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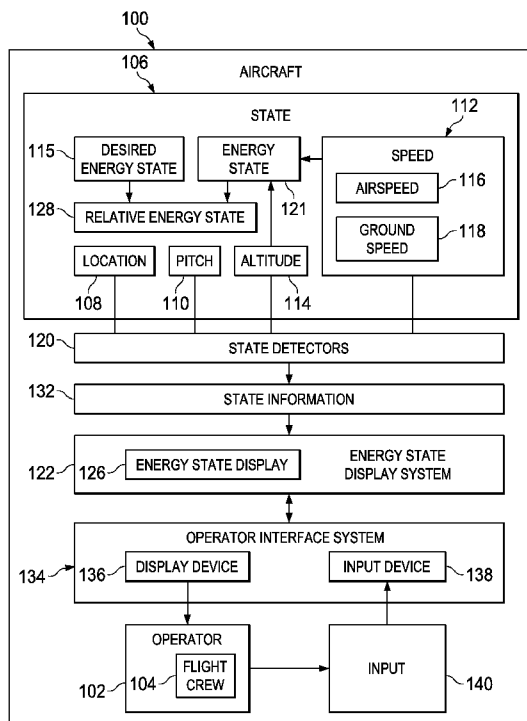


FIG. 1

(57) Abstract: A method and apparatus for displaying an energy state (121) of an aircraft (100). The energy state of the aircraft is identified by a processor unit based on a speed (112) of the aircraft and an altitude (114) of the aircraft. An indication of the energy state is displayed by the processor unit.



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AIRCRAFT ENERGY STATE DISPLAY

BACKGROUND

The present disclosure relates generally to systems and methods for displaying information for indicating the state of an aircraft to a flight crew. More particularly, the present disclosure relates to displaying information indicating the energy state of an aircraft to a flight crew as the aircraft is descending to land.

Airspeed is the speed of an aircraft in flight relative to the air around the aircraft. If the airspeed of an aircraft is too low, the aircraft may stall. An airspeed that is too high during cruise flight of the aircraft may cause flutter. An airspeed that is too high during an approach to landing may cause damage to the aircraft flaps or other aircraft systems.

Ground speed is the speed of an aircraft with respect to the ground over which it is flying. At certain times during the operation of an aircraft, it may be desirable that the ground speed of the aircraft is not too high or too low. For example, the ability of an aircraft to fly through wind shear conditions may be reduced if the ground speed of the aircraft is too low during an approach and landing operation. If the ground speed of an aircraft is too high during approach and landing, the aircraft may land beyond the end of the runway, or may land at a position on the runway and with such speed that it may be difficult to stop the aircraft before the aircraft reaches the end of the runway. The desired upper limit of the ground speed of an aircraft during an approach may be determined using a stopping distance calculation for the aircraft.

A pilot or other operator of an aircraft may control the speed of the aircraft, both the airspeed and ground speed, by controlling the pitch, power setting, or both the pitch and power setting of the aircraft. Changing the pitch of the aircraft changes the angle of attack between the aircraft and the oncoming flow of air through which the aircraft is flying. The power setting of the aircraft may be changed by changing the power delivered by the aircraft engines to move the aircraft through the air. This power is often referred to as the thrust provided by the aircraft engines.

A pilot or other operator of an aircraft controls the aircraft so that the airspeed is within desired limits. Currently, ground speed is not usually considered during many aircraft operations. However, considering ground speed may be helpful in

some aircraft operations. For example, considering the aircraft ground speed may be helpful in performing approach operations in gusty wind conditions.

Controlling an aircraft so that both the airspeed and ground speed of the aircraft are within desired limits may be challenging in some cases under some operational conditions. For example, a sudden increase in the headwind encountered by an aircraft during an approach and landing operation may cause the airspeed of the aircraft to increase suddenly. A human pilot, or automatic control system, may respond to the increase in airspeed by reducing the power setting of the aircraft. However, reducing the power output of the aircraft engines may reduce the ground speed of the aircraft to a speed that is below the desired ground speed for landing the aircraft. For example, reducing the power setting in this case may reduce the ground speed below a desired ground speed for responding to wind shears, downbursts, and other sudden changes in the winds around the aircraft, such as when a headwind gust suddenly dies out.

Accordingly, it would be beneficial to have a method and apparatus that takes into account one or more of the issues discussed above as well as possibly other issues.

SUMMARY

A first illustrative embodiment provides a method for displaying an energy state of an aircraft. The energy state of the aircraft is identified by a processor unit based on a speed of the aircraft and an altitude of the aircraft. An indication of the energy state is displayed by the processor unit.

Another illustrative embodiment provides an apparatus comprising an energy state identifier and an operator interface generator. The energy state identifier is configured to identify an energy state of an aircraft based on a speed of the aircraft and an altitude of the aircraft. The operator interface generator is configured to generate an energy state display comprising an indication of the energy state.

Another illustrative embodiment provides a method for identifying a projected stopping point of an aircraft. An energy state of the aircraft is identified by a processor unit during an approach to landing using a ground speed of the aircraft and an altitude of the aircraft. The projected stopping point of the aircraft is identified by the processor unit using the energy state of the aircraft.

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

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BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the illustrative embodiments are set forth in the appended claims. The illustrative embodiments, however, as well as a preferred mode of use, further objectives, and features thereof will best be understood by reference to the following detailed description of illustrative embodiments of the present disclosure when read in conjunction with the accompanying drawings, wherein:

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Figure 1 is an illustration of a block diagram of an aircraft in accordance with an illustrative embodiment;

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Figure 2 is an illustration of a block diagram of an energy state display system in accordance with an illustrative embodiment;

Figure 3 is an illustration of a block diagram of an energy state display in accordance with an illustrative embodiment;

Figure 4 is an illustration of an example of an energy state display in accordance with an illustrative embodiment;

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Figure 5 is an illustration of another example of an energy state display in accordance with an illustrative embodiment;

Figure 6 is an illustration of a flowchart of a process for displaying an energy state of an aircraft in accordance with an illustrative embodiment; and

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Figure 7 is an illustration of a block diagram of a data processing system in accordance with an illustrative embodiment.

DETAILED DESCRIPTION

The different illustrative embodiments recognize and take into account a number of different considerations. "A number," as used herein with reference to items, means one or more items. For example, "a number of different considerations" means one or more different considerations.

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The different illustrative embodiments recognize and take into account that currently, the ground speed of an aircraft may not be taken into account to determine

the energy state of an aircraft during an approach to landing. The different illustrative embodiments recognize and take into account that using ground speed information to determine the energy state of an aircraft during approaches may improve the quality and increase the safety of aircraft landing, especially in adverse weather conditions.

5 The different illustrative embodiments recognize and take into account that the information provided to pilots on final approach to landing may not allow the pilot to respond in a desired manner to changing wind conditions. The different illustrative embodiments also recognize and take into account that the current algorithms used by automatic control systems may result in undesired responses to changing wind
10 conditions on final approach in certain situations. For example, currently, a pilot or automatic control system may respond to encountering a headwind gust on final approach to landing by reducing the power setting of the aircraft. However, if the headwind suddenly goes away, there may not be enough time to increase the power provided by the aircraft engines before running out of airspeed and altitude, resulting in
15 landing short of the runway. Such a scenario is possible if the aircraft encounters a downburst on final approach.

In a downburst, the aircraft typically first encounters a headwind followed by the downflow itself. Then the aircraft may enter the outflow, resulting in an even larger sudden change in airspeed. Keeping the ground speed up helps deal with the
20 downflow and the outflow. Currently, a human pilot or an automatic control system may not be provided with sufficient or appropriate information for controlling the aircraft in the most desired and effective manner in response to such situations.

The different illustrative embodiments recognize and take into account that currently, an approach to landing an aircraft may be flown at a speed that is sufficiently
25 above the stall speed of the aircraft to provide a reasonable amount of margin for landing the aircraft on the runway at a desired position and speed in various weather conditions. For example, a typical approach to landing may be flown at 1.3 times the stall speed of the aircraft. One half of the steady headwind component and a full gust factor may be added to determine a target airspeed for the aircraft. This provides a
30 sufficient margin in most cases. The target airspeed and the wind conditions at the airport are then used to calculate a desired ground speed for the approach.

In extreme conditions, the typical margin above the stall speed of the aircraft that may be used during an approach to landing may not be sufficient. A

downburst is one example of possible extreme conditions. Another example would be very high winds occurring during extreme weather conditions, such as in a hurricane. Many airports may have wind shear warning systems or other systems that may provide the pilot with a warning that such extreme landing conditions may exist. The pilot may then respond appropriately, such as by adjusting the target approach speed. However, there are also many other airports that may not have wind shear or other warning systems of this type. Furthermore, a downburst, or other sudden change in wind conditions may affect an aircraft before the ground based sensors that are part of a wind shear warning system or other ground based warning system may detect the condition.

