to **18** (Figure **14**) may move the flaps **302** by a flap deflection increment of approximately one (**1**) degree of actual flap angle. However, moving the variable-trailing-edge-position switch **512** between two adjacent switch positions may move the flaps **302** in flap deflection increments of less than or greater than approximately one (**1**) degree of actual
 15 flap angle.

In an embodiment, the variable-trailing-edge-position switch **512** may be configured to be non-movable unless commanded by positive action from the flight crew. For example, the variable-trailing-edge-position switch **512** may require depressing the variable-trailing-edge-position switch **512**, or pulling up on the variable-trailing-edge-position switch **512** before the switch can be moved or rotated. The variable-trailing-edge-position switch **512** may also be configured as a detented switch having discrete contacts and/or mechanical stops to prevent inadvertent actuation of the variable-trailing-edge-position switch **512**. In addition, the variable-trailing-edge-position switch **512** may be configured such that flap extension and flap retraction are commanded by moving the
 20 variable-trailing-edge-position switch **512** in mutually exclusive directions. In a further embodiment, instead of mechanically selecting a desired flap setting **322** using the variable-trailing-edge-position switch **512**, a desired flap setting **322** may be digitally selected in a software program (not shown) that may optionally be implemented in the flight control computer **540**. Such an arrangement may also include a means for allowing the flight crew to
 25 override the optimum flap setting **320** or adjust the optimum flap setting **320** to a desired flap setting **322** which may be different than the optimum flap setting **320**
 30

Referring to Figure **15**, shown is a sectional view of a wing **116** illustrating the positioning of the leading edge device **200** in the sealed position **222** on the wing leading edge **124** when the edge control device **504** is in the takeoff/go-around position **526**. The

trailing edge flap **302** may be automatically commanded to an optimum flap setting **320** (shown in solid lines) when the edge control device **504** is in the takeoff/go-around position **526**. Shown in phantom lines is the flap **302** moved to a desired flap setting **322** which may be different than the optimum flap setting **320** computed by the flight control computer **540**.

5 The variable-trailing-edge-position switch **512** may allow the flight crew to fine-tune the flap setting in relatively small flap deflection increments **318**.

Referring to Figure 16, shown is an embodiment of the edge control system **500** with the edge control device **504** in a landing position **528** (e.g., a third control device position). The edge control device **504** may be operable to engage a third command mode for

10 automatically extending a leading edge device to a gapped position **224** while the third command mode is engaged and at least one leading edge gap **226** condition occurs. In an embodiment, when the edge control device **504** is moved to the landing position **528**, if the flight control computer **540** detects the occurrence of a leading edge gap **226** condition of the aircraft **100**, the edge control device **504** may engage the third command mode causing the

15 device actuation system **144** to automatically extend the leading edge device **200** to the gapped position **224**. For example, when the aircraft **100** is descending on approach, the leading edge devices **200** such as the slats **202** may be initially maintained in a sealed position **222** to minimize aerodynamic noise that would otherwise be generated with the slats **202** in the gapped position **224**. When the edge control device **504** is moved to the landing

20 position **528**, the slats **202** may be automatically extended to the gapped position **224** if the actual angle of attack **546** of the wings **116** relative to the airflow direction **136** exceeds a threshold angle of attack which may be pre-programmed into the flight control computer **540**.

In Figure 16, when the edge control device **504** is in the landing position **528**, the flight control computer **540** may inhibit movement of the leading edge slats **202** from the

25 sealed position **222** to the gapped position **224** as long as the actual radio altitude of the aircraft **100** exceeds a threshold radio altitude. The flight control computer **540** may generate a gap command when the actual angle of attack **546** of the wings **116** exceeds a threshold angle of attack regardless of the radio altitude of the aircraft **100**. In addition, the flight control computer **540** may also generate a gap command when the aircraft **100** descends

30 below the threshold radio altitude regardless of the angle of attack **546** of the wings **116**. Upon generation of the gap command by the flight control computer **540**, the edge control system **500** may automatically command the slat actuation system **250** to extend the leading edge slats **202** from the sealed position **222** to the gapped position **224**. The flight control computer **540** may also generate a retract command to retract the leading edge slats **202** from

the gapped position **224** to the sealed position **222** when the angle of attack to the wings **116** is less than the threshold angle of attack and/or the aircraft **100** ascends above the threshold radial altitude.

In Figure 16, when the edge control device **504** is moved to the landing position **528**, the edge control system **500** may also automatically command the flap actuation system **350** to extend the trailing edge devices **300** (e.g., flaps) according to an extension schedule. For example, the flight control computer **540** may continuously receive aircraft state data **542** such as forward airspeed, vertical speed, changes in engine thrust, spoiler (i.e., speedbrake) deployment, and other aircraft state data **542**. The flight control computer **540** may determine the optimum flap settings **320** as a function of the aircraft state data **542**. The optimum flap setting **320** may be such that aerodynamic noise and/or engine noise is minimized. The edge control system **500** may include flaps load relief capability allowing for temporarily and automatically retracting the flaps **302** when the aircraft **100** airspeed exceeds the flap placard speed, and allowing the flaps **302** to be automatically extended back to the optimum flap setting **320** when the aircraft **100** airspeed is less than the flap placard speed.

Referring to Figure 17, shown is a sectional view of a wing **116** illustrating the slat **202** extended from the sealed position **222** to the gapped position **224** in response to the actual angle of attack **546** of the wing exceeding a threshold angle of attack. With the leading edge slats **202** extended to the gapped position **224**, wing camber may be increased which may improve the lift characteristics of the wing **116**. In addition, when the leading edge slats **202** are in the gapped position **224**, a gap **226** may be formed between the slats **202** and the wing leading edge **124** allowing air to flow through the gap **226** which may delay flow separation over the wing upper surface **128** at high angles of attack and thereby delay stall onset to improve stall performance. Figure 13 illustrates the automated movement of the slats **202** (just before the 80-minute mark) from the sealed position **222** to the gapped position **224** in response to the aircraft **100** descending below a threshold radio altitude.

In Figure 17, in a further embodiment, the edge control system **500** may automatically command the slat actuation system **250** to extend the outboard slats **206** to the gapped position **224** while initially maintaining the inboard slats **204** in the sealed position **222**. The inboard slats **204** may be moved to the gapped position **224** after the outboard slats **206** reach the gapped position **224**. By initially moving the outboard slats **206** to the gapped position **224** prior to the inboard slats **204**, stall characteristics of the aircraft **100** may be improved due to the tendency of the reduced-camber inboard portion of the wing **116** to stall

prior to the increased-camber outboard portion and causing the nose of the aircraft **100** to pitch down which may aid in stall recovery. Figure **17** also illustrates the automated extension of the leading edge devices **200** (e.g., flaps) to progressively deeper flap settings until the flaps **302** are in the final landing flaps setting. As indicated above, the flight control computer **540** may
 5 determine an optimum flap setting **320** at each step in the extension sequence to minimize noise during deployment of the flaps **302**. In addition, the automated extension of the flaps **302** may reduce the number of tasks required by the flight crew during approach.

Referring to Figure **18**, shown is an embodiment of the edge control system **500** illustrating the functionality thereof when the edge control device **504** is manually moved from
 10 the landing position **528** to the takeoff/go-around position **526** as may occur during initiation of a go-around operation in the event of an aborted landing. The flight control computer **540** may include go-around logic for computing an optimum flap setting **320** for the go-around operation when the edge control device **504** is in the landing position **528**. The flight control computer **540** may continuously compute the optimum flap setting **320** based on aircraft state data **542** and/or
 15 airport information **548**.

In Figure **18**, the aircraft state data **542** may include aircraft gross weight, aircraft center of gravity, flap detent setting, aircraft-in-air indication, and flaps load relief capability. In addition, the aircraft state data **542** may include the deflection angle increment that may be available for positioning the flaps **302**, the maximum go-around thrust capability of the propulsion units **104**,
 20 and other aircraft state data **542**. The aircraft-in-air indication may provide an indication to the flight control computer **540** regarding whether the aircraft **100** is in the air or on the ground. The airport information **548** may include outside air temperature, barometric pressure, and other information that may affect the determination of the optimum flap setting **320**. The optimum flap setting **320** may be displayed in the display window **514** whenever the edge control device **504** is
 25 in the landing flaps **302** position and/or the takeoff/go-around position **526**.

In Figure **18**, the pilot may initiate a go-around operation by selecting a TOGA switch (not shown) on the thrust levers (not shown) causing the thrust levers to automatically advance to a go-around thrust setting (e.g., a maximum thrust setting). The pilot may retract the landing gear and manually move the edge control device **504** (e.g., flap lever **506**) from the landing position **528** to
 30 a takeoff/go-around position **526** causing the trailing edge devices **300** (e.g. flaps) to automatically move to the optimum flap setting **320** as determined by the flight control computer **540**. The aircraft **100** may climb to a predetermined altitude (e.g., **1,500** feet) and accelerate to a

flaps-up maneuvering speed after which the aircraft **100** may perform another approach. In addition, when the edge control device **504** is manually moved from the landing position **528** to the takeoff/go-around position **526**, the leading edge devices **200** (e.g., slats **202**) may be automatically retracted from a gapped position **224** to a sealed position **222** to reduce
 5 aerodynamic drag and improve the climb performance of the aircraft **100** during the go-around operation.

In Figure **18**, the variable-trailing-edge-position switch **512** may allow the flight crew to manually adjust the position of the flaps **302** from the computed optimum flap setting **320** to a desired flap setting **322** that is different than the optimum flap setting **320**. Alternatively, the
 10 flight control computer may be configured to automatically adjust the position of the flaps **302** to the desired flap setting **322**. The variable-trailing-edge-position switch **512** may allow the flight crew to fine-tune the position of the flaps **302** prior to initiation of the go-around operation. For example, the pilot may change the flap setting from the optimum flap setting **320** to a desired flap setting **322** in consideration of obstacles or terrain that may be located in the area where the go-around operation will be performed. The variable-trailing-edge-position switch **512** may also
 15 allow the flight crew to manually adjust the flap setting as the go-around operation progresses.

Referring to Figure **19**, shown is a sectional view of a wing **116** illustrating the leading edge slat **202** automatically moved from the gapped position **224** to the sealed position **222** in response to the flight crew manually moving the edge control device **504** from the landing
 20 position **528** to the takeoff/go-around position **526**. Also shown is the automatic retraction of the trailing edge flap **302** from the landing flaps **302** setting to the optimum flap setting **320** when the edge control device **504** is moved from the landing position **528** to the takeoff/go-around position **526**. The optimum flap setting **320** may be different than a standard flap setting associated with a standard takeoff or go-around flap detent. For example, the optimum flap setting **320** may
 25 correspond to a flap deflection angle **316** of eighteen (18) degrees instead of a standard flap deflection angle **316** of twenty (20) degrees. The optimum flap setting **320** may optimize the climb performance of the aircraft **100** by allowing for a shallower flap setting resulting in reduced aerodynamic drag relative to the amount of aerodynamic drag generated by the flaps **302** in a standard flap deflection angle **316** for a go-around operation. In Figure **19**, also shown in
 30 phantom lines are optional desired flap settings **322** corresponding to flap deflection increments for positioning the flaps **302** using the variable-trailing-edge-position switch **512**. By adjusting (e.g., rotating) the variable-trailing-edge-position switch **512**, the flight crew may manually

select a desired flap setting **322** which may be different than the optimum flap setting **320** computed by the flight control computer **540**.

Figure **20** shows a block diagram of a system **500** for controlling a high-lift device of an aircraft (e.g., leading edge devices **200** and trailing edge devices **300**) according to some examples of the present disclosure. As described herein, the system **500** may include an interface **150**, which may be located in the flight deck **138** of the aircraft **100**. The interface **150** may be configured for receiving input from the flight crew and/or providing feedback to the flight crew. The interface **150** may be implemented as an edge control interface **502**, for example as previously described with reference to Figures **2**, **9**, **11**, **14**, **16**, and **18**. The interface **150** may include an edge control device **504** operable to control a position of the high-lift device therewith. The edge control device **504** may be operable to select any of a plurality of control device positions **510**, each of which is associated with a different flight phase **544** of the aircraft. The edge control device **504** may be operable to engage, in response to a selection of one of a plurality of control device positions **510**, an automatic command mode for actuating the high-lift device in an automated manner based on the flight phase associated with the selected control device position.

The system **500** may further include a flight control computer **540** which may be operable in a plurality of command modes **560** (e.g., **560**-(**1**), **560**-(**2**), **560**-(**3**), etc.). Each one of the command modes **560** may be associated with a given flight phase **540** (e.g., **544**-(**1**), **544**-(**2**), **544**-(**3**), etc.). The edge control device **504** may be operable to engage a particular command mode **560** responsive to selecting a control device position **510** associated with the corresponding flight phase. The flight control computer **540** may be configured to receive aircraft state data **542** and may be further configured to compute a high-lift device setting for the high-lift device (e.g., an optimal flap setting **320**, an optimal slat setting **220**) based, at least in part, on the aircraft state data **542**. The interface **150** and the flight control computer **540** may be communicatively coupled to one another and/or to an actuation system **144** which may be configured to actuate one or more of the high-lift devices of the aircraft. The actuation system **144** may be configured to automatically actuate the high-lift device to a computed high-lift device setting if a command mode is engaged.

For example, in a first command mode **560**-(**1**), which may be a variable camber mode (e.g., Figure **2**) associated with a first control device position **544**-(**1**) such as a cruise position **520** (e.g., Figure **2**) of the edge control device **504**, the actuation system **144** may be configured to actuate the high-lift device in an upward direction and a downward direction relative to a retracted position. In some examples and as described above, the actuation

system **144** may be configured to actuate the high-lift device in an upward direction and/or a downward direction in small increments, for example, and without limitation, in increments of up to approximately two (2) degrees. In further examples, the edge control device **504** may be operable to engage, in response to selection of a second control device position **544-**
 5 (2) (e.g., a hold position **522** – Figure 9), a second command mode **560-(2)** for automatically commanding a leading edge device **200** to a sealed position **222** upon engagement of the second command mode **560-(2)**.

In yet further examples, the edge control device **504** may be operable to engage, in response to a selection of a third control device position or a fourth control device position,
 10 respective third or fourth command modes **560** for automatically commanding the high-lift device(s) according to other control logic, as described herein. In some examples, the interface **150** may include a plurality of edge control devices e.g., a first edge control device **504**, and a second edge control device which may be implemented as a switch **512** (Figure 18). The second edge control device may be operable to override commands to the high-lift
 15 devices during a command mode, for example to allow the flight crew to select a desired setting for the high-lift device which may be different from the computed high-lift device setting without necessitating movement of the first edge control device **504** from the first control device position. The system **300**, upon selection of a desired setting may be configured to command the high-lift device(s) to the desired setting.

20 The interface **150** may further include an indicator **516** configured to provide information about the high-lift device. The indicator **516** may be configured to indicate a position of the high-lift device. For example, the indicator **516** may be configured to indicate a computed high-lift device setting, a setting selected by the flight crew (e.g., a desired setting **322**), a deflection angle of the high-lift device corresponding to either the computed
 25 setting or the desired setting, or combinations thereof. The indicator **516** may be integrated with or separate from the edge control device **502**. As described herein, the control device **504** may be movable to a plurality of control device positions **510**. In this regard, the control device **504** and control device position **510** selected thereby may function as an indicator of the position of the flap, which can be used instead of or in addition to one or more other
 30 indicators of the interface **150**. In some examples, the indicator **516** may be a display **514** (see Figure 18) or other device for communicating information about the high-lift device to the pilot (e.g., when the high-lift device is automatically commanded by the system **300**). Virtually any information about the high-lift devices may be displayed in the display **514**, for example the slat and/or flap deflection angle **216**, **316**, the optimum slat and/or flap setting,

220, **320**, the desired setting **322**, a status **554** of the slats (e.g., scaled or gapped), or combinations thereof.