The different illustrative embodiments provide a system and method for taking into account the ground speed of an aircraft during an approach and landing operation. In accordance with an illustrative embodiment, the ground speed of the aircraft may be used to identify an energy state of the aircraft as the aircraft approaches a runway to land.

An indication of the energy state of the aircraft may be presented to the pilot in a manner that allows the pilot to use the information to respond more effectively to changing wind conditions during the approach to landing. For example, an indication of the energy state of the aircraft may indicate the difference between the current energy state of the aircraft and a desired energy state of the aircraft at a current point in the approach to landing. The pilot may respond by decreasing the power setting of the aircraft if the current energy state of the aircraft is greater than the desired energy state. Similarly, the pilot may respond by increasing the power setting of the aircraft if the current energy state is below the desired energy state.

Since the energy state for the aircraft is determined based on ground speed, the energy state information displayed to the pilot in the energy state display reduces the likelihood that the pilot will change the power setting of the aircraft in an undesired manner in response to changing wind conditions that may affect the airspeed of the aircraft but does not affect the desired ground speed for landing the aircraft. In accordance with an illustrative embodiment, the energy state of the aircraft also may be used as a factor to consider in addition to currently used factors, such as airspeed and altitude, by an automatic control system for controlling the aircraft during approach and landing.

Turning now to **Figure 1**, an illustration of a block diagram of an aircraft is depicted in accordance with an illustrative embodiment. Aircraft **100** may be any type of aircraft. For example, without limitation, aircraft **100** may be a passenger aircraft, a cargo aircraft, a military aircraft, or any other type of aircraft. Aircraft **100** may be operated by an airline or other commercial entity, a military unit or any other government entity, or any other public or private entity.

Aircraft **100** may be a manned aircraft or an unmanned aircraft. If aircraft **100** is a manned aircraft, aircraft **100** may be controlled by operator **102** onboard aircraft **100**. For example, operator **102** onboard aircraft **100** may include flight crew **104**. Flight crew **104** may include a pilot or other human operator of aircraft **100**. If aircraft **100** is an unmanned aircraft, operator **102** may control aircraft **100** from a remote location that is not onboard aircraft **100**.

State **106** of aircraft **100** may define various characteristics of aircraft **100** at a particular point in time. For example, without limitation, state **106** of aircraft **100** may include location **108**, pitch **110**, speed **112**, and altitude **114** of aircraft **100**. Other characteristics of aircraft **100** may include rate of descent, rate of climb, pitch rate, acceleration, deceleration, turn rate, bank angle, wind conditions affecting the aircraft, other characteristics, or various combinations of characteristics. However, not all of these possible characteristics may be used or displayed in illustrative embodiments.

Location **108** of aircraft **100** may refer to the geographic location of aircraft **100**. For example, location **108** may refer to the location of a point on the earth directly below aircraft **100** when aircraft **100** is in flight. Location **108** may be used to determine the distance from aircraft **100** to a location of interest. For example, location **108** of aircraft **100** may be used to determine the distance of aircraft **100** in flight from a runway on which aircraft **100** is attempting to land.

Location **108** of aircraft also may be used to determine desired energy state **115**. Desired energy state **115** may include an altitude of the approach course at the current distance from the runway.

Pitch **110** may refer to the nose up or down angle of aircraft **100** relative to the horizontal. Pitch **110** of aircraft **100** may be changed by operator **102** to control speed **112**, altitude **114**, or both speed **112** and altitude **114** of aircraft **100**.

Speed **112** of aircraft **100** may be airspeed **116** or ground speed **118**. Airspeed **116** refers to speed **112** of aircraft **100** with respect to the air through which

aircraft **100** is flying. Ground speed **118** refers to speed **112** of aircraft **100** with respect to the ground over which aircraft **100** is flying. Pilots fly aircraft based mostly on indicated airspeed. However, indicated airspeed is not necessarily the true airspeed. For example, air density and altitude affect true airspeed versus indicated airspeed.

5 This difference may affect the calculation of desired ground speed based on the approach indicated speed and the winds. This effect would add to the ground speed calculated without this taken into account.

State **106** of aircraft **100** at any point in time may be determined by state detectors **120**. State detectors **120** may include various devices and systems on aircraft
10 **100** for identifying the current state **106** of aircraft **100**. For example, without limitation, location **108** of aircraft **100** may be identified using a global positioning system or other navigation system for determining the current geographic location of aircraft **100**. The locations used in the energy calculations described herein may be the distance from a runway, which is used to determine the approach slope height at this distance out, and
15 hence the desired energy.

Pitch **110** of aircraft **100** may be identified using a gyroscope or in another appropriate manner. Airspeed **116** may be identified using a pitot tube or other appropriate airspeed measuring device. Ground speed **118** may be identified using any appropriate ground speed identification system. For example, without limitation, ground
20 speed **118** may be identified using a global positioning system, distance measuring equipment, or any other appropriate system or method for identifying ground speed **118**. Altitude **114** of aircraft **100** may be identified using an altimeter or any other appropriate instrument that may be used to identify altitude **114**. For example, altitude **114** may be part of location **108** that is determined using a global positioning system. Altitude **114**
25 also is used to determine energy state **121** of aircraft **100** in accordance with an illustrative embodiment.

In accordance with an illustrative embodiment, energy state display system **122** may be configured to identify energy state **121** of aircraft **100**. Energy state display system **122** may be configured to display an indication of energy state **121** to
30 operator **102** of aircraft **100** on energy state display **126**. Operator **102** may use the indication of energy state **121** displayed on energy state display **126** to operate aircraft **100** in a more effective manner.

Energy state **121** of aircraft **100** may refer to the total kinetic and potential energy of aircraft **100** at a particular point in time. The kinetic energy of aircraft **100** is a function of speed **112**. For example, the kinetic energy of aircraft **100** may be identified as $\frac{1}{2} M V^2$, wherein M is a mass of aircraft **100**, and V is ground speed **118** of aircraft **100**. In accordance with an illustrative embodiment, energy state display system **122** may identify energy state **121** of aircraft **100** using ground speed **118** to identify the kinetic energy component of energy state **121**. The potential energy for aircraft **100** may be identified as $m \cdot g \cdot h$, wherein m is the mass of the aircraft, g is the acceleration due to gravity, e.g., approximately 9.8 meters per second squared, and h is altitude **114** of aircraft **100**. Energy state **121** then may be identified as the sum of the kinetic and potential energy of aircraft **100**.

In accordance with an illustrative embodiment, the indication of energy state **121** presented to operator **102** in energy state display **126** may be an indication of relative energy state **128**. Relative energy state **128** may refer to the difference between energy state **121** of aircraft **100** and desired energy state **115** for aircraft **100**. For example, energy state **121** of aircraft **100** may be identified at a particular point where aircraft **100** is descending in an approach for landing. Desired energy state **115** may identify the energy of aircraft **100** at the energy state corresponding to the altitude of the approach slope at the current distance of the aircraft from the runway and the desired ground speed.

In this case, relative energy state **128**, the difference between energy state **121** and desired energy state **115**, identifies whether aircraft **100** currently has too much energy or too little energy relative to the ideal energy state which would correspond to flying the approach slope exactly at the correct altitude and at the desired ground speed. This will cause aircraft **100** to land at the desired point on the runway at the desired ground speed **118**. By displaying an indication of relative energy state **128** to operator **102** on energy state display **126** in an appropriate manner, operator **102** may be able to identify any appropriate action that may be needed for controlling aircraft **100** to land aircraft **100** at the desired point on the runway and at the desired ground speed **118** and airspeed **116**.

Energy state display system **122** may identify relative energy state **128** for aircraft **100** from state information **132** provided to energy state display system **122** from state detectors **120**. For example, state information **132** may include information

identifying the current ground speed **118** and altitude **114** of aircraft **100**. In accordance with an illustrative embodiment, relative energy state **128** may be identified by energy state display system **122** in a manner that does not require knowledge of the mass of aircraft **100**.

5 Energy state display **126** may be updated continuously. For example, without limitation, energy state display **126** may update at least 10 times per second or at another appropriate rate.

10 Energy state display **126** may be displayed to operator **102** on any appropriate operator interface system **134**. For example, without limitation, operator interface system **134** may be located on the flight deck or in any other appropriate location on aircraft **100**. Operator interface system **134** may comprise any appropriate display device **136** and input device **138**. Display device **136** may be configured for displaying energy state display **126** to operator **102**. Input device **138** may be configured for receiving input **140** from operator **102**. For example, energy state display
15 **126** displayed on display device **136** may prompt operator **102** to enter a desired ground speed **118** for landing aircraft **100**. The desired ground speed **118** for landing aircraft **100** may be provided as input **140** by operator **102** using input device **138**. The desired ground speed **118** of aircraft **100** at landing may be provided to energy state display system **122** from operator interface system **134**. The desired ground speed **118**
20 of aircraft **100** at landing may define desired energy state **115** for aircraft **100** as aircraft **100** is descending in approach for landing. Therefore, energy state display system **122** may use the desired ground speed **118** for aircraft **100** at landing to identify relative energy state **128**.

25 The illustration of **Figure 1** is not meant to imply physical or architectural limitations to the manner in which different illustrative embodiment may be implemented. Other components in addition to, in place of, or both in addition to and in place of the ones illustrated may be used. Some components may be unnecessary in some illustrative embodiments. Also, the blocks are presented to illustrate some functional components. One or more of these blocks may be combined or divided into
30 different blocks when implemented in different illustrative embodiments. For example, energy state display system **122** and operator interface system **134** may be located on aircraft **100**. In this case, the information presented on energy state display **126** may be used by flight crew **104** onboard aircraft **100** to control aircraft **100** in a more effective

manner. In another example, operator **102** may operate aircraft **100** from a remote location that is not onboard aircraft **100**. For example, aircraft **100** may be an unmanned aircraft that is operated by operator **102** from a remote location that is not onboard aircraft **100**. In this case, energy state display system **122** and operator interface system **134** may be located at the remote location from which operator **102** controls the operation of aircraft **100**. In this case, state detectors **120** onboard aircraft **100** may provide state information **132** from aircraft **100** to energy state display system **122** via any appropriate communications system for providing communications between aircraft **100** and energy state display system **122** located at a remote location from aircraft **100**.

In another example, operator **102** of aircraft **100** may include an automatic control system for controlling the operation of aircraft **100** or an automatic control system in combination with a human operator for controlling the operation of aircraft **100**. In this example, an indication of energy state **124** of aircraft **100**, such as an indication of relative energy state **128**, may be identified and provided to the automatic control system. The automatic control system may be configured to use the energy state information that is provided to control aircraft **100** in a more effective manner.

Turning now to **Figure 2**, an illustration of a block diagram of an energy state display system is depicted in accordance with an illustrative embodiment. In this example, energy state display system **200** is an example of one implementation of energy state display system **122** in **Figure 1**.

Energy state display system **200** may include state information receiver **202**. State information receiver **202** may be configured to receive information identifying the current state of an aircraft from various state detectors on the aircraft. For example, without limitation, state information receiver **202** may be configured to receive information identifying location **204**, pitch **206**, altitude **208**, ground speed **210**, or other conditions or combinations of conditions of the aircraft.

Ground speed **210** may be identified by ground speed identification system **212**. Ground speed identification system **212** may include any appropriate device, system, or method for identifying ground speed **210** of an aircraft. For example, without limitation, ground speed identification system **212** may include global positioning system **214**, distance measuring equipment **216**, or any other system or equipment or

combinations of systems and equipment that may be used to identify ground speed **210** of the aircraft.

State information received by state information receiver **202** may be provided to energy state identifier **220** in energy state display system **200**. For example, without limitation, energy state identifier **220** may be configured to identify relative energy state **222** for the aircraft from altitude **208** and ground speed **210** of the aircraft along with desired ground speed **224**. Desired ground speed **224** may be provided to energy state display system **200** as input from operator **226** of the aircraft using operator interface **228**.

Relative energy state **222** may be provided from energy state identifier **220** to operator interface generator **230** in energy state display system **200**. Operator interface generator **230** may be configured to generate energy state display **232** for displaying an indication of relative energy state **222**. Operator interface generator **230** may use state information for the aircraft from state information receiver **202**, geographical information **234**, and information identifying glide slope **236** of the aircraft to generate energy state display **232**. For example, without limitation, geographical information **234** and glide slope **236** may be obtained by operator interface generator **230** from a number of databases or other sources of information that may be part of, or accessible by, energy state display system **200**.

Energy state display **232** also may be configured to prompt operator **226** to input information via operator interface **228**. Such information input by operator **226** may be used by energy state identifier **220**, included in energy state display **232** by operator interface generator **230**, or both. For example, desired ground speed **224** input by operator **226** via operator interface **228** may be used by energy state identifier **220** to identify relative energy state **222** and may be displayed in energy state display **232** generated by operator interface generator **230**.

Turning now to **Figure 3**, an illustration of a block diagram of an energy state display is depicted in accordance with an illustrative embodiment. In this example, energy state display **300** may be an example of one implementation of energy state display **126** in **Figure 1** or energy state display **232** in **Figure 2**.

Energy state display **300** may include operator input prompts **302**. For example, without limitation, operator input prompts **302** may prompt the operator of an aircraft to input information related to a landing such as desired ground speed **304**,

runway surface conditions **306**, reported wind conditions **308**, or other information or combinations of information. Information input by the operator in response to operator input prompts **302** may be displayed as part of energy state display **300**.

Energy state display **300** also may include profile view display **310**. Profile view display **310** may present a profile view of an aircraft approach to landing. For example, without limitation, profile view display **310** may include graphical or other representations or indications of glide slope **312**, runway **314**, geographical features **316**, aircraft location **318**, projection of aircraft location **320**, aircraft pitch **322**, indication of energy state **324**, and projection of energy state **326**. For example, desired stopping point **327** for an aircraft landing on runway **314** may be any appropriate point on runway **314**. Indication of energy state **324** may be an indication of relative energy state **328**. For example, without limitation, indication of energy state **324** may be displayed as offset **330** from glide slope **312** to indicate relative energy state **328**.

Other information that may be displayed in energy state display **300** may include ground speed **332**, estimated touch down airspeed **334**, runway information **336**, wind information **338**, stopping information **340**, and warnings **342**. Wind information **338** may include headwind component **344** and crosswind component **346** of wind at landing. Stopping information **340** may include information for identifying projected stopping point **348**. Projected stopping point **348** may be a point on or near a runway at which the aircraft with the current energy state attempting a landing is projected to be able to stop. Warnings **342** may include indications that the current energy state of the aircraft is too high or too low to perform a landing. For example, warnings **342** may indicate that projected stopping point **348** is short of the runway or beyond the end of the runway.

Turning now to **Figure 4**, an illustration of an example of an energy state display is depicted in accordance with an illustrative embodiment. In this example, energy state display **400** is an example of one implementation of energy state display **126** in **Figure 1**, energy state display **232** in **Figure 2**, or energy state display **300** in **Figure 3**.

In this example, energy state display **400** may prompt an operator to enter target ground speed **402** and information identifying reported winds **404** at landing. Headwind component **406** and crosswind component **408** of the wind at landing may be determined from reported winds **404** and displayed on energy state display **400**.

Energy state display **400** may include profile view display **410**. Profile view display **410** may present a profile view of an approach to landing. For example, profile view display **410** may include line **412** indicating glide slope, a graphical representation of runway **414**, and graphical representation **416** of geographical features on the approach to landing.

An appropriate symbol **418** may be displayed to indicate the location of the aircraft. For example, without limitation, symbol **418** may represent a side view of an aircraft. Arrow **420** extending from symbol **418** may be displayed to indicate a projection of the aircraft location from the current location. The orientation of symbol **418** may indicate the pitch of the aircraft.

Any appropriate symbol **422** may be used as an indication of the energy state of the aircraft. Arrow **424** extending from symbol **422** may indicate a projection of the energy state from the current energy state. The vertical position of symbol **422** with respect to line **412** indicating the glide slope may indicate the energy state of the aircraft relative to the desired energy state. In this example, the position of symbol **422** indicates that the energy state of the aircraft is greater than desired. Therefore, in this case, warning **426** may be displayed to indicate that the energy of the aircraft for the approach is too high.

Turning now to **Figure 5**, an illustration of another example of an energy state display is depicted in accordance with an illustrative embodiment. In this example, energy state display **500** is another example of one implementation of energy state display **126** in **Figure 1**, energy state display **232** in **Figure 2**, or energy state display **300** in **Figure 3**.

In this example, energy state display **500** may prompt an operator to enter target ground speed **502** and information identifying reported winds **504** at landing. Headwind component **506** and crosswind component **508** of the wind at landing may be determined from reported winds **504** and displayed on energy state display **500**.

Energy state display **500** may include profile view display **510**. Profile view display **510** may present a profile view of an approach to landing. For example, profile view display **510** may include line **512** indicating glide slope, a graphical representation of runway **514**, and graphical representation **516** of geographical features on the approach to landing.

An appropriate symbol **518** may be displayed to indicate the location of the aircraft. For example, without limitation, symbol **518** may represent a side view of an aircraft. Arrow **520** extending from symbol **418** may be displayed to indicate a projection of the aircraft location from the current location. The orientation of symbol **418** may indicate the pitch of the aircraft.