In some examples, the indicator **516** may be implemented as a fill-type indicator (e.g., a tape indicator similar to an airspeed tape), for example as shown in Figures **21A-21B**.
 5 Figure **21A** shows an example of a fill-type indicator **150** indicating CLIMB-DESCEND to indicate that the trailing edge devices **300** (e.g., flaps **302**) are in a climb setting or approach setting. The fill-type indicator **150** may include a vertical gage representing maximum available flap deflection and may additionally including a horizontal bar that may be vertically movable along the vertical gage. The vertical position of the horizontal bar on the
 10 vertical gage may indicate the actual flap deflection angle of the flaps or a percentage of maximum flap deflection. Figure **21B** shows the fill-type indicator **150** indicating TOGA **3** to indicate that the trailing edge devices **300** (e.g., flaps **302**) are in a takeoff or go-around setting and further showing the horizontal bar in a vertically lower position than in Figure **21A** to indicate a deeper flap setting corresponding to the takeoff or go-around setting. Other
 15 fill-type indicators may be used. For example, the indicator **516** may be implemented as a gage indicator in which the full gage corresponds to the full extension of flaps available (e.g., maximum flap deflection) and the actual flap deflection angle or a percentage of maximum flap deflection may be displayed in a corresponding position in the gage. In further examples, the indicator **516** may be one of a plurality of fill-type indicators including at least
 20 one indicator for displaying information relating to a leading edge device of the aircraft and at least one indicator for displaying information relating to a trailing edge device of the aircraft. Virtually any information about the high-lift devices may be displayed.

Referring to Figures **22-23**, shown in Figure **22** is a flow chart illustrating one or more operations that may be included in a method **600** of operating high-lift devices such as
 25 leading edge devices **200** and/or trailing edge devices **300** of an aircraft **100**. Figure **23** illustrates a flight profile of an aircraft **100** and the different control device positions **510** corresponding to different flight phases **544** during an aircraft mission.

Step **602** of the method **600** of Figure **22** may include positioning an edge control device **504** in a first control device position of a plurality of control device positions **510**. As
 30 indicated above, each of the plurality of control device positions **510** may be associated with a flight phase **544** (Figure **20**) of the aircraft **100**. In an embodiment, the method may include moving the edge control device **504** to a cruise position **520** (UP) when the aircraft **100** is in a cruise phase (Figure **23**). For example, the edge control device **504** may be moved to the cruise position **520** before or when the aircraft **100** reaches a cruising altitude.

Step **604** of the method **600** of Figure **22** may include engaging a command mode in response to positioning the edge control device **504** in the first control device position. Engagement of the automatic command mode may cause actuation of the high-lift device in an automated manner based on the flight phase **544** associated with the selected control device position **510**. As shown in Figure **20**, each one of the command modes **560** (e.g., **560**-(1), **560**-(2), **560**-(3), etc.) may be associated with a corresponding flight phase **540** (e.g., **544**-(1), **544**-(2), **544**-(3), etc.).

Step **606** of the method **600** of Figure **22** may include computing a high-lift device setting for a high-lift device. In an embodiment, the flight control computer **540** may be configured to compute a high-lift device setting based, at least in part, on the aircraft state data **542**. The aircraft state data **542** may include aircraft gross weight, aircraft center of gravity, aircraft angle of attack, Mach number, altitude, and/or other aircraft parameters or combinations thereof. The flight control computer **540** may be preprogrammed with the aircraft state data **542** and/or the aircraft state data **542** may be periodically or continuously provided to the flight control computer **540**. The flight control computer **540** may compute the high-lift device setting as an optimum flap setting **320** and/or an optimum slat setting based, at least in part, on the aircraft state data **542**.

Step **608** of the method **600** of Figure **22** may include automatically actuating the high-lift device to the high-lift device setting while the command mode is engaged. For example, the method may include automatically actuating a leading edge device **200** and/or a trailing edge device **300** to a corresponding high-lift device setting, when the command mode is engaged. In some embodiments, the system **500** may include a first edge control device (e.g., a flap lever **506** – Figure **18**) and a second edge control device (e.g., a switch **512** – Figure **18**). The method may also include using the second edge control device to command the high-lift device to a second high-lift device setting different from the computed high-lift device setting while the first edge control device (e.g., flap lever **506**) remains in the first control device position. The method may include actuating the high-lift device to the second high-lift device setting. In this regard, the second edge control device may allow the flight crew to fine tune or adjust the computed high-lift device setting to a different high-lift device setting.

In some examples where the first control device position is a cruise position **520**, and the high-lift device includes a leading edge device **200**, a trailing edge device **300**, or both, the method may include automatically actuating the leading edge device **200**, the trailing edge device **300**, or both in an upward direction and a downward direction relative to

a retracted position **208, 308** when the command mode (e.g., a first command mode) is engaged. In this regard, the method may include automatically actuating one or more of the leading edge devices **200** and/or one or more of the trailing edge devices **300** in a variable camber mode when the edge control device **504** is in the cruise position **520**. For example, in
 5 the variable camber mode, the slats **202** and/or the flaps **302** may be actuated to their respective optimum slat setting **220** and optimum flap setting **320** in an upward direction **210, 310** and a downward direction **212, 312** relative to a retracted position **208, 308** and within the limits of the above-described slat deflection angle **216** and flap deflection angle **316** as shown in Figure 5. The edge control system **500** may periodically (e.g., every five minutes,
 10 etc.) reposition the slats **202** and flaps **302** to surface deflection angles that may be optimized with regard to aircraft gross weight, aircraft center of gravity, altitude, Mach number, and /or other aircraft state data **542**, as shown in Figure 8.

The method may include varying the wing **116** camber in response to actuating the leading edge devices **200** and the trailing edge devices **300** to their optimum deflection
 15 angles in the upward direction **210, 310** and the downward direction **212, 312** to minimize aerodynamic drag. In some example, the inboard devices **140** and outboard devices **142** may be differentially deployed as shown in Figures 6-7 to vary the wing **116** camber along a spanwise direction of the wings **116**. The leading edge devices **200** and the trailing edge devices **300** may be automatically actuated according to weight-CG-altitude-airspeed
 20 scheduled surface deflection angles to vary the wing camber along a chordwise direction and/or along a spanwise direction to minimize aerodynamic drag and/or to optimize spanwise load distribution to minimize wing bending at the wing root **130** which may allow for a reduction in the sizing of the wing structure.

Step **610** of the method **600** of Figure 22 may include displaying, in the flight
 25 deck **138** of the aircraft **100**, the high-lift device setting, a deflection angle corresponding to the high-lift device setting, or combinations thereof. In some examples, the aircraft **100** may include an indicator **516** (e.g., see Figure 20) configured to indicate the computed high-lift device setting, a desired setting, a deflection angle of the high-lift device corresponding to either the computed high-lift device setting or the desired setting, or combinations thereof.
 30 The indicator **516** may display information about the high-lift device to the flight crew when the high-lift device is automatically commanded by the system **300**. For example, the indicator **516** may display the actual flap deflection angle or a percentage of maximum flap deflection as shown in Figures 21A-21B.

Step **612** of the method **600** of Figure **22** may include positioning the edge control device **504** in a second control device position. For example, the method may include moving the edge control device **504** from a cruise position **520** (e.g., a first control device position) to a hold position **522** (e.g., a second control device position). The first control device position may correspond to a first command mode as described above. Step **614** of the method **600** of Figure **22** may include engaging a second command mode in response to positioning the edge control device in the second control device position. The first command mode and the second command mode may each be associated with a different flight phase of the aircraft.

Step **616** of the method **600** of Figure **22** may include actuating only a leading edge device **200** or a trailing edge device **300** in an automated manner if the second command mode is engaged. For example, where the second control device position is a hold position **522**, the method may include commanding the leading edge device **200** from a retracted position **208** to a sealed position **222** in response to moving the edge control device **504** to the hold position **522**. The trailing edge device **300** may be maintained in a retracted position **308** when the second command mode is engaged. For example, during initial descent from a cruising altitude as shown in Figure **23**, the flight crew may be instructed by air traffic control to maintain a specified altitude in a holding pattern above a destination airport prior to landing. In response to the instructions, the flight crew may move the edge control device **504** from the cruise position **520** to the hold position **522**. In response to moving the edge control device **504** to the hold position **522**, the leading edge devices **200** may be automatically commanded to a sealed position **222**, and the trailing edge devices **300** may be maintained in a retracted position **308**. For example, the inboard and outboard slats **204**, **206** may be moved from their respective optimum slat settings **220** (e.g. from the variable camber mode) to the sealed position **222** which may allow the aircraft **100** to maintain altitude at a reduced thrust setting resulting in reduced fuel consumption while the aircraft **100** is in the holding pattern.

Step **618** of the method **600** of Figure **22** may include positioning the edge control device in a third control device position to engage a third command mode. In some examples, the edge control device **504** (e.g., a flap lever **506**) may be moved to a climb/approach position **524** (CLB/APP). For example, during the descent of the aircraft **100** (Figure **23**), the flight crew may move the edge control device **504** from the hold position **522** (HOLD) to the climb/approach position **524** (CLB/APP). Alternatively, the flight crew may move the edge control device **504** from the cruise position **520** (UP) directly to the

climb/approach position **524** (CLB/APP) and may skip the hold position **522** (HOLD) to minimize the number of crew-commanded flap lever movements during an approach.

Step **620** of the method may include actuating a trailing edge device according to an extension sequence or a retraction sequence in response to engaging the third command mode. For example, the method may include extending the trailing edge device **300** according to an extension sequence when the third command mode corresponds to an approach phase or a landing phase of the aircraft **100**. The method may include retracting the trailing edge device **300** according to a retraction sequence when the third command mode corresponds to a climb phase. The leading edge devices **200** may be maintained in the sealed position **222** when the edge control device **504** is moved to the climb/approach position **524** which may reduce the amount of community noise (i.e., noise perceived on the ground) generated by the aircraft relative to the amount of noise generated when the leading edge devices **200** are in the gapped position **224**. The trailing edge devices **300** may be actuated according to an extension sequence or a retraction sequence when the edge control device **504** is moved to the climb/approach position **524** (CLB/APP). For example, when the aircraft **100** is descending during an approach phase (Figure **23**), the method may include automatically extending the trailing edge devices **300** according to an extension sequence (see Figure **13**). When the aircraft **100** is climbing such as after takeoff or during a go-around operation, the method may include automatically retracting the trailing edge device **300** according to a retraction sequence when the edge control device **504** is in the climb/approach position **524**.

In some embodiments, the method may include moving the edge control device **504** to a takeoff/go-around position **526** (TOGA). For example, during descent of the aircraft **100**, the flight crew may move the edge control device **504** from the climb/approach position **524** (CLB/APP) to the takeoff/go-around position **526** (TOGA). The method may include computing an optimum flap setting **320** using the flight control computer **540** based on the above-mentioned aircraft state data **542** which may be continuously provided to the flight control computer **540**. The trailing edge device **300** may be positioned at the optimum flap setting **320** in response to moving the edge control device **504** to the takeoff/go-around position **526**. In a further embodiment, the method may include changing the optimum flap setting **320** by selecting a desired flap setting **322** using the second edge control device (e.g., a switch **512** – Figure **18**) as described above. For example, an optimum flap setting **320** of twenty (**20**) degrees may be changed to a desired flap setting **322** of eighteen (**18**) degrees by rotating the variable-trailing-edge-position switch **512** until the desired flap setting **322**

appears in the display window **514** (Figure **14**). The desired flap setting **322** may be selected before or after moving the edge control device **504** to the takeoff/go-around position **526**. Movement of the trailing edge device **300** to the desired flap setting may require that the edge control device **504** is in the takeoff/go-around position **526**.

5 In some embodiments, the method may include moving the edge control device **504** to the landing position **528** (LAND). For example, during final approach of the aircraft **100**, the flight crew may move the edge control device **504** from the takeoff/go-around position **526** (TOGA) to the landing position **528** (LAND). Alternatively, the flight crew may move the edge control device **504** from the climb/approach position **524** (CLB/APP)
10 directly to the landing position **528** and may skip the takeoff/go-around position **526** to minimize the number of crew-commanded flap lever movements. In some embodiment when the edge control device **504** is moved to the landing position **528** (e.g., Figure **13**), the method may include gradually extending the trailing edge devices **300** to the final landing flaps setting according to an extension schedule. The flight control computer **540** may
15 continuously receive aircraft state data **542** such as forward airspeed, vertical speed, changes in engine thrust, spoiler (i.e., speedbrake) deployment, and other aircraft state data **542**. The flight control computer **540** may compute an optimum flap setting **320** at each step in the flap **302** extension sequence as a function of the aircraft state data **542** such as airspeed, aircraft gross weight, aircraft center of gravity, outside air temperature, and other data. The flight
20 control computer **540** may compute optimum flap settings **320** to minimize aerodynamic noise from the flaps **302** and/or minimize engine noise due to reduced thrust settings as a result of reduced aerodynamic drag generated by the flaps **302** at the optimum flap settings **320**.

 Step **622** of the method **600** of Figure **22** may include moving the edge control
25 device **504** to a control device position different from the first control device position. In some examples, the edge control device (e.g., flap lever **506**) may be moved to the landing position **528** (LAND). Step **624** of the method **600** of Figure **22** may include automatically extending a leading edge device **300** from a first position to a second position which is more deployed than the first position in response to detection of one or more conditions. For
30 example, the leading edge device may be automatically extended if a radio altitude of the aircraft **100** is less than a threshold radio altitude and/or if an actual angle of attack **546** of a wing **116** of the aircraft is greater than a threshold angle of attack. In an embodiment, the leading edge devices **200** may be extended from the sealed position **222** to the gapped position **224** upon detection of at least one of two above-mentioned autogap conditions. The

flight control computer **540** may initially inhibit movement of the leading edge devices **200** to the gapped position **224** when the edge control device **504** is initially moved to the landing position **528** (LAND) as a means to minimize community noise when the aircraft **100** is at a low altitude during final approach.

5 The method may include detecting the autogap condition and generating a gap command using the flight control computer **540** when the actual angle of attack **546** of the wings **116** exceeds a threshold angle of attack causing the leading edge devices **200** to automatically move from the sealed position **222** to the gapped position **224**. In the gapped position **224**, air may flow through the gap **226** between the wing **116** and the leading edge
10 device **200** allowing the airflow to remain attached to the wing upper surface **128** at high angles of attack which may delay stalling. Below a threshold radio altitude, the flight control computer **540** may also detect an autogap condition and generate a gap command causing the leading edge devices **200** to automatically extend to the gapped position **224** to provide a stable landing configuration for the aircraft **100**.

15 The method may additionally include moving the edge control device **504** from the landing position **528** (LAND) to the takeoff/go-around position **526** (TOGA) as shown in Figure **23**. The edge control device **504** may be moved to the takeoff/go-around position **526** as part of the procedure for initiating a go-around operation in the event that a landing is aborted. Prior to moving the edge control device **504** from the landing position **528** to the
20 takeoff/go-around position **526**, the flight control computer **540** may compute an optimum flap setting **320** for the go-around operation based on aircraft state data **542** as indicated above. The method may also include moving the trailing edge devices **300** to an optimum flap setting **320** for the go-around operation in response to moving the edge control device **504** to the takeoff/go-around position **526**. For example, prior to touchdown of the aircraft
25 **100**, the trailing edge flaps **302** may be retracted from the final landing flap setting to the optimum flap setting **320** to reduce aerodynamic drag. The reduction in aerodynamic drag may improve the climb rate of the aircraft **100** during the go-around operation. The flight crew may also adjust the optimum flap setting **320** to a desired flap setting **322** using the variable-trailing-edge-position switch **512** as the go-around operation progresses.
30 Alternatively, the flight control computer **540** may be configured to automatically adjust the flaps **302** to the optimum flap setting **320** computed by the flight control computer **540**.

Additional modifications and improvements of the present disclosure may be apparent to those of ordinary skill in the art. Thus, the particular combination of parts described and illustrated herein is intended to represent only certain embodiments of the present disclosure

and is not intended to serve as limitations of alternative embodiments or devices within the scope of the disclosure.