Any appropriate symbol **522** may be used as an indication of the energy state of the aircraft. Arrow **524** extending from symbol **522** may indicate a projection of the energy state from the current energy state. The vertical position of symbol **522** with respect to line **512** indicating the glide slope may indicate the energy state of the aircraft relative to the desired energy state. The amount of vertical displacement of the energy symbol may be calculated by solving the equation: the current energy state of the aircraft minus the desired energy state for the aircraft equals mgh for h , wherein m is the mass of the aircraft, g is the acceleration due to gravity, e.g., approximately 9.8 meters per second squared, and h is altitude. The current energy state and the desired energy state of the aircraft are both a function of m . Therefore, when solving for h , m drops out of this equation, so the mass of the aircraft need not be known to solve this equation for h . The determined value for h then may be plotted to the same scale as the vertical profile view. The zero point of this energy or h scale is set at a point on the approach slope at the current distance of the aircraft from the runway. In this example, the vertical position of symbol **522** with respect to line **512** indicating the glide slope indicates that the energy state of the aircraft is less than desired. Therefore, in this case, warning **526** may be displayed to indicate that the energy of the aircraft for the approach is too low.

Turning now to **Figure 6**, an illustration of a flowchart of a process for displaying an energy state of an aircraft is depicted in accordance with an illustrative embodiment. The process in **Figure 6** may be implemented, for example, in energy state display system **200** in **Figure 2**.

The process may begin by receiving speed and altitude information (operation **602**). Position information, such as the distance of the aircraft from a runway, also may be received. Desired speed information also may be received (operation **604**). For example, desired speed information may be a desired ground speed at landing provided by an operator of the aircraft.

The relative energy state of the aircraft then may be identified (operation **606**). For example, the relative energy state may be identified using the received speed and altitude information and the received desired speed information. An indication of the energy state of the aircraft then may be displayed (operation **608**), with the process
5 terminating thereafter. For example, an indication of the relative energy state of the aircraft may be displayed in an energy state display.

Turning now to **Figure 7**, an illustration of a block diagram of a data processing system is depicted in accordance with an illustrative embodiment. In this example, data processing system **700** is an example of one implementation of a data
10 processing system for implementing energy state display system **200** in **Figure 2**.

In this illustrative example, data processing system **700** includes communications fabric **702**. Communications fabric **702** provides communications between processor unit **704**, memory **706**, persistent storage **708**, communications unit **710**, input/output (I/O) unit **712**, and display **714**. Memory **706**, persistent storage **708**,
15 communications unit **710**, input/output (I/O) unit **712**, and display **714** are examples of resources accessible by processor unit **704** via communications fabric **702**.

Processor unit **704** serves to run instructions for software that may be loaded into memory **706**. Processor unit **704** may be a number of processors, a multi-processor core, or some other type of processor, depending on the particular
20 implementation. Further, processor unit **704** may be implemented using a number of heterogeneous processor systems in which a main processor is present with secondary processors on a single chip. As another illustrative example, processor unit **704** may be a symmetric multi-processor system containing multiple processors of the same type.

Memory **706** and persistent storage **708** are examples of storage devices
25 **716**. A storage device is any piece of hardware that is capable of storing information, such as, for example, without limitation, data, program code in functional form, and other suitable information either on a temporary basis or a permanent basis. Storage devices **716** also may be referred to as computer readable storage devices in these examples. Memory **706**, in these examples, may be, for example, a random access
30 memory or any other suitable volatile or non-volatile storage device. Persistent storage **708** may take various forms, depending on the particular implementation.

For example, persistent storage **708** may contain one or more components or devices. For example, persistent storage **708** may be a hard drive, a

flash memory, a rewritable optical disk, a rewritable magnetic tape, or some combination of the above. The media used by persistent storage **708** also may be removable. For example, a removable hard drive may be used for persistent storage **708**.

5 Communications unit **710**, in these examples, provides for communications with other data processing systems or devices. In these examples, communications unit **710** is a network interface card. Communications unit **710** may provide communications through the use of either or both physical and wireless communications links.

10 Input/output (I/O) unit **712** allows for input and output of data with other devices that may be connected to data processing system **700**. For example, input/output (I/O) unit **712** may provide a connection for user input through a keyboard, a mouse, and/or some other suitable input device. Further, input/output (I/O) unit **712** may send output to a printer. Display **714** provides a mechanism to display information
15 to a user.

 Instructions for the operating system, applications, and/or programs may be located in storage devices **716**, which are in communication with processor unit **704** through communications fabric **702**. In these illustrative examples, the instructions are in a functional form on persistent storage **708**. These instructions may be loaded into
20 memory **706** for execution by processor unit **704**. The processes of the different embodiments may be performed by processor unit **704** using computer-implemented instructions, which may be located in a memory, such as memory **706**.

 These instructions are referred to as program instructions, program code, computer usable program code, or computer readable program code that may be read
25 and executed by a processor in processor unit **704**. The program code in the different embodiments may be embodied on different physical or computer readable storage media, such as memory **706** or persistent storage **708**.

 Program code **718** is located in a functional form on computer readable media **720** that is selectively removable and may be loaded onto or transferred to data
30 processing system **700** for execution by processor unit **704**. Program code **718** and computer readable media **720** form computer program product **722** in these examples. In one example, computer readable media **720** may be computer readable storage media **724** or computer readable signal media **726**.

Computer readable storage media **724** may include, for example, an optical or magnetic disk that is inserted or placed into a drive or other device that is part of persistent storage **708** for transfer onto a storage device, such as a hard drive, that is part of persistent storage **708**. Computer readable storage media **724** also may take
5 the form of a persistent storage, such as a hard drive, a thumb drive, or a flash memory, that is connected to data processing system **700**. In some instances, computer readable storage media **724** may not be removable from data processing system **700**.

In these examples, computer readable storage media **724** is a physical or tangible storage device used to store program code **718** rather than a medium that
10 propagates or transmits program code **718**. Computer readable storage media **724** is also referred to as a computer readable tangible storage device or a computer readable physical storage device. In other words, computer readable storage media **724** is a media that can be touched by a person.

Alternatively, program code **718** may be transferred to data processing
15 system **700** using computer readable signal media **726**. Computer readable signal media **726** may be, for example, a propagated data signal containing program code **718**. For example, computer readable signal media **726** may be an electromagnetic signal, an optical signal, and/or any other suitable type of signal. These signals may be transmitted over communications links, such as wireless communications links, optical
20 fiber cable, coaxial cable, a wire, and/or any other suitable type of communications link. In other words, the communications link and/or the connection may be physical or wireless in the illustrative examples.

In some illustrative embodiments, program code **718** may be downloaded over a network to persistent storage **708** from another device or data processing system
25 through computer readable signal media **726** for use within data processing system **700**. For instance, program code stored in a computer readable storage medium in a server data processing system may be downloaded over a network from the server to data processing system **700**. The data processing system providing program code **718** may be a server computer, a client computer, or some other device capable of storing
30 and transmitting program code **718**.

The different components illustrated for data processing system **700** are not meant to provide architectural limitations to the manner in which different embodiments may be implemented. The different illustrative embodiments may be

implemented in a data processing system including components in addition to and/or in place of those illustrated for data processing system **700**. Other components shown in **Figure 7** can be varied from the illustrative examples shown. The different embodiments may be implemented using any hardware device or system capable of running program code. As one example, data processing system **700** may include organic components integrated with inorganic components and/or may be comprised entirely of organic components excluding a human being. For example, a storage device may be comprised of an organic semiconductor.

In another illustrative example, processor unit **704** may take the form of a hardware unit that has circuits that are manufactured or configured for a particular use. This type of hardware may perform operations without needing program code to be loaded into a memory from a storage device to be configured to perform the operations.

For example, when processor unit **704** takes the form of a hardware unit, processor unit **704** may be a circuit system, an application specific integrated circuit (ASIC), a programmable logic device, or some other suitable type of hardware configured to perform a number of operations. With a programmable logic device, the device is configured to perform the number of operations. The device may be reconfigured at a later time or may be permanently configured to perform the number of operations. Examples of programmable logic devices include, for example, a programmable logic array, a programmable array logic, a field programmable logic array, a field programmable gate array, and other suitable hardware devices. With this type of implementation, program code **718** may be omitted, because the processes for the different embodiments are implemented in a hardware unit.

In still another illustrative example, processor unit **704** may be implemented using a combination of processors found in computers and hardware units. Processor unit **704** may have a number of hardware units and a number of processors that are configured to run program code **718**. With this depicted example, some of the processes may be implemented in the number of hardware units, while other processes may be implemented in the number of processors.

In another example, a bus system may be used to implement communications fabric **702** and may be comprised of one or more buses, such as a system bus or an input/output bus. Of course, the bus system may be implemented

using any suitable type of architecture that provides for a transfer of data between different components or devices attached to the bus system.

Additionally, communications unit **710** may include a number of devices that transmit data, receive data, or both transmit and receive data. Communications unit **710** may be, for example, a modem or a network adapter, two network adapters, or some combination thereof. Further, a memory may be, for example, memory **706**, or a cache, such as that found in an interface and memory controller hub that may be present in communications fabric **702**.

The flowcharts and block diagrams described herein illustrate the architecture, functionality, and operation of possible implementations of systems, methods, and computer program products according to various illustrative embodiments. In this regard, each block in the flowcharts or block diagrams may represent a module, segment, or portion of code, which comprises one or more executable instructions for implementing the specified logical function or functions. It should also be noted that, in some alternative implementations, the functions noted in a block may occur out of the order noted in the figures. For example, the functions of two blocks shown in succession may be executed substantially concurrently, or the functions of the blocks may sometimes be executed in the reverse order, depending upon the functionality involved.

The description of the different illustrative embodiments has been presented for purposes of illustration and description and is not intended to be exhaustive or to limit the embodiments in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. Further, different illustrative embodiments may provide different benefits as compared to other illustrative embodiments. The embodiment or embodiments selected are chosen and described in order to best explain the principles of the embodiments, the practical application, and to enable others of ordinary skill in the art to understand the disclosure for various embodiments with various modifications as are suited to the particular use contemplated.

CLAIMS:

What is claimed is:

- 5 1. A method for displaying an energy state (121) of an aircraft (100), comprising:
identifying, by a processor unit (704), the energy state (121) of the aircraft (100)
based on a speed (112) of the aircraft (100) and an altitude (114) of the aircraft (100);
and
displaying, by the processor unit (704), an indication of the energy state (121).
- 10 2. The method of claim 1, wherein identifying the energy state (121) of the aircraft
(100) comprises identifying the energy state (121) of the aircraft (100) based on a
ground speed (118) of the aircraft (100) and the altitude (114) of the aircraft (100).
- 15 3. The method of claim 2 further comprising:
identifying, during an approach of the aircraft (100) to landing on a runway (314),
a projected stopping point (348) for the aircraft (100) using the energy state (121) of the
aircraft (100) based on the ground speed (118) of the aircraft (100); and
displaying a warning (426) when the projected stopping point (348) for the aircraft
20 (100) is not a desired stopping point (327) for the aircraft (100) on the runway (314).
4. The method of claim 1 further comprising:
identifying a relative energy state (128) of the aircraft (100) based on a difference
between the energy state (121) of the aircraft (100) and a desired energy state (115) for
25 the aircraft (100) and wherein displaying the indication of the energy state (121)
comprises displaying an indication of the relative energy state (128) of the aircraft (100).
5. The method of claim 4, wherein:
the desired energy state (115) is determined based on a desired ground speed
30 (118) for the aircraft (100); and
the indication of the relative energy state (128) identifies how much altitude (114)
the aircraft (100) at the desired ground speed (118) would have to have the relative
energy state (128).

6. The method of claim 4 further comprising:

displaying in a profile view display (310) a representation of a glide slope (312) for the aircraft (100); and

5 displaying the indication of the relative energy state (128) of the aircraft (100) relative to the representation of the glide slope (312).

7. The method of claim 6, wherein:

a direction of the indication of the relative energy state (128) from the representation of the glide slope (312) identifies whether the energy state (121) of the aircraft (100) is greater than or less than the desired energy state (115) for the aircraft (100); and

a distance of the indication of the relative energy state (128) from the representation of the glide slope (312) identifies an amount by which the energy state (121) of the aircraft (100) is greater than or less than the desired energy state (115) for the aircraft (100), wherein an amount of vertical displacement of the indication of the relative energy state (128) from the representation of the glide slope is calculated by solving the equation: energy state (121) minus desired energy state (115) equals mgh for h , wherein m is the mass of the aircraft (100), g is the acceleration due to gravity, and h is altitude, and then converting h to a scale of the profile view display (310) to determine the amount of vertical displacement of the indication of the relative energy state (128) from the representation of the glide slope (312) at a point on the glide slope (312) corresponding to a distance of the aircraft (100) from a runway (314).

8. An apparatus, comprising:

an energy state identifier (220) configured to identify an energy state (121) of an aircraft (100) based on a speed (112) of the aircraft (100) and an altitude (114) of the aircraft (100); and

an operator interface generator (230) configured to generate an energy state display (126) comprising an indication of the energy state (121).

9. The apparatus of claim 8, wherein the energy state identifier (220) is configured to identify the energy state (121) of the aircraft (100) based on a ground speed (118) of the aircraft (100) and the altitude (114) of the aircraft (100).

5 10. The apparatus of claim 9, wherein the operator interface generator (230) is further configured to:

identify, during an approach of the aircraft (100) to landing on a runway (314), a projected stopping point (348) for the aircraft (100) using the energy state (121) of the aircraft (100) based on the ground speed (118) of the aircraft (100); and

10 display a warning (426) when the projected stopping point (348) for the aircraft (100) is not a desired stopping point (327) for the aircraft (100) on the runway (314).

11. The apparatus of claim 8, wherein:

the energy state identifier (220) is configured to identify a relative energy state (128) of the aircraft (100) based on a difference between the energy state (121) of the aircraft (100) and a desired energy state (115) for the aircraft (100); and

the operator interface generator (230) is configured to display an indication of the relative energy state (128) of the aircraft (100).

20 12. The apparatus of claim 11, wherein:

the desired energy state (115) is determined based on a desired ground speed (118) for the aircraft (100); and

the indication of the relative energy state (128) identifies how much altitude (114) the aircraft (100) at the desired ground speed (118) would have to have the relative energy state (128).

13. The apparatus of claim 11, wherein the operator interface generator (230) is configured to:

display a representation of a glide slope (312) for the aircraft (100) in a profile view display (310); and

display the indication of the relative energy state (128) of the aircraft (100) relative to the representation of the glide slope (312).

14. The apparatus of claim 13, wherein:

a direction of the indication of the relative energy state (128) from the representation of the glide slope (312) identifies whether the energy state (121) of the aircraft (100) is greater than or less than the desired energy state (115) for the aircraft (100); and

a distance of the indication of the relative energy state (128) from the representation of the glide slope (312) identifies an amount by which the energy state (121) of the aircraft (100) is greater than or less than the desired energy state (115) for the aircraft (100).

15. A method for identifying a projected stopping point (348) of an aircraft (100), comprising:

identifying, by a processor unit (704), an energy state (121) of the aircraft (100) during an approach to landing using a ground speed (118) of the aircraft (100) and an altitude (114) of the aircraft (100); and

identifying, by the processor unit (704), the projected stopping point (348) of the aircraft (100) using the energy state (121) of the aircraft (100).

16. The method of claim 15 further comprising:

displaying a warning (426) when the projected stopping point (348) is not a desired stopping point (327) for the aircraft (100).

17. The method of claim 15 further comprising:

displaying a representation of a runway (314) to which the aircraft (100) is making the approach to landing; and

displaying an indication of the projected stopping point (348) with respect to the representation of the runway (314).

18. The method of claim 17, wherein identifying the energy state (121) of the aircraft (100) comprises identifying a relative energy state (128) of the aircraft (100) based on a difference between the energy state (121) of the aircraft (100) and a desired energy state (115) for the aircraft (100), wherein the desired energy state (115) is determined using a desired ground speed (118) for the aircraft (100).

19. The method of claim 18, wherein an indication of the relative energy state (128) identifies how much altitude (114) the aircraft (100) at the desired ground speed (118) would have to have the relative energy state (128).

5

20. The method of claim 18 further comprising:

displaying in a profile view display (310) the representation of the runway (314), a representation of a glide slope (312) for the aircraft (100), and an indication of the relative energy state (128) of the aircraft (100) relative to the representation of the glide slope (312).