According to an aspect of the present disclosure there is provided a system for controlling a high-lift device of an aircraft, comprising an interface for placement in a flight
5 deck of an aircraft and including an edge control device for controlling a position of a high-lift device of the aircraft and operable to select any of a plurality of control device positions, each one of the plurality of control device positions corresponding to a different flight phase of the aircraft; and the edge control device operable to engage, in response to a selection of a first control device position, a command mode for actuating the high-lift device in an automated
10 manner based on the flight phase associated with the first control device position.

The system disclosed wherein the edge control device is positionable in at least one of the following control device positions: a cruise position, a hold position, a climb/approach position, a takeoff/go-around position, a landing position, the first control device position being the cruise position.

15 The system disclosed further comprising a flight control computer communicatively coupled to the interface and configured to compute a high-lift device setting for the high-lift device; and an actuation system configured to automatically actuate the high-lift device to the high-lift device setting if the command mode is engaged.

The system disclosed further comprising a device actuation system operatively
20 coupled to the high-lift device and configured to actuate the high-lift device in an upward direction and a downward direction relative to a retracted position.

The system disclosed wherein the edge control device is operable to engage, in response to a selection of a second control device position, a second command mode for automatically commanding a leading edge device to a sealed position upon engagement of the
25 second command mode.

The system disclosed further comprising a device actuation system operable to actuate a trailing edge device, and wherein the interface is configured to command the device actuation system to extend and/or retract the trailing edge device according to an extension sequence and/or a retraction sequence, respectively, if the edge control device is moved to the
30 climb/approach position or the landing position.

The system disclosed wherein the edge control device is a first edge control device, the interface further including a second edge control device operable to select a desired setting for the high-lift device different from the computed high-lift device setting without movement of the first edge control device from the first control device position.

The system disclosed wherein the edge control device is operable to engage, in response to a selection of a third control device position, a third command mode for automatically extending a leading edge device to a gapped position while the third command mode is engaged and at least one of the following conditions is met: a radio altitude of the aircraft is below a threshold radio altitude, an actual angle of attack exceeds a threshold angle of attack.

The system disclosed wherein the interface further comprises an indicator configured to indicate the computed high-lift device setting, the desired setting, a deflection angle of the high-lift device corresponding to either the computed high-lift device setting or the desired setting, or combinations thereof.

The system disclosed wherein the indicator is a fill-type indicator for displaying the deflection angle of the high-lift device, the setting for the high-lift device, or combinations thereof.

The system disclosed wherein the indicator is one of a plurality of fill-type indicators including at least one indicator for displaying information relating to a leading edge device and at least one indicator for displaying information relating to a trailing edge device.

According to a further aspect of the present disclosure there is provided an aircraft, comprising a wing including at least one of a leading edge device and a trailing edge device; an edge control system including an edge control device positionable in one of a plurality of control device positions, each one of the control device positions corresponding to a flight phase of an aircraft; and the edge control system configured to command a device actuation system to actuate at least one of the leading edge device and the trailing edge device in an automated manner based on the control device position and corresponding flight phase.

According to a further aspect of the present disclosure there is provided a method of operating a high-lift device of an aircraft, the method comprising positioning an edge control device of an aircraft in a first control device position from a plurality of control device positions, each of the plurality of control device positions associated with a flight phase of the aircraft; engaging a command mode in response to the positioning of the edge control device in the first control device position; computing a high-lift device setting; and automatically actuating the high-lift device to the high-lift device setting while the command mode is engaged.

The method disclosed wherein the first control device position is a cruise position, and wherein the high-lift device includes a leading edge device, a trailing edge device, or both, the method further comprising actuating the leading edge device, the trailing edge

device, or both in an upward direction and a downward direction relative to a retracted position.

The method disclosed further comprising displaying, in a flight deck of the aircraft, the high-lift device setting, a deflection angle corresponding to the high-lift device setting, or combinations thereof.

The method disclosed further comprising computing the high-lift device setting based, at least in part, on aircraft state data.

The method disclosed wherein the aircraft state data includes aircraft gross weight, aircraft center of gravity, Mach number, altitude, or combinations thereof.

The method disclosed wherein the command mode is a first command mode, the method further comprising engaging a second command mode in response to positioning the edge control device in a second control device position; and actuating only a leading edge device or a trailing edge device in an automated manner if the second command mode is engaged.

The method disclosed wherein the second control device position is a hold position, the method further comprising commanding the leading edge device to a sealed position in response to moving the edge control device to the hold position.

The method disclosed wherein the command mode is a first command mode, the method further comprising positioning the edge control device in a third control device position to engage a third command mode; and actuating a trailing edge device according to at least one of the following extending the trailing edge device according to an extension sequence when the third command mode corresponds to an approach phase or a landing phase; and retracting the trailing edge device according to a retraction sequence when the third command mode corresponds to a climb phase.

The method disclosed wherein the edge control device is a first edge control device, the method further comprising using a second edge control device, commanding the high-lift device to a second high-lift device setting different from the computed high-lift device setting while the first edge control device remains in the first control device position; and actuating the high-lift device to the second high-lift device setting.

The method disclosed further comprising moving the edge control device to a control device position different from the first control device position; and automatically extending a leading edge device from a first position to a second position which is more deployed than the first position in response to detection of one or more of the following conditions: a radio

altitude of the aircraft being less than a threshold radio altitude; and an angle of attack of a wing of the aircraft being greater than a threshold angle of attack.

EMBODIMENTS IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A system for controlling a high-lift device of an aircraft, wherein a high-lift device comprises a leading edge device or a trailing edge device and wherein the system comprises:
- an interface for placement in a flight deck of an aircraft wherein the interface is configured to receive an input from a flight crew and/or provide feedback to the flight crew and wherein the interface includes:
- a first edge control device for controlling a position of a high-lift device of the aircraft and operable to:
- select any of a plurality of control device positions, each one of the plurality of control device positions associated with a different flight phase of the aircraft; and
- engage, in response to a selection of a first control device position, a command mode for actuating the high-lift device in an automated manner based on the flight phase associated with the first control device position;
- a flight control computer communicatively coupled to the interface and configured to compute a high-lift device setting for the high-lift device;
- an actuation system configured to automatically actuate the high-lift device to the computed high-lift device setting if the command mode is engaged; and
- wherein the interface further includes a second edge control device operable to select a desired setting for the high-lift device different from the computed high-lift device setting without movement of the first edge control device from the first control device position.

2. The system of claim 1, wherein the first edge control device is positionable in a cruise position, and wherein the first control position is the cruise position.
3. The system of claim 2, wherein the first edge control device is further positionable in any of, a hold position, a climb/approach position, a takeoff/go-around position, and a landing position.
4. The system of claim 3, further comprising a device actuation system operable to actuate the trailing edge device, and wherein:
- the interface is configured to command the device actuation system to extend and/or retract the trailing edge device according to an extension sequence and/or a retraction sequence, respectively, if the first edge control device is moved to the climb/approach position or the landing position.
5. The system of any one of claims 1 to 4, wherein:
- the actuation system is operatively coupled to the high-lift device and configured to actuate the high-lift device in an upward direction and a downward direction relative to a retracted position.
6. The system of any one of claims 1 to 5, wherein:
- the first edge control device is operable to engage, in response to a selection of a second control device position, a second command mode for automatically commanding the leading edge device to a sealed position upon engagement of the second command mode.
7. The system of any one of claims 1 to 6, wherein:
- the first edge control device is operable to engage, in response to a selection of a third control device position, a third command mode for automatically extending the leading edge device to a gapped position while the third command mode is engaged and at least one of the following conditions is met:

a radio altitude of the aircraft is below a threshold radio altitude, and an actual angle of attack exceeds a threshold angle of attack.

8. A system of any one of claims 1 to 7, wherein the interface further comprises:

5 an indicator configured to indicate the computed high-lift device setting, the desired setting, a deflection angle of the high-lift device corresponding to either the computed high-lift device setting or the desired setting, or combinations thereof.

9. The system of claim 8, wherein:

10 the indicator is a fill-type indicator for displaying the deflection angle of the high-lift device, the computed high-lift device setting, the desired setting or combinations thereof.

10. The system of claim 8, wherein:

15 the indicator is one of a plurality of fill-type indicators including at least one indicator for displaying information relating to the leading edge device and at least one indicator for displaying information relating to the trailing edge device.

11. A method of operating a high-lift device of an aircraft, wherein the high-lift device comprises a leading edge device or a trailing edge device and wherein the method comprising:

20 positioning a first edge control device of an aircraft in a first control device position of a plurality of control device positions, each of the plurality of control device positions associated with a flight phase of the aircraft;

engaging a command mode in response to the positioning of the first edge control device in the first control device position;

25 computing a high-lift device setting;

automatically actuating the high-lift device to the computed high-lift device setting while the command mode is engaged; and

5 positioning a second edge control device in a desired setting for the high-lift device, wherein the desired setting is different from the computed high-lift device setting and no movement of the first edge control device from the first control device position is required.

12. The method of claim 11, wherein the first control device position is a cruise position, and wherein the high-lift device includes the leading edge device, the trailing edge device, or both, the method further comprising:

10 actuating the leading edge device, the trailing edge device, or both in an upward direction and a downward direction relative to a retracted position.

13. The method of claim 11 or 12, further comprising:

15 displaying, in a flight deck of the aircraft, the computed high-lift device setting, the desired setting, a deflection angle corresponding to either the computed high-lift device setting, the desired setting, or combinations thereof.

14. The method of any one of claims 11 to 13, further comprising:

computing the high-lift device setting based, at least in part, on aircraft state data.

15. A system for controlling a high-lift device of an aircraft, comprising:

20 an interface for placement in a flight deck of the aircraft and including a first edge control device for controlling a position of the high-lift device of the aircraft, wherein the first edge control device is operable to:

select any of a plurality of control device positions, each one of the plurality of control device positions associated with a flight phase of the

aircraft and corresponding to a different standard device setting for the high-lift device; and

engage, in response to a selection of a first control device position of the plurality of control device positions, a command mode for actuating the high-lift device in an automated manner based on the flight phase associated with the first control device position; and

a flight control computer communicatively coupled to the interface and configured to compute an optimum device setting for the high-lift device based on aircraft state data, the computed optimum device setting including a setting that is different than a standard device setting associated with a control device position;

the interface further including a second edge control device for further controlling the position of the high-lift device, wherein the second edge control device is operable to select a desired setting different from the computed optimum device setting for the high-lift device without movement of the first edge control device;

a device actuation system communicatively coupled to the flight control computer and operatively coupled to the high-lift device and configured to:

continuously periodically and automatically adjust the high-lift device to a series of the computed optimum device settings based on the aircraft state data including at least altitude, airspeed, and weight if the command mode is engaged; and

adjust the high-lift device to the desired setting different from the computed optimum device setting if second edge control device is actuated.

16. The system of claim **15**, wherein the device actuation system is further configured to actuate the high-lift device in an upward direction and a downward direction relative to a retracted position.
17. The system of claim **15** or **16**, wherein:
- 5 the first edge control device is positionable in at least one of the following control device positions: a cruise position, a hold position, a climb/approach position, a takeoff/go-around position, a landing position; and
- the first control device position is the cruise position.
18. The system of claim **17**, wherein:
- 10 the device actuation system is further operable to actuate a trailing edge device; and
- the interface is configured to command the device actuation system to extend and/or retract the trailing edge device according to an extension sequence and/or a retraction sequence, respectively, if the first edge control device is
- 15 moved to the climb/approach position or the landing position.
19. The system of any one of claims **15** to **18**, wherein the device actuation system is further operable to actuate a leading edge device.
20. The system of claim **19**, wherein the first edge control device is operable to engage, in response to a selection of a second control device position, a second command mode for automatically commanding the leading edge device to a sealed position upon
- 20 engagement of the second command mode.
21. The system of claim **19** or **20**, wherein the first edge control device is operable to engage, in response to a selection of a third control device position, a third command mode for automatically extending the leading edge device to a gapped position while
- 25 the third command mode is engaged and at least one of the following conditions is

met: a radio altitude of the aircraft is below a threshold radio altitude, and an actual angle of attack exceeds a threshold angle of attack.

22. The system of any one of claims **15** to **17**, wherein the interface further comprises:

5 an indicator configured to indicate the computed optimum device setting, the desired setting, a deflection angle of the high-lift device corresponding to either the computed optimum device setting or the desired setting, or combinations thereof.

23. The system of claim **22**, wherein the indicator is a fill indicator for displaying the deflection angle of the high-lift device, the computed optimum device setting, the
10 desired setting, or combinations thereof.

24. The system of claim **22**, wherein the indicator is one of a plurality of fill indicators including at least one indicator for displaying information relating to a leading edge device and at least one indicator for displaying information relating to a trailing edge device.

15 **25.** The system of any one of claims **15** to **24**, wherein the optimum device setting is computed for, at least, drag reduction and/or wing load alleviation relative to when the high lift device is at a standard device setting.

26. An aircraft, comprising:

20 a wing including at least one of a leading edge device and a trailing edge device;

 an edge control system including:

 a first edge control device positionable in one of a plurality of control device positions, each one of the control device positions corresponding to a flight phase of an aircraft and a different standard device setting for
25 at least one of the leading edge device and the trailing edge device;

5 a flight control computer communicatively coupled to the edge control system and configured to compute an optimum device setting based on aircraft state data for at least one of the leading edge device and trailing edge device, the computed optimum device setting including a setting that is different than a standard device setting associated with a control device position; and

the edge control system further including a second edge control device operable to select a desired setting different from the computed optimum device setting for at least one of the leading edge device and the trailing edge device without movement of the first edge control device,

10 wherein:

the first edge control device is configured to command a device actuation system to adjust at least one of the leading edge device and the trailing edge device in a continuous periodic and automated manner to a series of the optimum device settings based on the aircraft state data including at least altitude, airspeed, and weight;

the second edge control device is configured to command the device actuation system to adjust at least one of the leading edge device and the trailing edge device to the desired setting; and

20 the device actuation system is configured to adjust at least one of the leading edge device and the trailing edge device in deflection angle increments that are smaller than the angle between the standard device settings.

27. The aircraft of claim **26**, wherein the optimum device setting is computed for, at least, drag reduction and/or wing load alleviation relative to when the high lift device is at a standard device setting.

28. A method of operating a high-lift device of an aircraft, the method comprising:

positioning a first edge control device of the aircraft in a first control device position of a plurality of control device positions, each of the plurality of control device positions associated with a flight phase of the aircraft and corresponding to a different standard device setting for the high-lift device;

5 engaging a command mode in response to the positioning of the first edge control device in the first control device position;

 computing an optimum device setting for the high-lift device based on aircraft state data, the computed optimum device setting including a setting that is different than a standard device setting associated with a control device position;
10

 continuously periodically and automatically adjusting the high-lift device to a series of the computed optimum device settings based on the aircraft state data including at least altitude, airspeed, and weight in deflection angle increments that are smaller than the angle between the standard device settings while the command mode is engaged; and
15

 using a second edge control device, commanding the high-lift device to a desired device setting different from the computed optimum device setting while the first edge control device remains in the first control device position.

29. The method of claim **28**, further comprising:

20 displaying, in a flight deck of the aircraft, the computed optimum device setting, the desired device setting, a deflection angle corresponding to either the computed optimum device setting or the desired device setting, or combinations thereof.

30. The method of claim **28** or **29**, wherein computing the optimum device setting
25 comprises computing the optimum device setting for drag reduction and/or wing load alleviation relative to when the high lift device is at a standard device setting.