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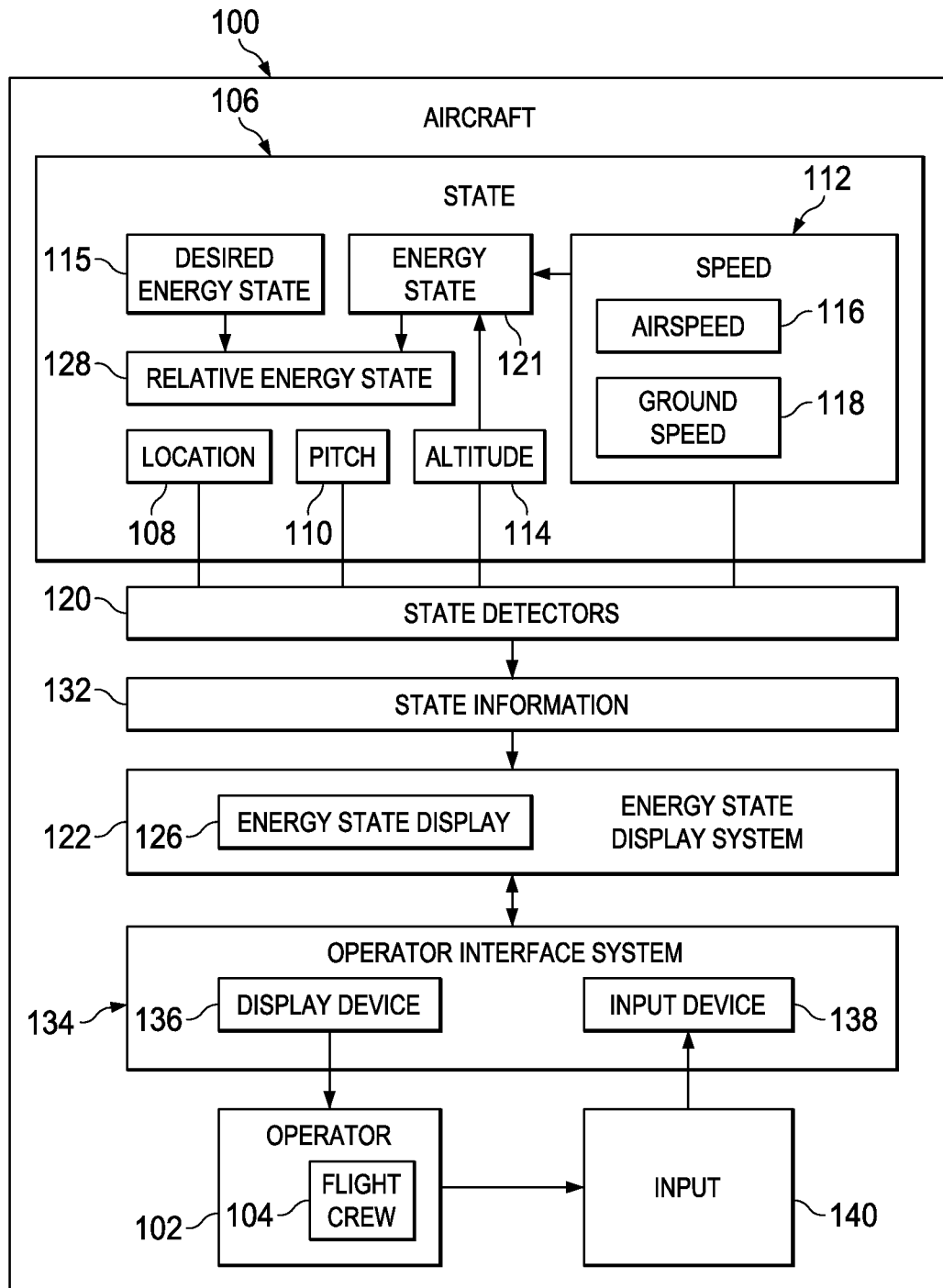


FIG. 1

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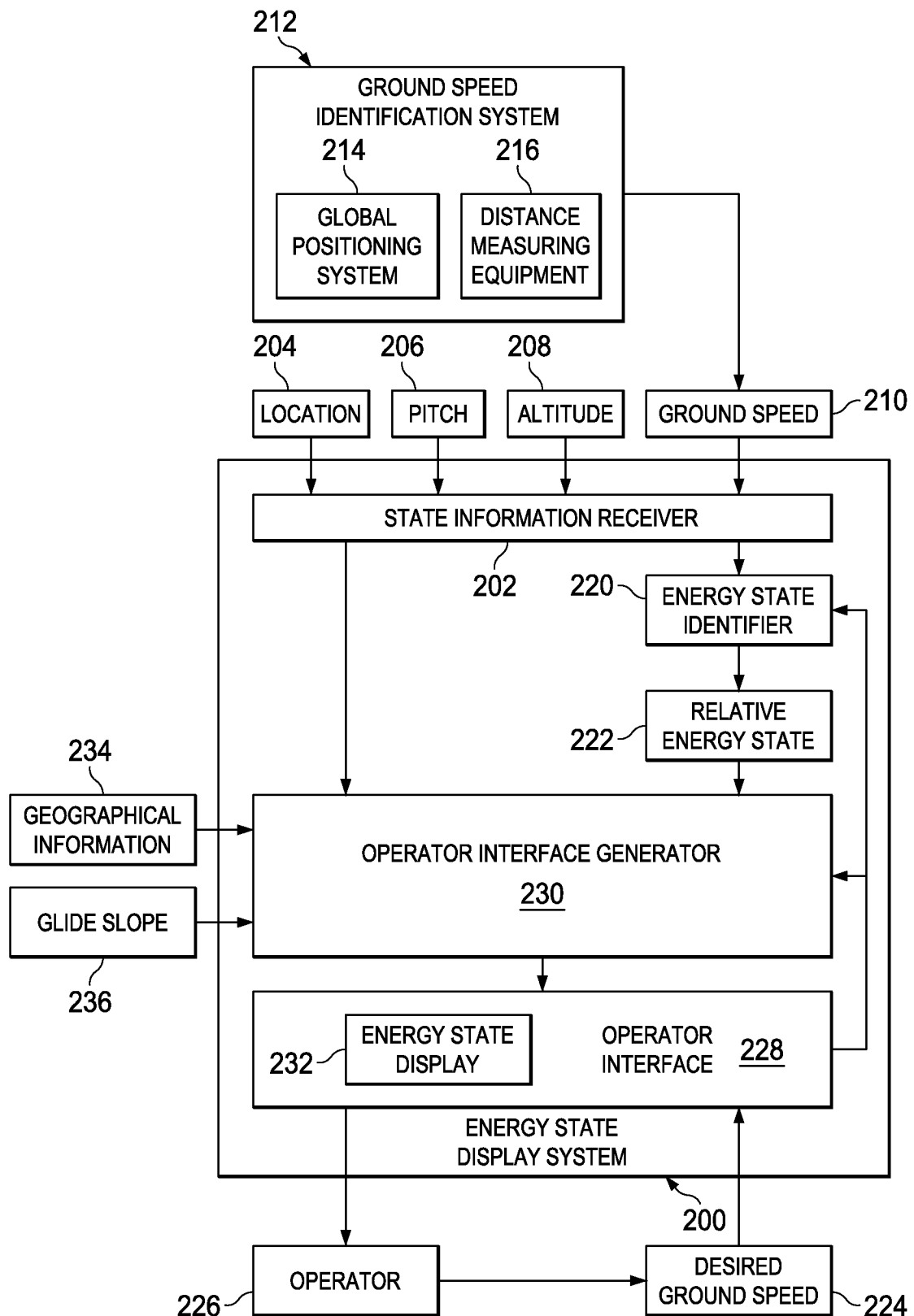
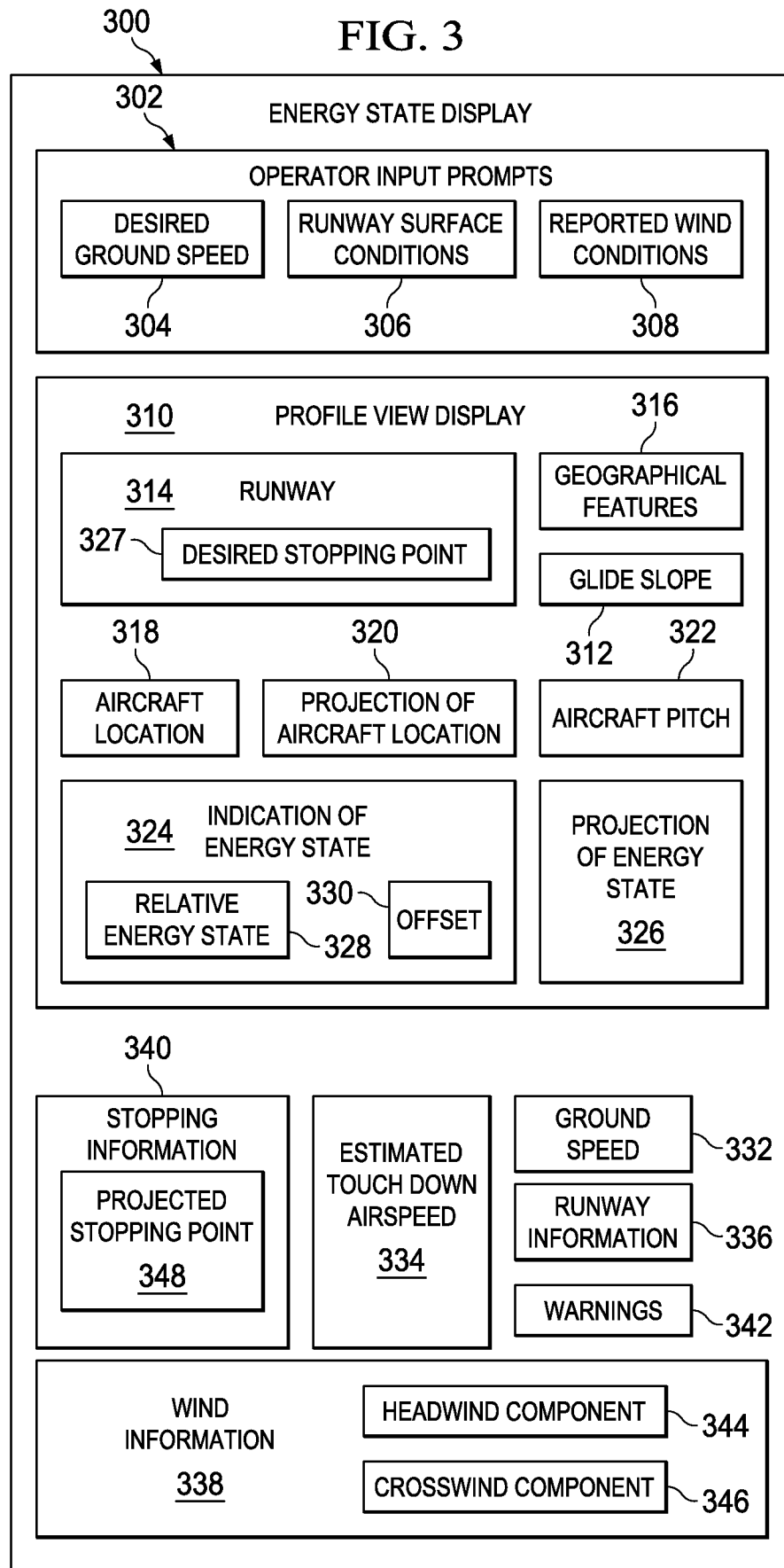


FIG. 2

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FIG. 3



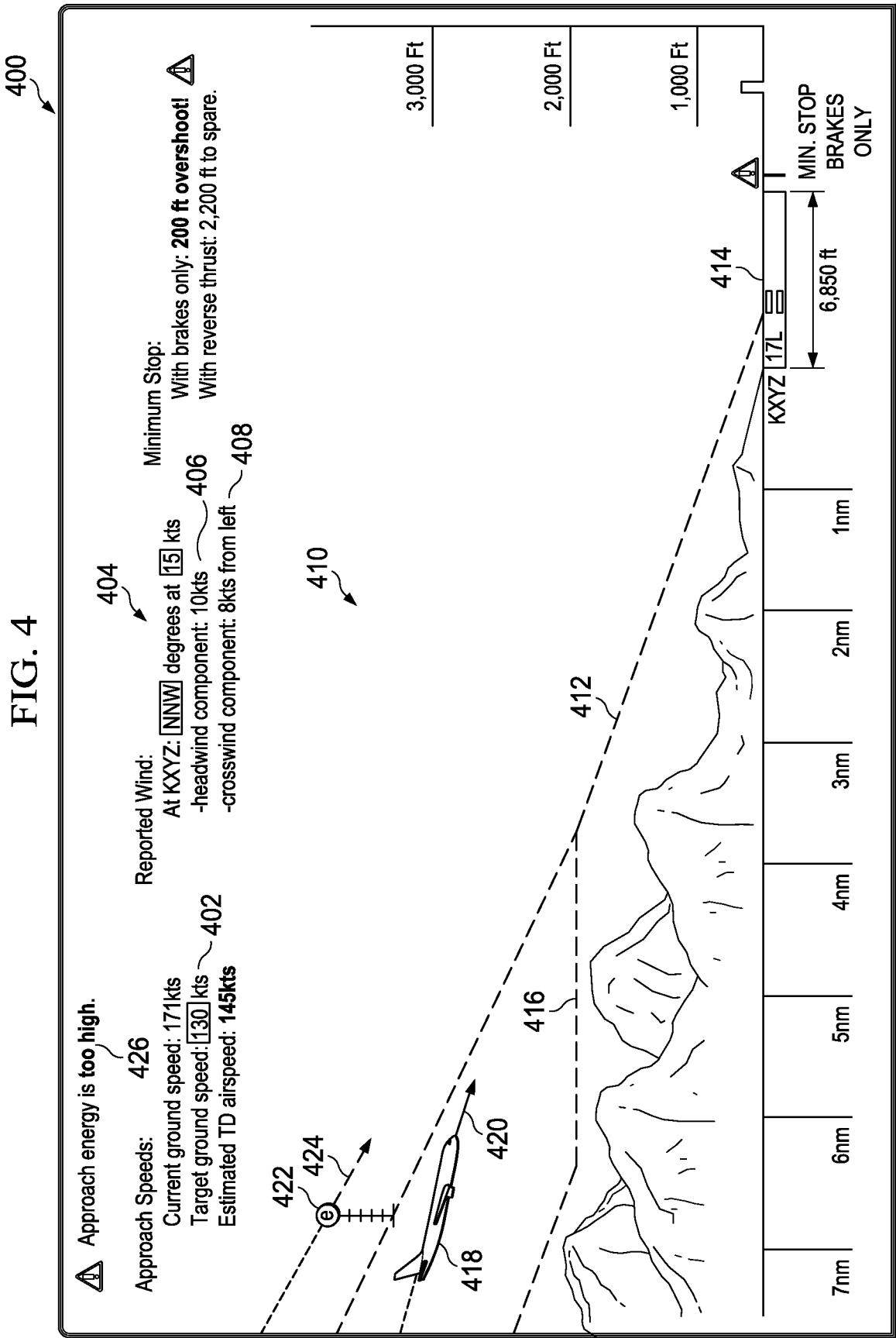
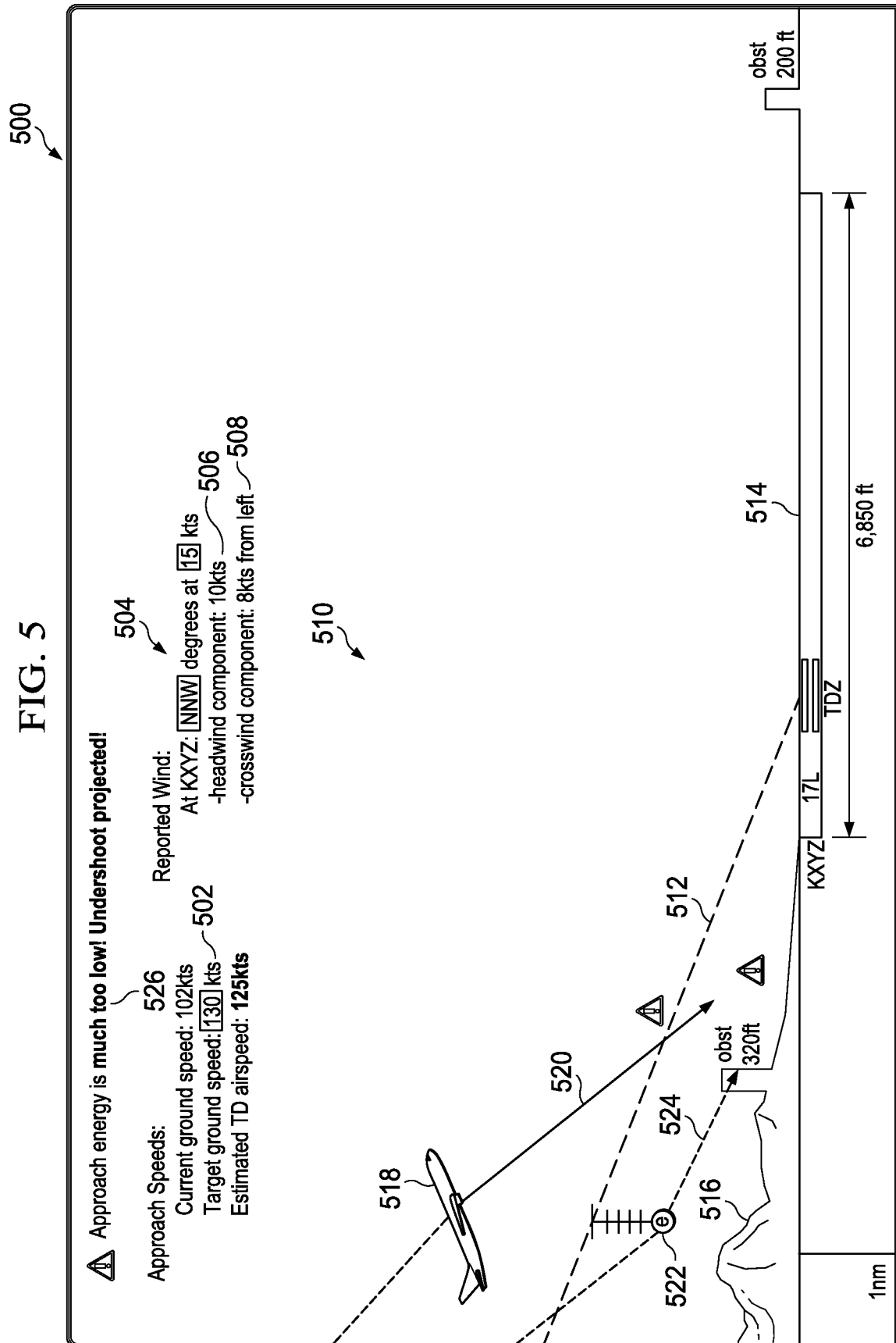