31. The method of any one of claims 28 to 30, wherein the high-lift device includes a leading edge device, a trailing edge device, or both.
32. The method of claim 31, wherein the first control device position is a cruise position
5 and the method further comprising:

 actuating the leading edge device, the trailing edge device, or both in an upward direction and a downward direction relative to a retracted position.
33. The method of claim 31 or 32, wherein the command mode is a first command mode, the method further comprising:

10 engaging a second command mode in response to positioning the first edge control device in a second control device position; and

 actuating only the leading edge device or the trailing edge device in an automated manner if the second command mode is engaged.
34. The method of claim 33, wherein the second control device position is a hold position,
15 the method further comprising:

 commanding the leading edge device to a sealed position in response to moving the first edge control device to the hold position.
35. The method of claim 31 or 32, wherein the command mode is a first command mode, the method further comprising:

20 positioning the first edge control device in a third control device position to engage a third command mode; and

 actuating the trailing edge device according to at least one of the following:

extending the trailing edge device according to an extension sequence
when the third command mode corresponds to an approach phase or a
landing phase; and

retracting the trailing edge device according to a retraction sequence
when the third command mode corresponds to a climb phase.

36. The method of any one of claims **31** to **35**, further comprising:

moving the first edge control device to a control device position different from
the first control device position; and

automatically extending the leading edge device from a first position to a
second position which is more deployed than the first position in response to
detection of one or more of the following conditions:

a radio altitude of the aircraft being less than a threshold radio altitude;
and

an angle of attack of a wing of the aircraft being greater than a threshold
angle of attack.

37. The method of any one of claims **28** to **36**, the method further comprising:

actuating the high-lift device to the desired device setting after commanding the
high-lift device to the desired device setting.

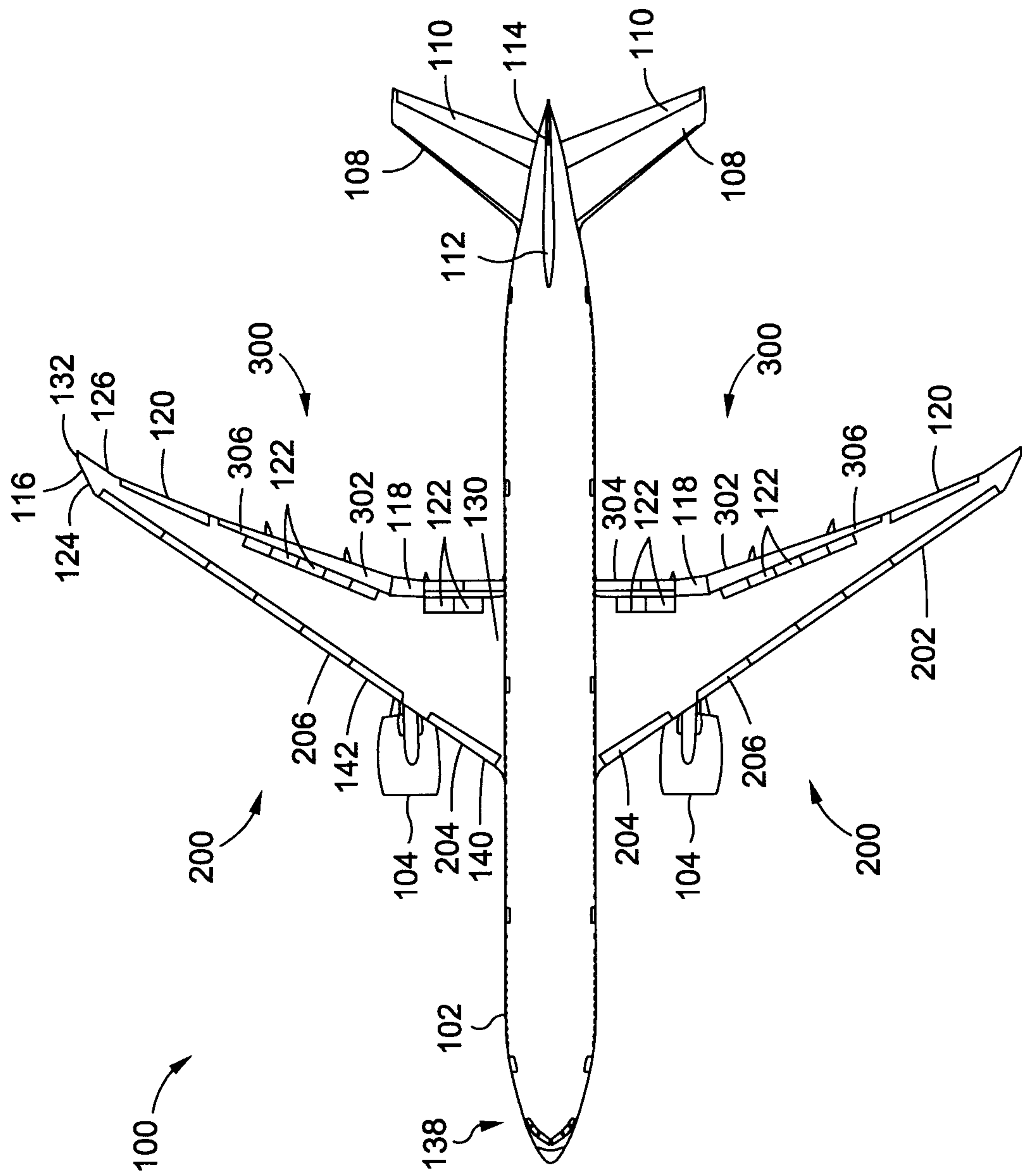


FIG. 1

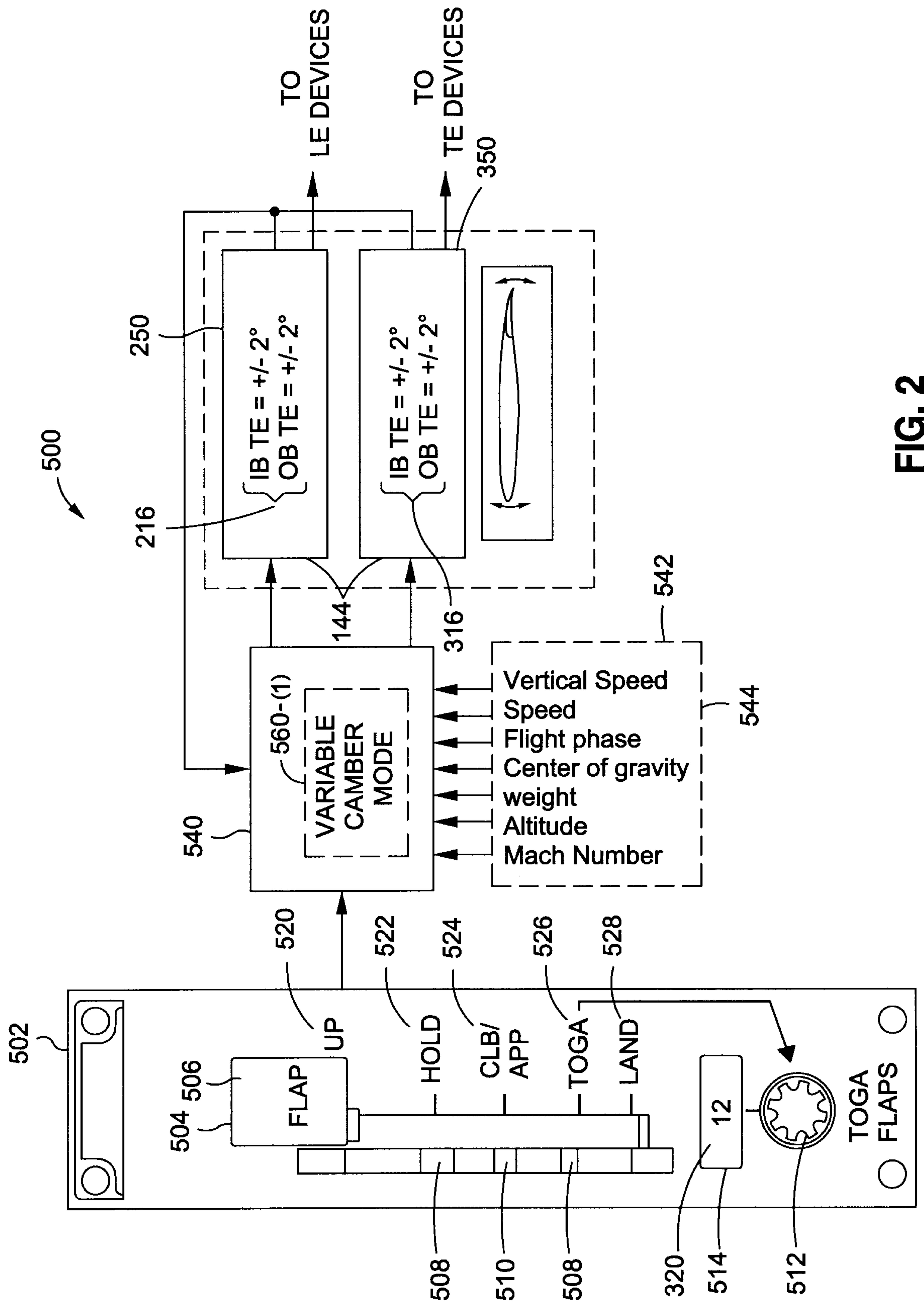
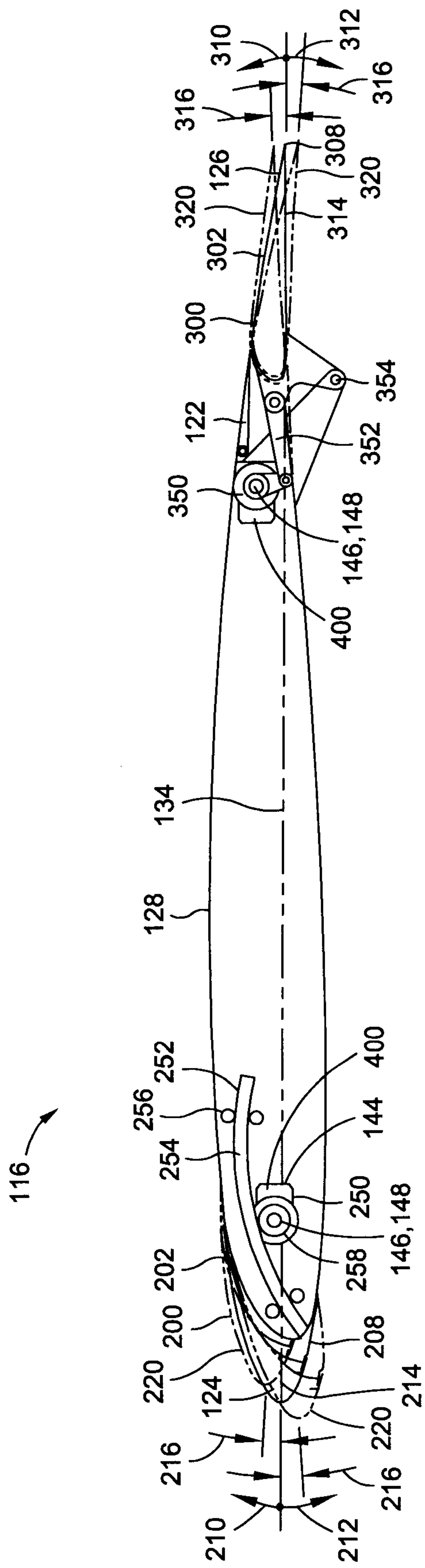


FIG. 2

**FIG. 3**

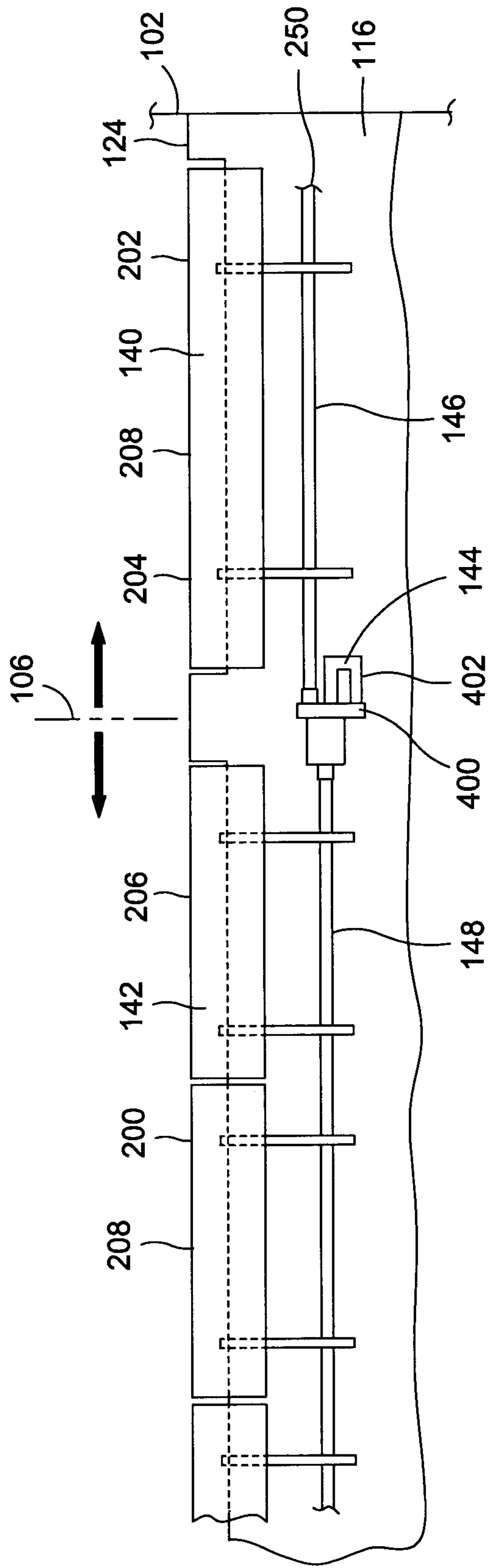
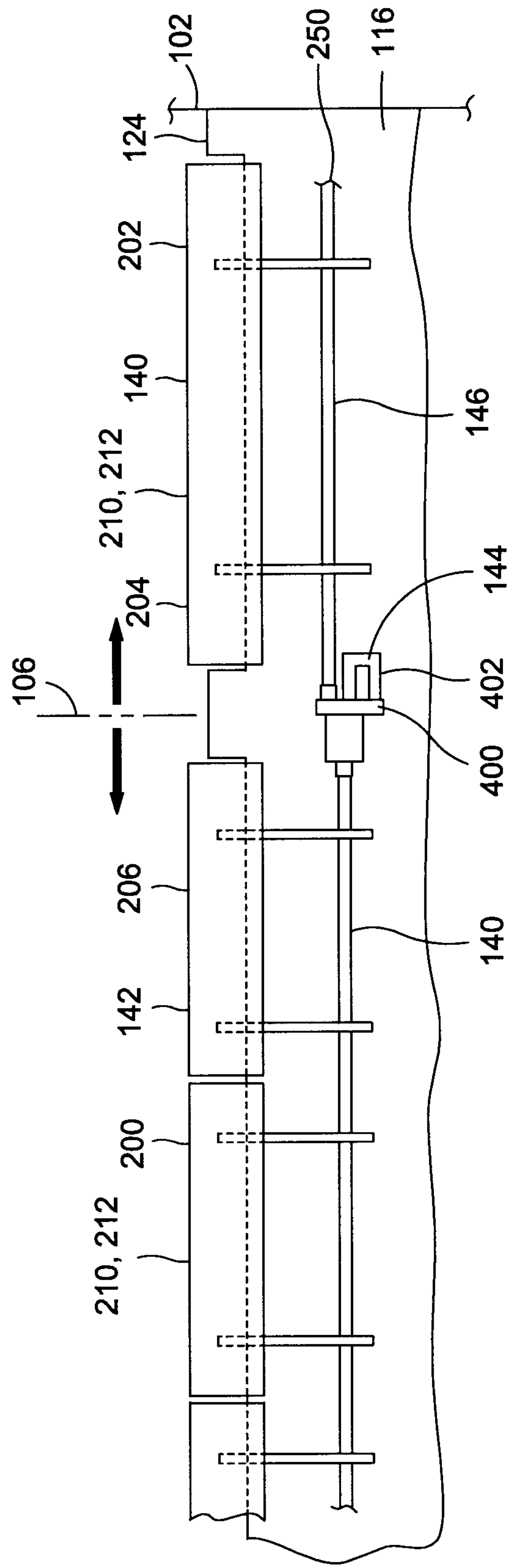
**FIG. 4**

FIG. 5

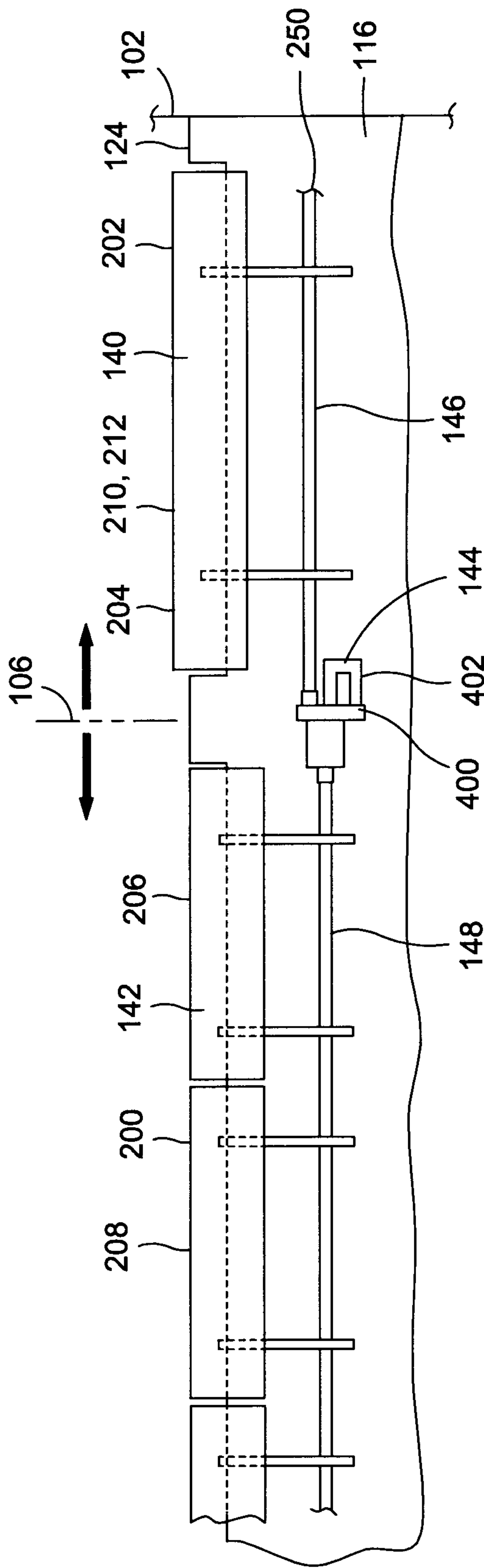


FIG. 6

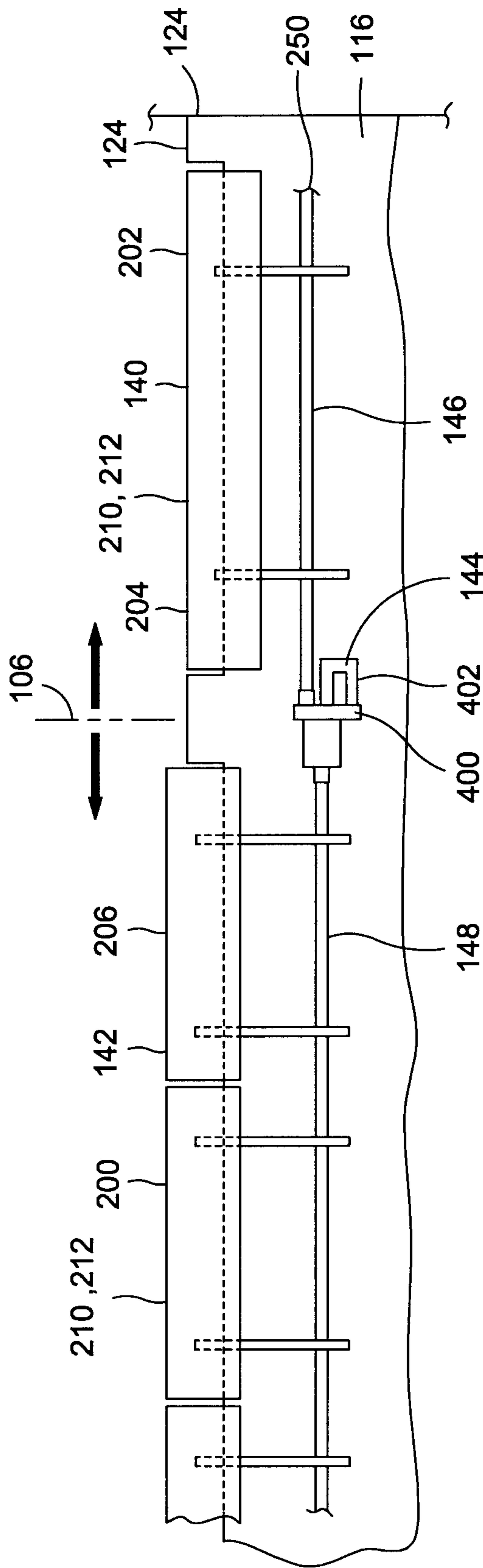


FIG. 7

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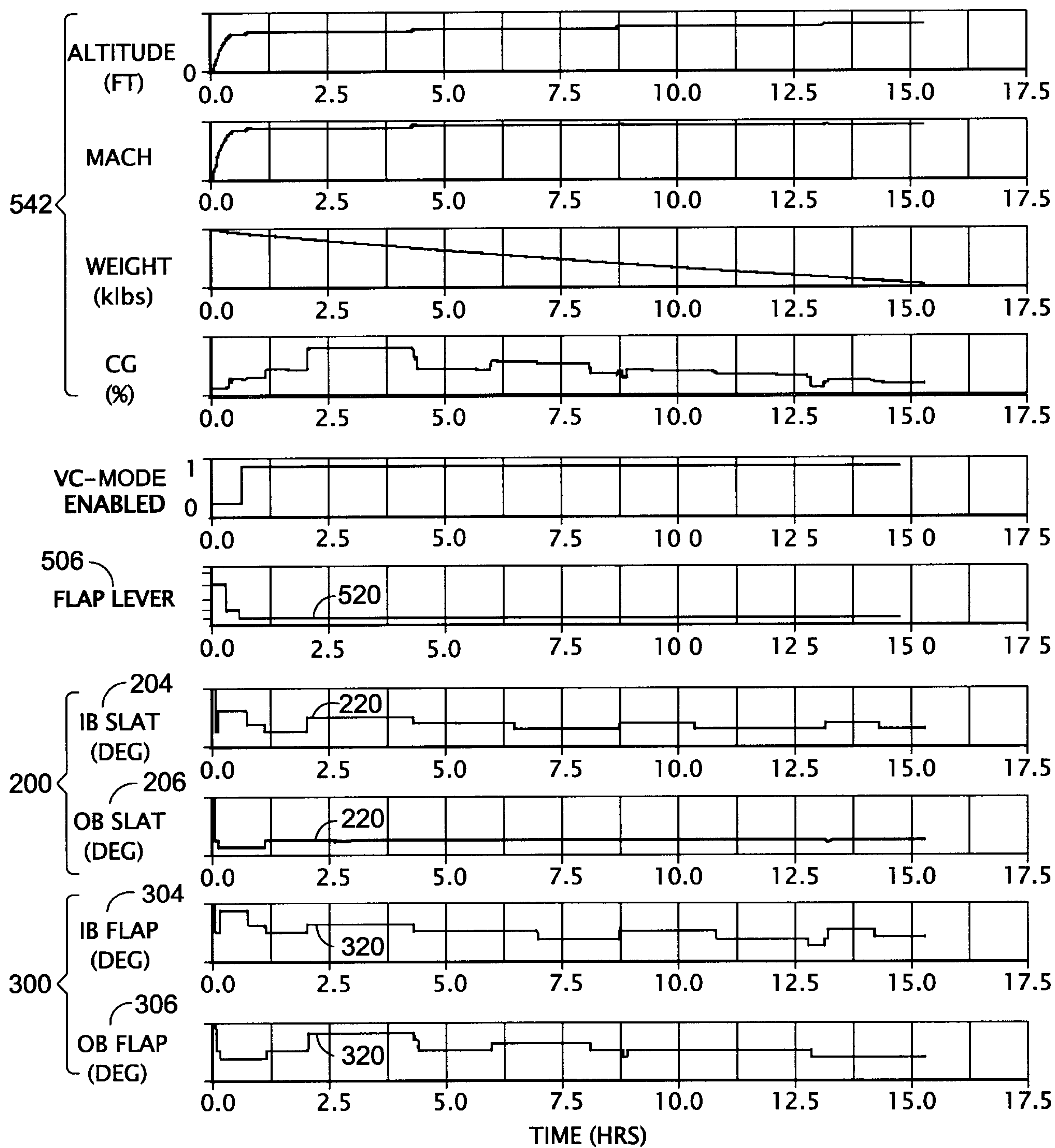