FIG. 5



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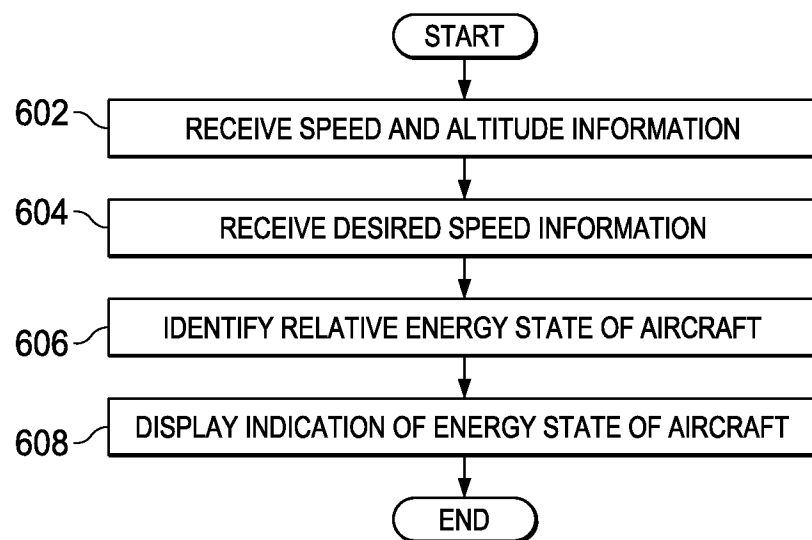
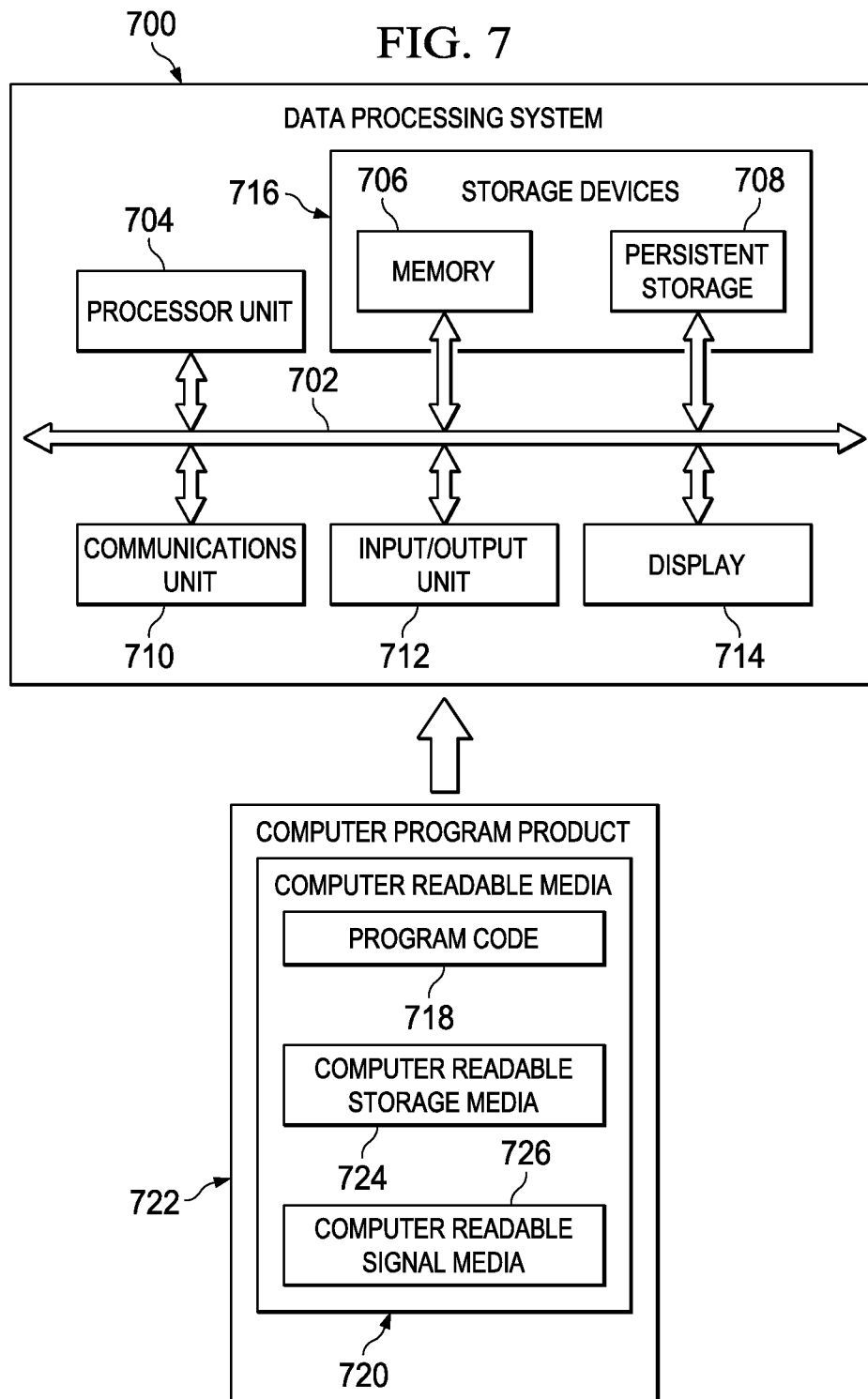


FIG. 6

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FIG. 7



INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/067885

A. CLASSIFICATION OF SUBJECT MATTER
INV. B64D43/00 G01C23/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B64D G01C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 903 801 A1 (AIRBUS FRANCE SAS [FR]) 18 January 2008 (2008-01-18)	1-5, 8-12, 15-19
Y	page 1, line 13 - page 4, line 14; figures 1,2, 4a-4c page 5, line 1 - page 7, line 25 page 8, line 12 - page 9, line 16 page 10, lines 5-17	6,7,13, 14,20
Y	US 2006/004496 A1 (TUCKER MICHAEL J [US] ET AL) 5 January 2006 (2006-01-05) paragraphs [0004], [0015], [0016], [0020] - [0022], [0026], [0027], [0029], [0037] - [0042], [0045]; figures 7-10,13-16	6,7,13, 14,20
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

24 June 2014

Date of mailing of the international search report

02/07/2014

Name and mailing address of the ISA/

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Authorized officer

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/067885

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 148 260 A1 (HONEYWELL INT INC [US]) 27 January 2010 (2010-01-27)	1-3,5, 8-10,12, 15,16
A	paragraphs [0001] - [0007], [0021], [0022], [0026] - [0045]; figures 4-6 -----	6,7,13, 14,17-20
X	US 2004/044446 A1 (STAGGS THOMAS J [US]) 4 March 2004 (2004-03-04)	1-3,5, 8-10,12, 15,16
A	paragraphs [0007] - [0011], [0013], [0014], [0016], [0018], [0021], [0023], [0054], [0056], [0059], [0069] - [0071]; figures 1-9, 11, 13, 15-20 paragraphs [0076], [0077], [0088], [0094], [0095], [0101], [0105], [0106], [0113] - [0122] -----	6,7,13, 14,17-20
X	US 2004/075586 A1 (GLOVER JOHN H [US]) 22 April 2004 (2004-04-22) paragraphs [0003] - [0010], [0052], [0056], [0076] - [0078]; figures 1,3a, 4 -----	1,2,8,9
T	US 7 075 457 B1 (CHIDESTER THOMAS R [US] ET AL) 11 July 2006 (2006-07-11) -----	
T	US 7 561 946 B1 (SCHIPPER JOHN F [US]) 14 July 2009 (2009-07-14) -----	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2013/067885

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
FR 2903801	A1	18-01-2008	FR 2903801 A1	18-01-2008
			US 2008012729 A1	17-01-2008

US 2006004496	A1	05-01-2006	US 2006004496 A1	05-01-2006
			US 2010305783 A1	02-12-2010

EP 2148260	A1	27-01-2010	AT 543128 T	15-02-2012
			EP 2148260 A1	27-01-2010
			US 2010036552 A1	11-02-2010

US 2004044446	A1	04-03-2004	NONE	

US 2004075586	A1	22-04-2004	AU 2003287094 A1	04-05-2004
			EP 1552356 A2	13-07-2005
			US 2004075586 A1	22-04-2004
			WO 2004036328 A2	29-04-2004

US 7075457	B1	11-07-2006	US 7075457 B1	11-07-2006
			US 7161501 B1	09-01-2007
			US 7212135 B1	01-05-2007

US 7561946	B1	14-07-2009	NONE	