FIG. 8

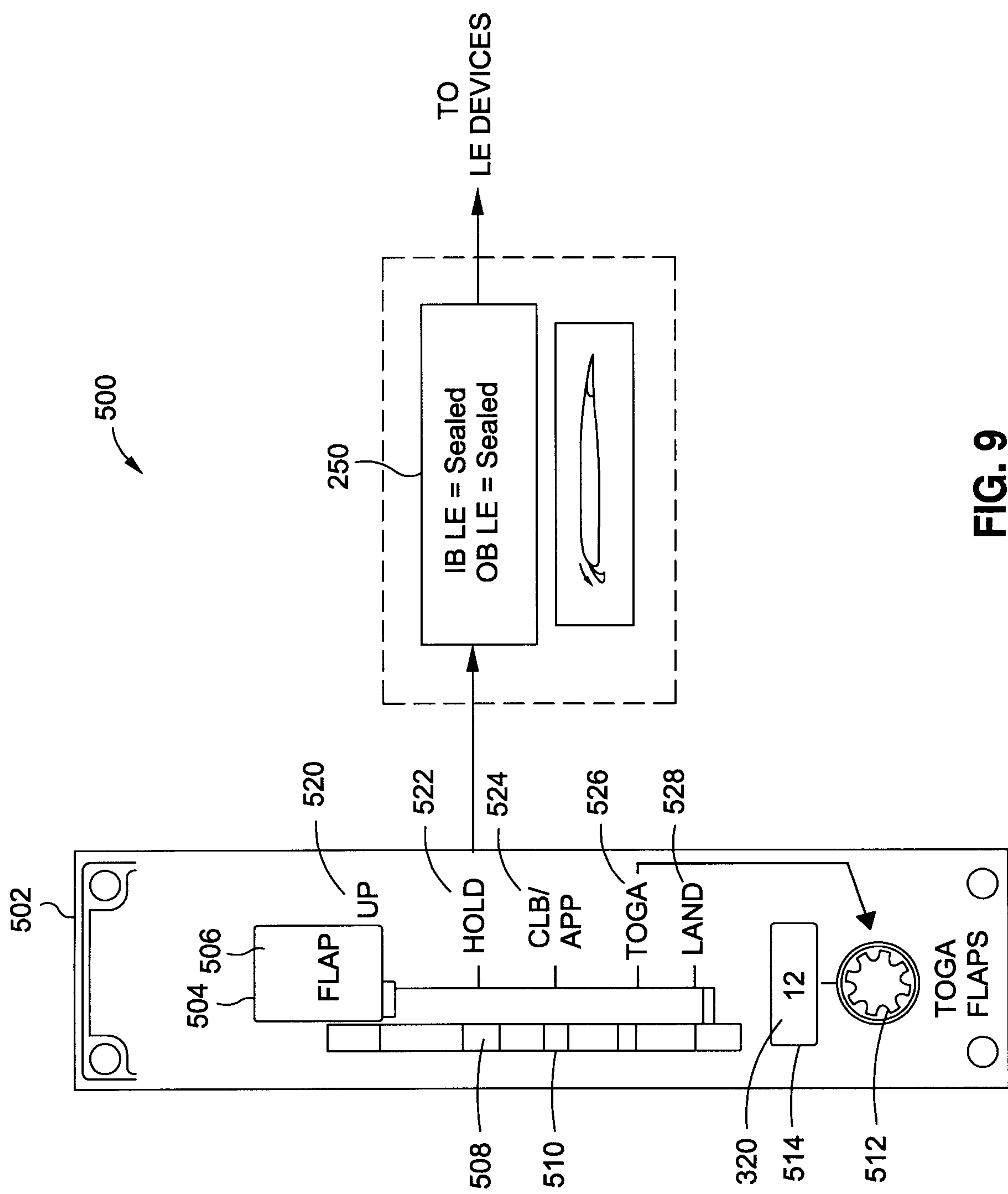


FIG. 9

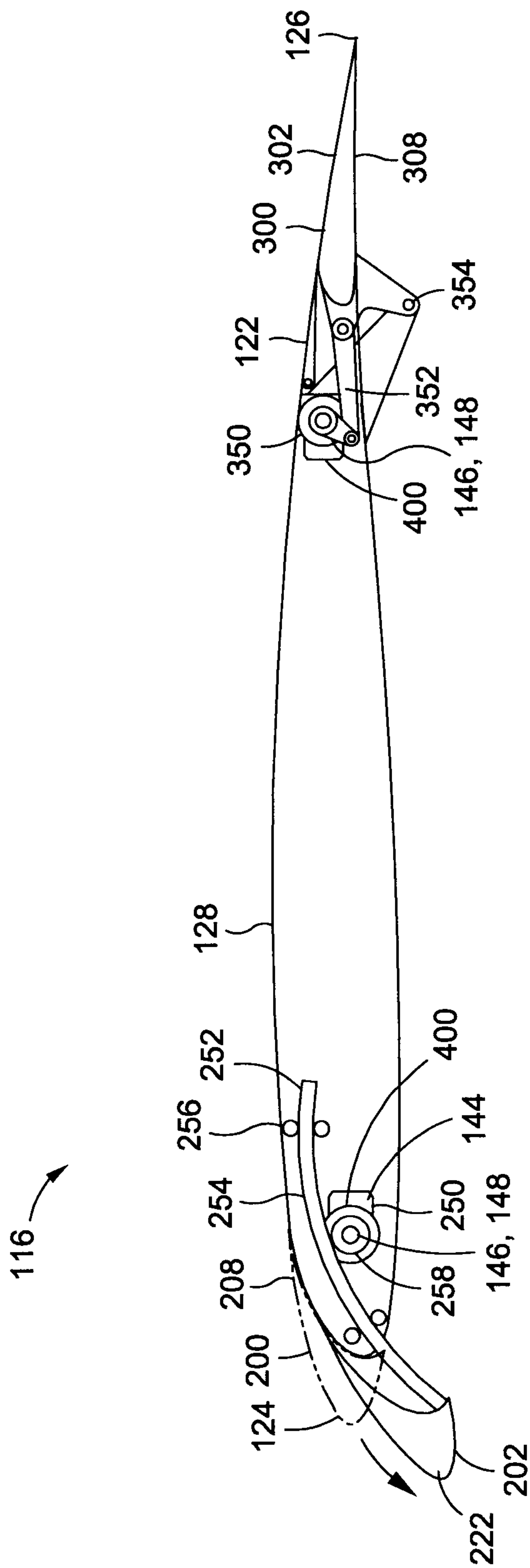


FIG. 10

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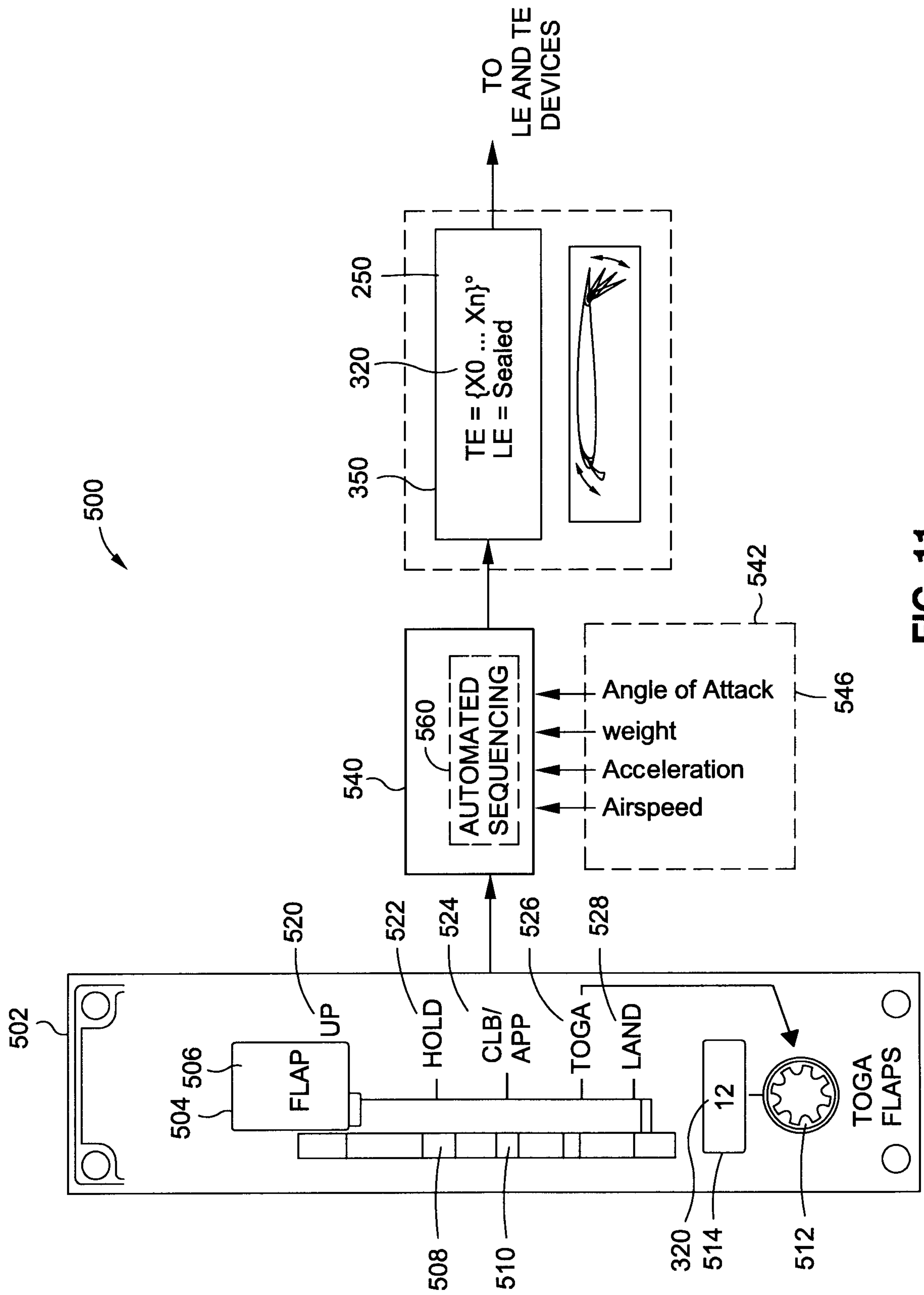


FIG. 11

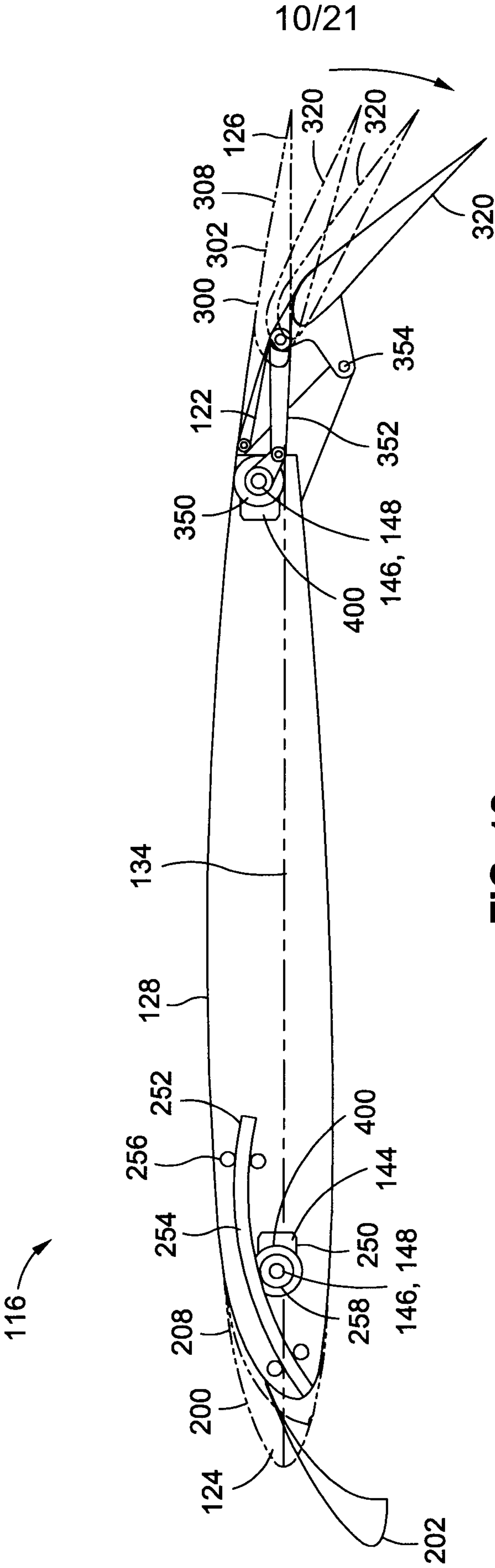


FIG. 12

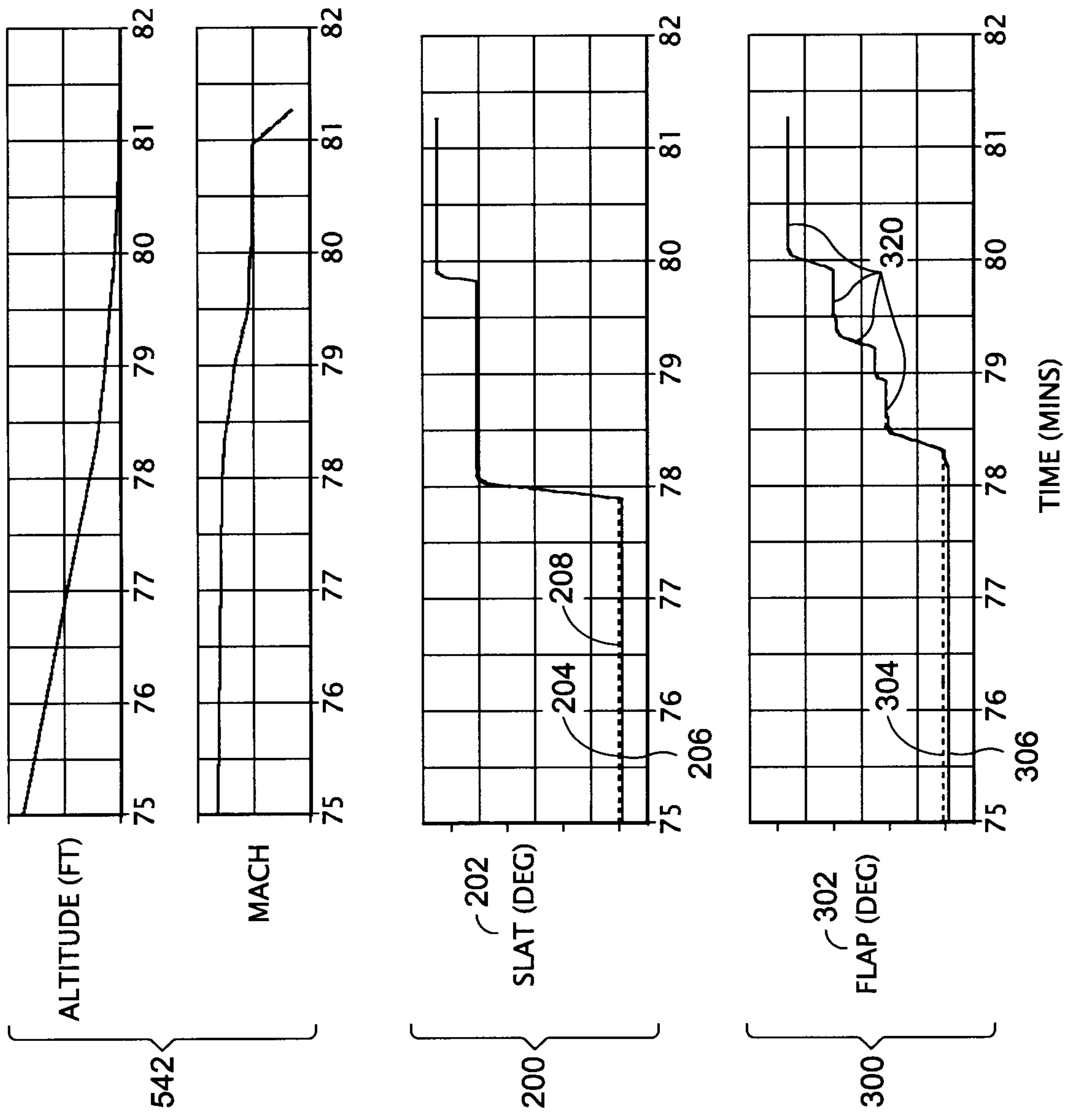


FIG. 13

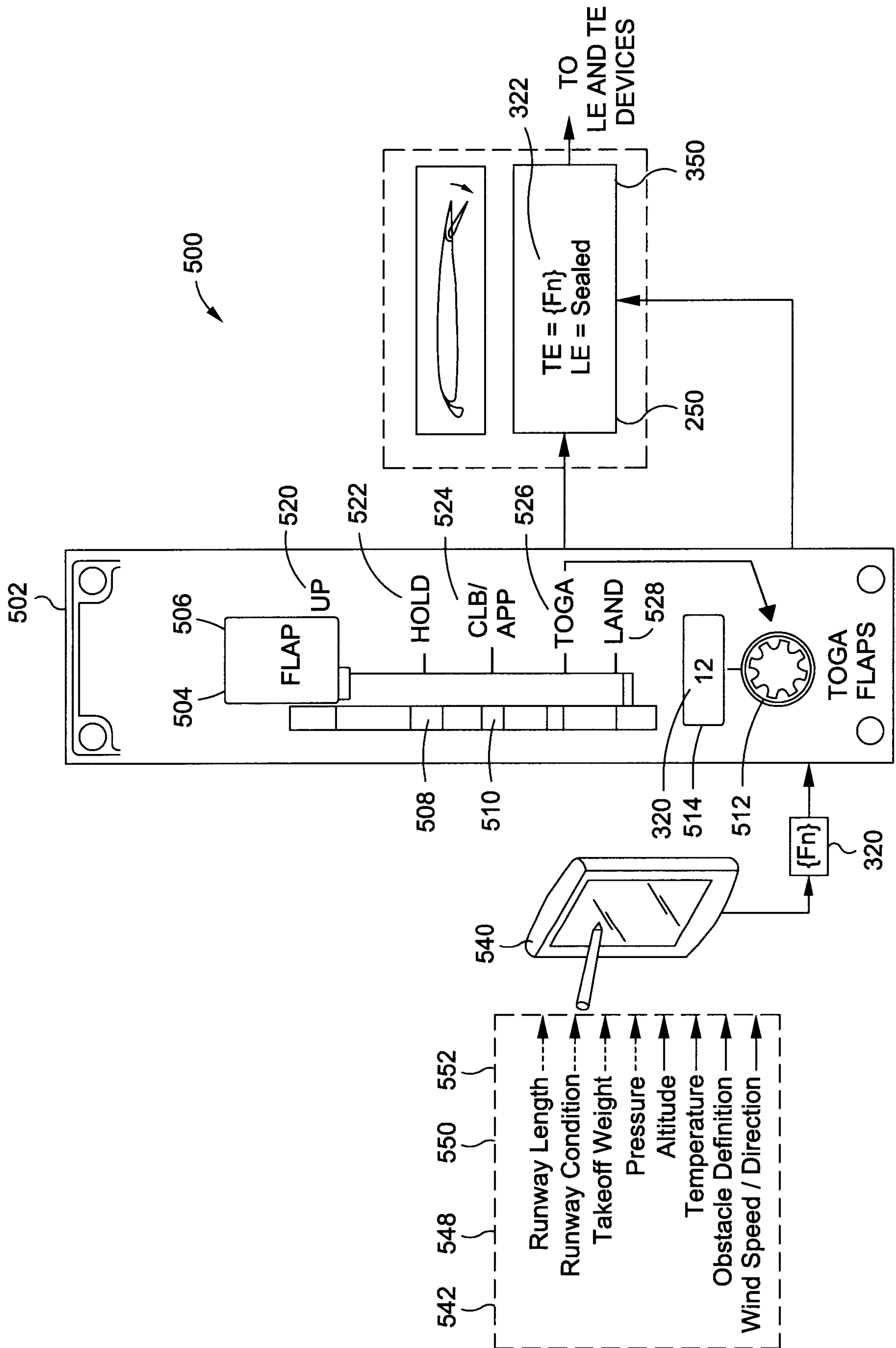


FIG. 14

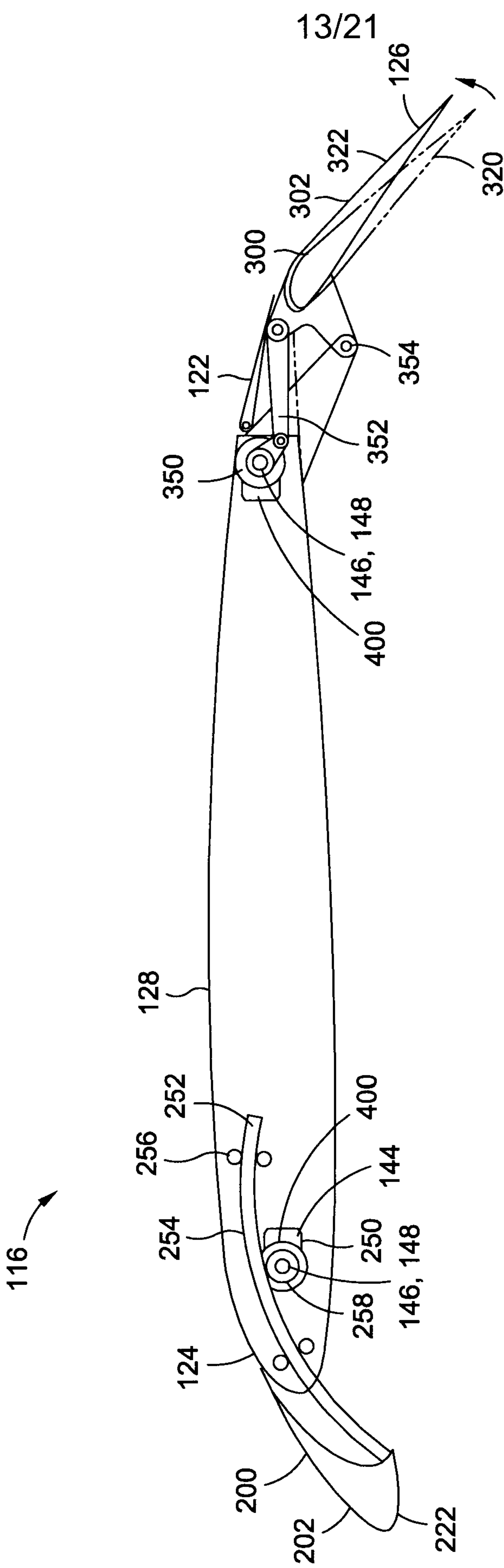
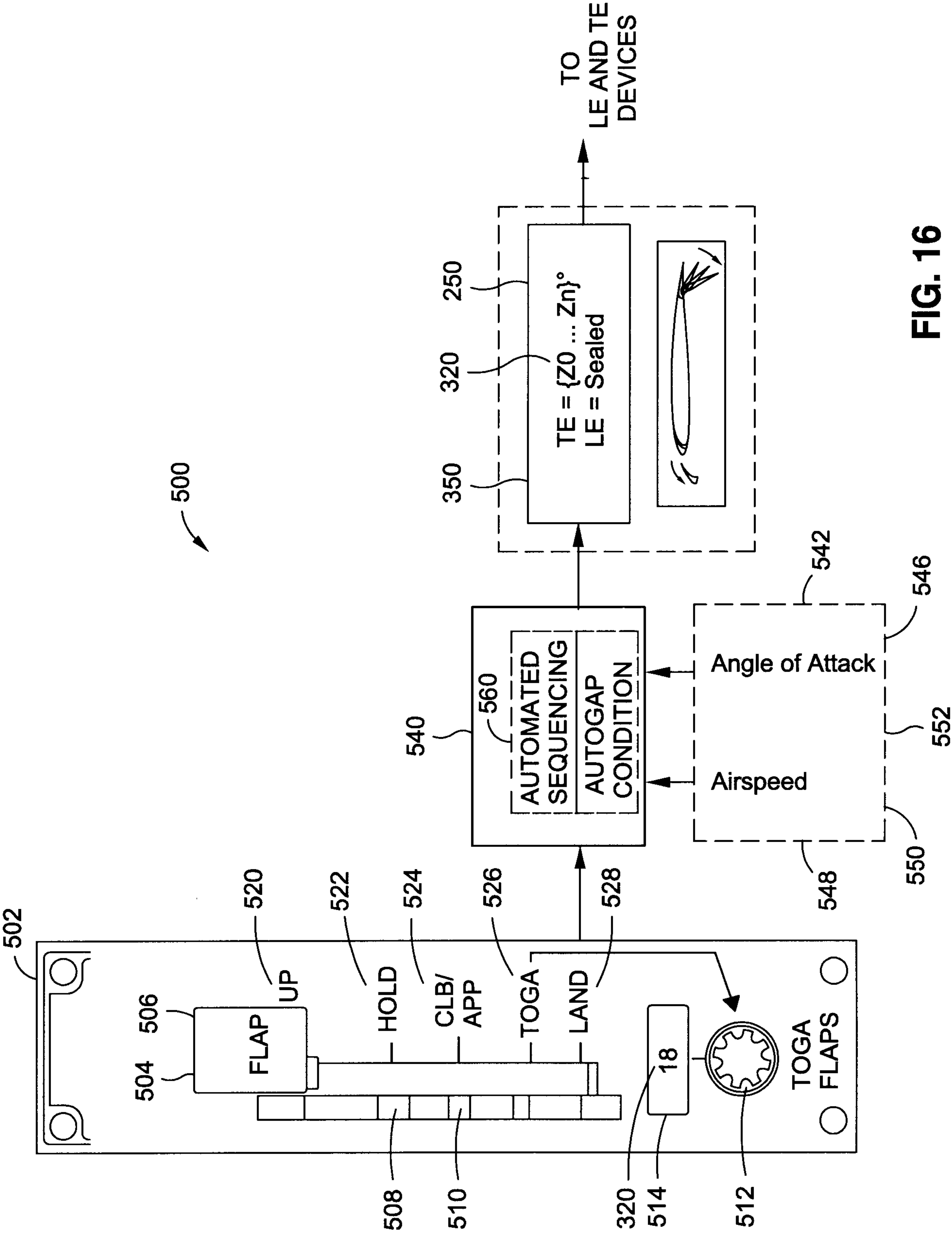


FIG. 15



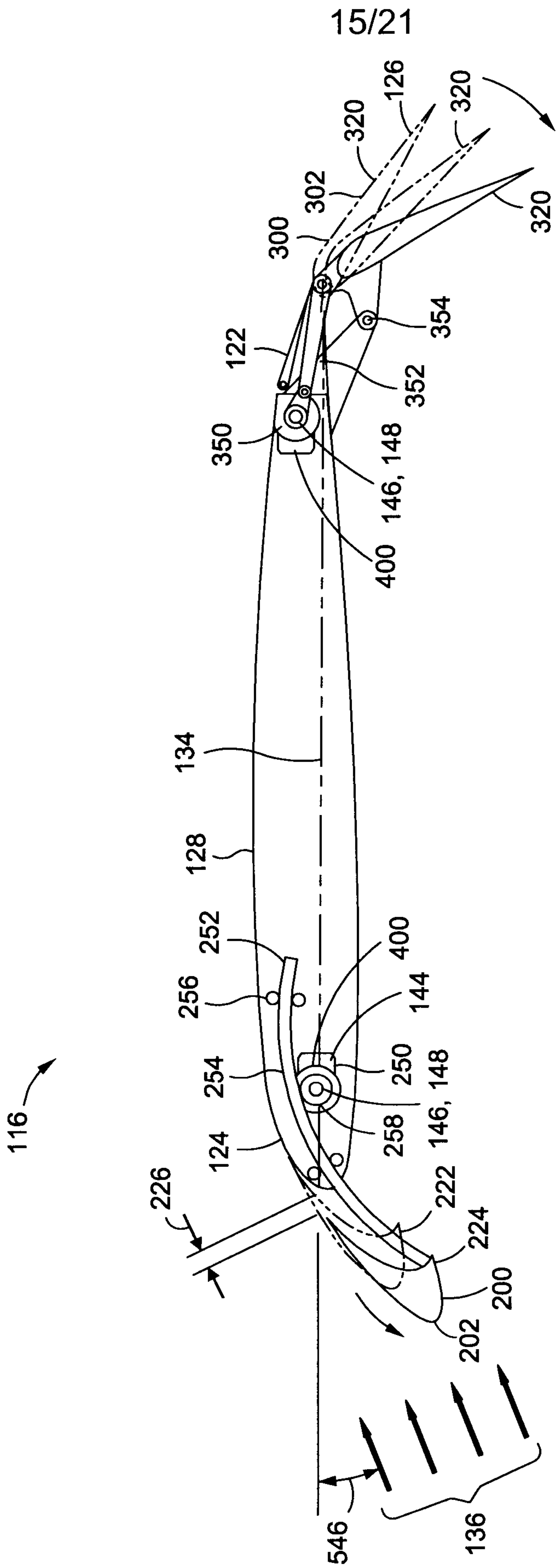
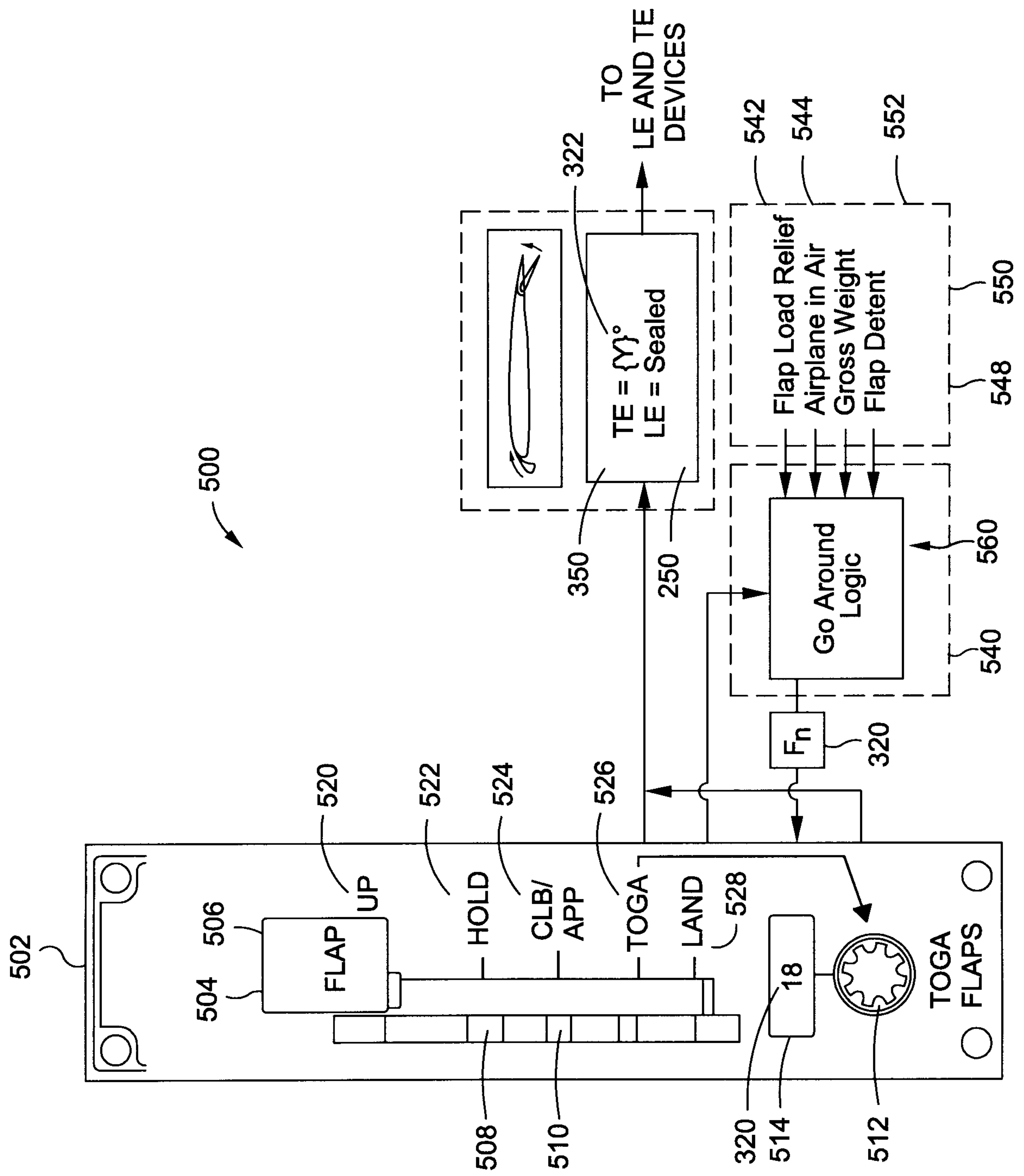


FIG. 17



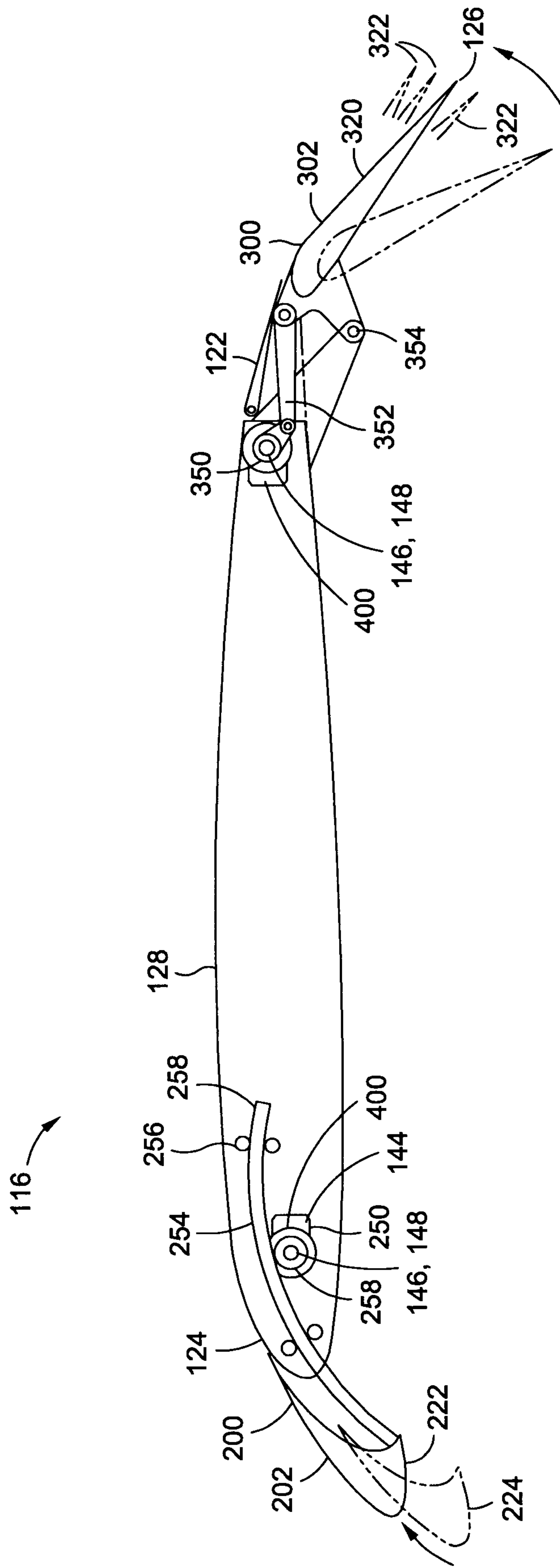


FIG. 19

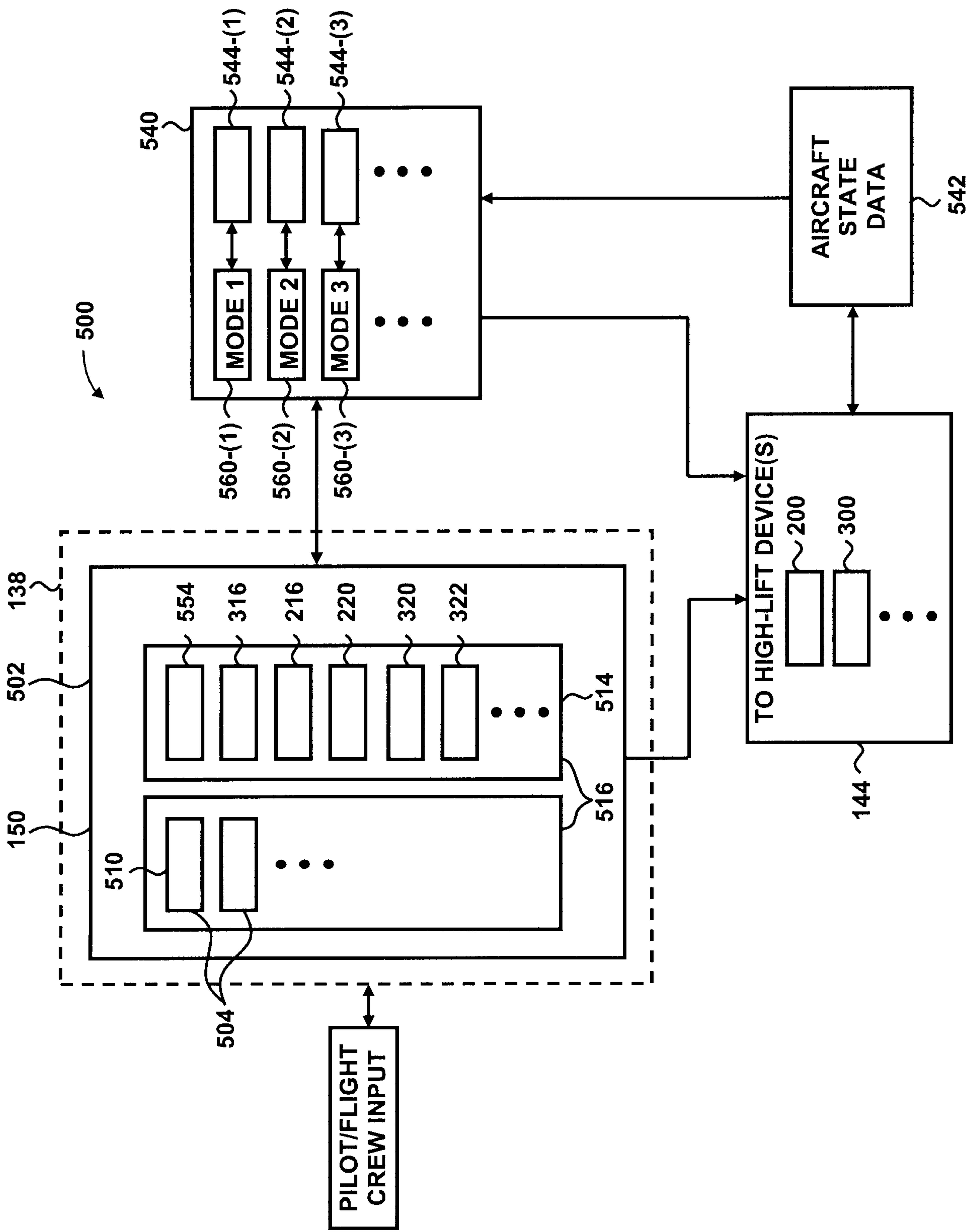


FIG. 20

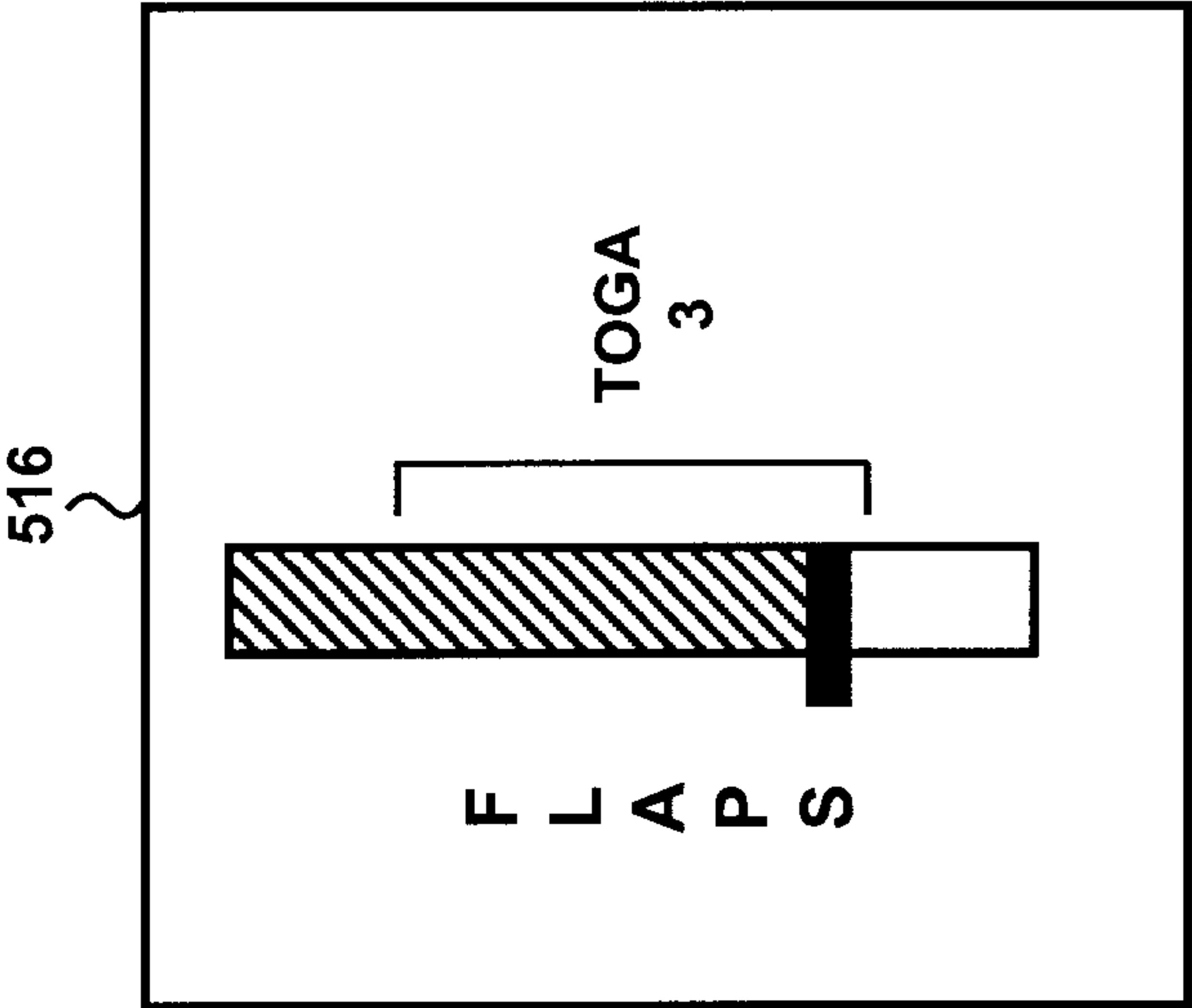


FIG. 21A

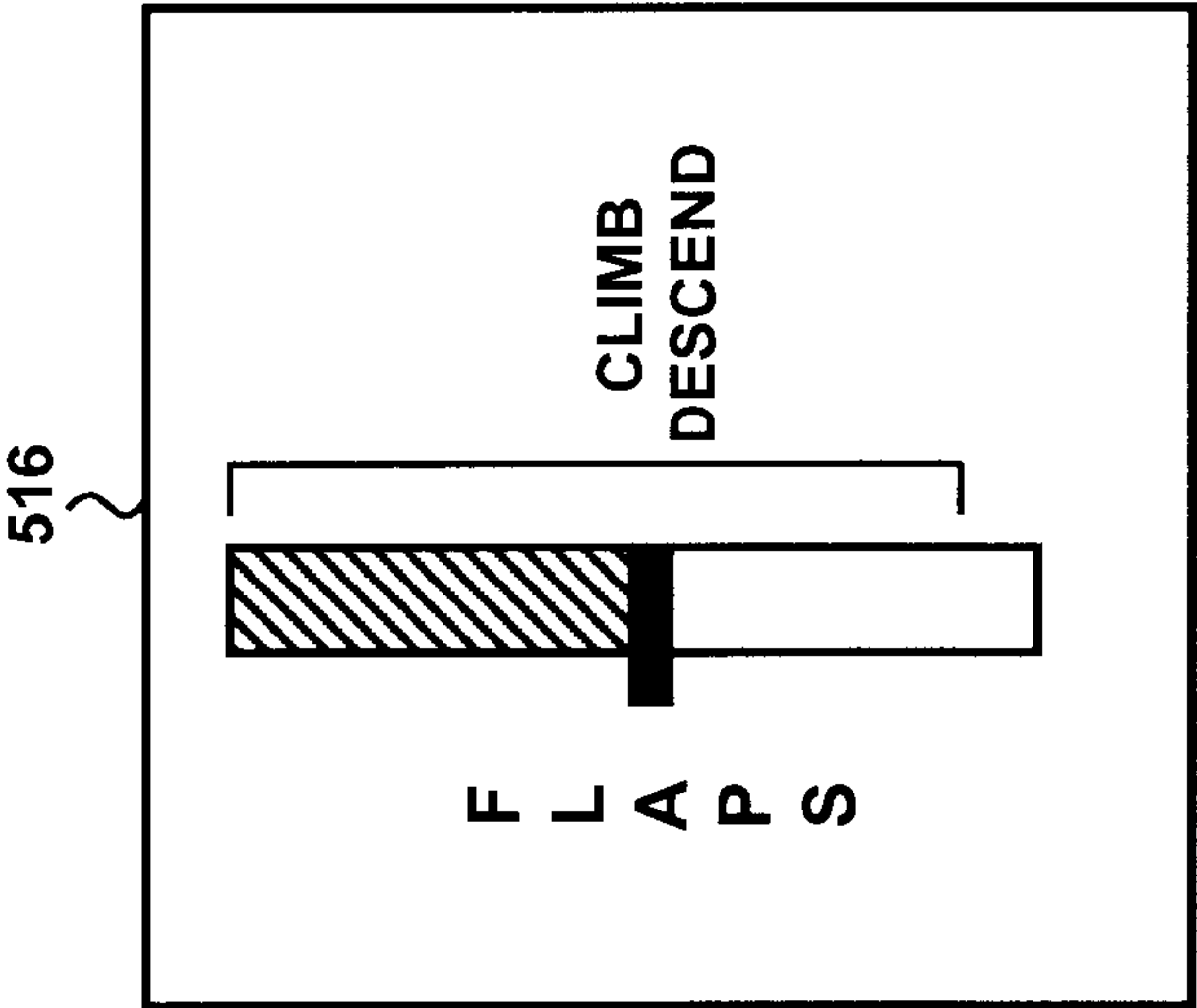


FIG. 21B

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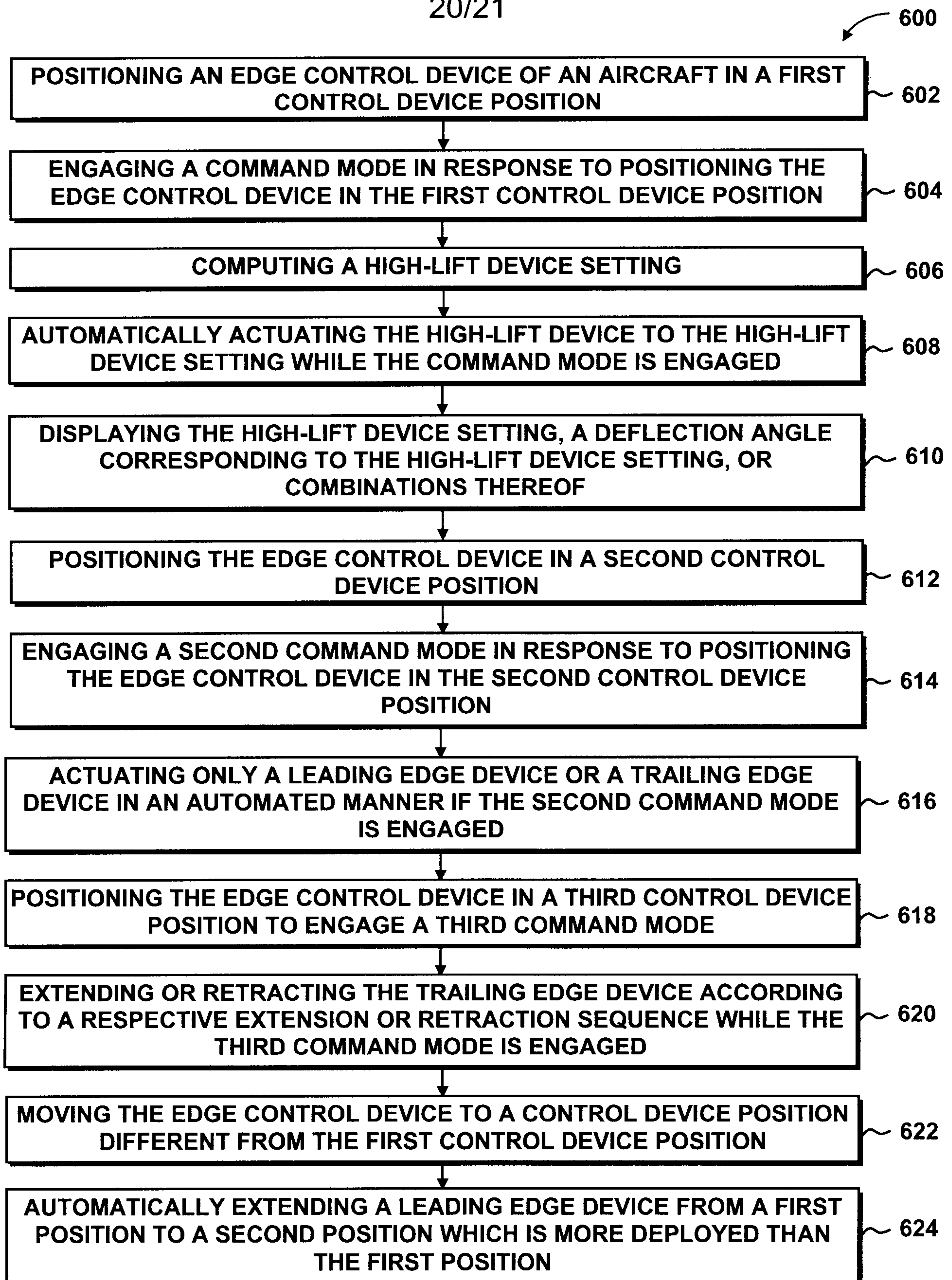


FIG. 22

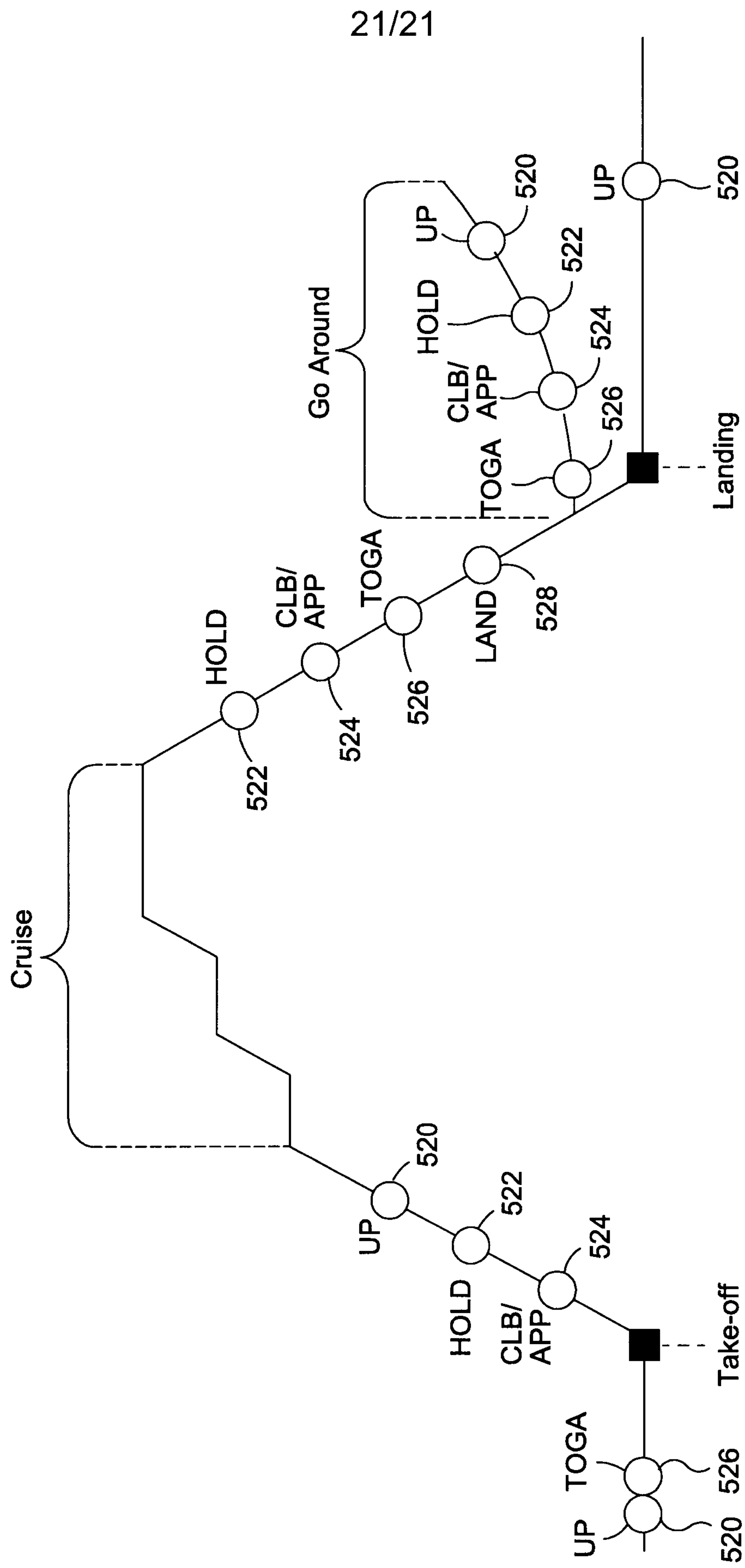


FIG. 23

