



US 20250259726A1

(19) **United States**

(12) **Patent Application Publication**
Naber et al.

(10) **Pub. No.: US 2025/0259726 A1**

(43) **Pub. Date: Aug. 14, 2025**

(54) **TECHNIQUES FOR TRANSPORTING
AUTONOMOUS PATIENT SUPPORT
APPARATUSES AND MEDICAL EQUIPMENT
TO AN INCIDENT SCENE**

Publication Classification

(51) **Int. Cl.**
G16H 20/13 (2018.01)
G05D 1/228 (2024.01)
(52) **U.S. Cl.**
CPC **G16H 20/13** (2018.01); **G05D 1/228**
(2024.01)

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(21) Appl. No.: **19/195,913**

(22) Filed: **May 1, 2025**

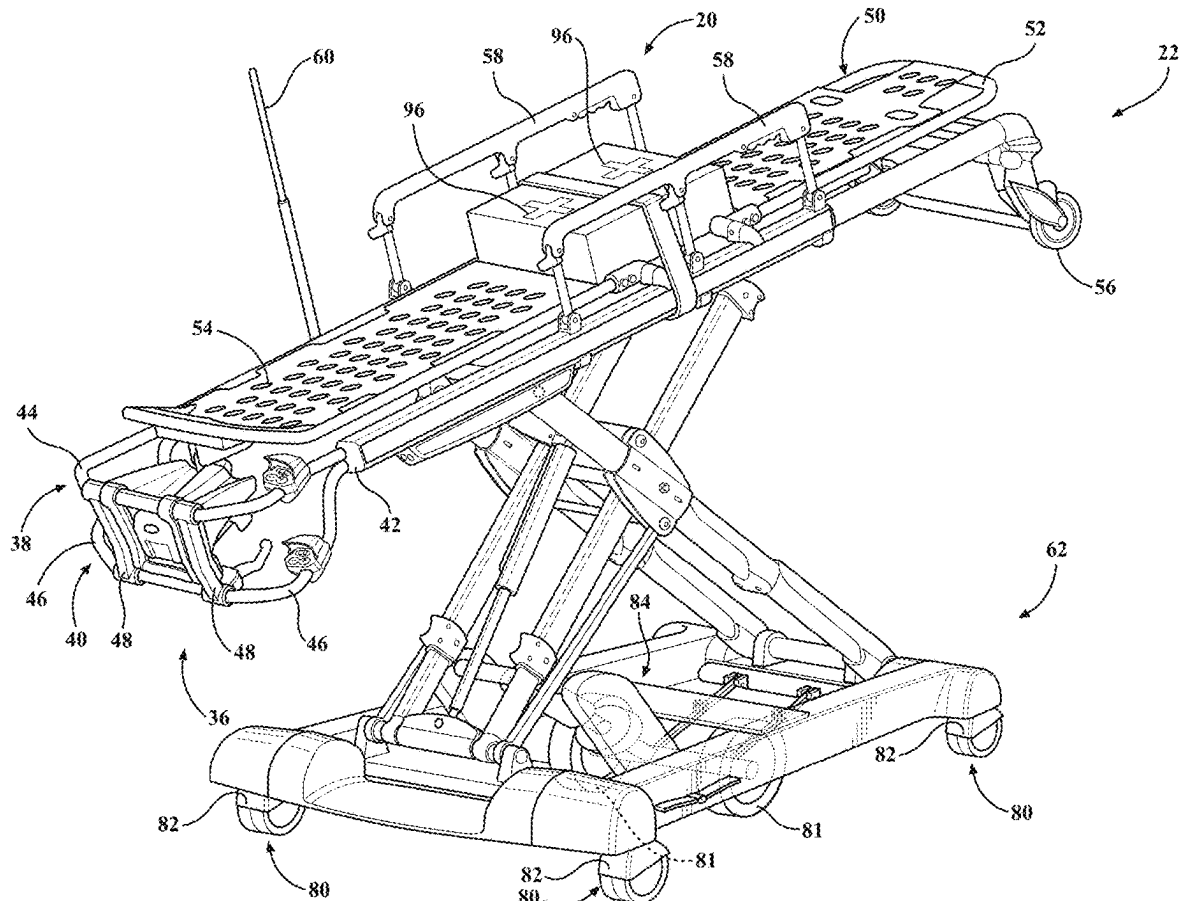
Related U.S. Application Data

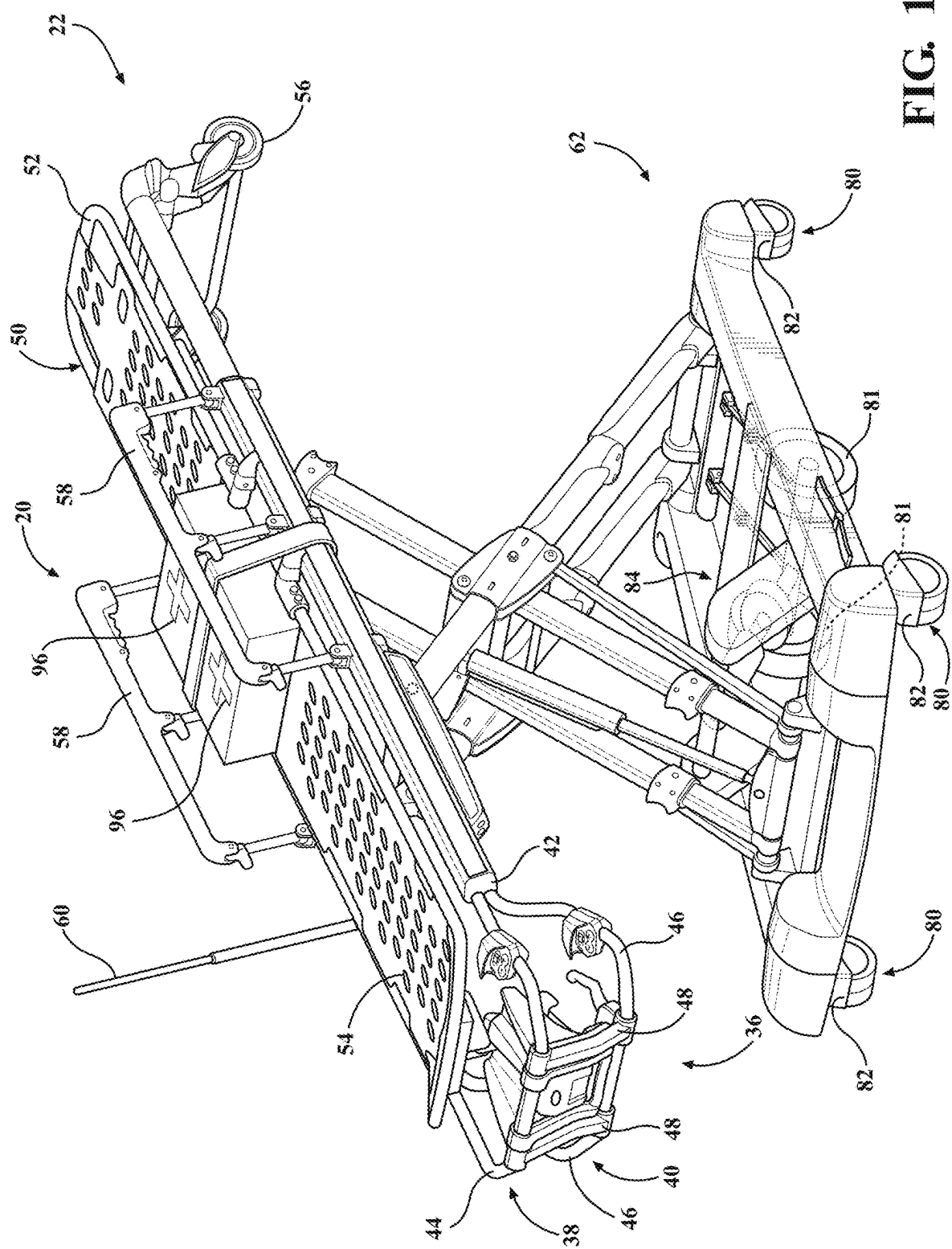
(63) Continuation of application No. 18/436,077, filed on Feb. 8, 2024, now Pat. No. 12,315,613, which is a continuation of application No. 16/671,723, filed on Nov. 1, 2019, now Pat. No. 11,929,157.

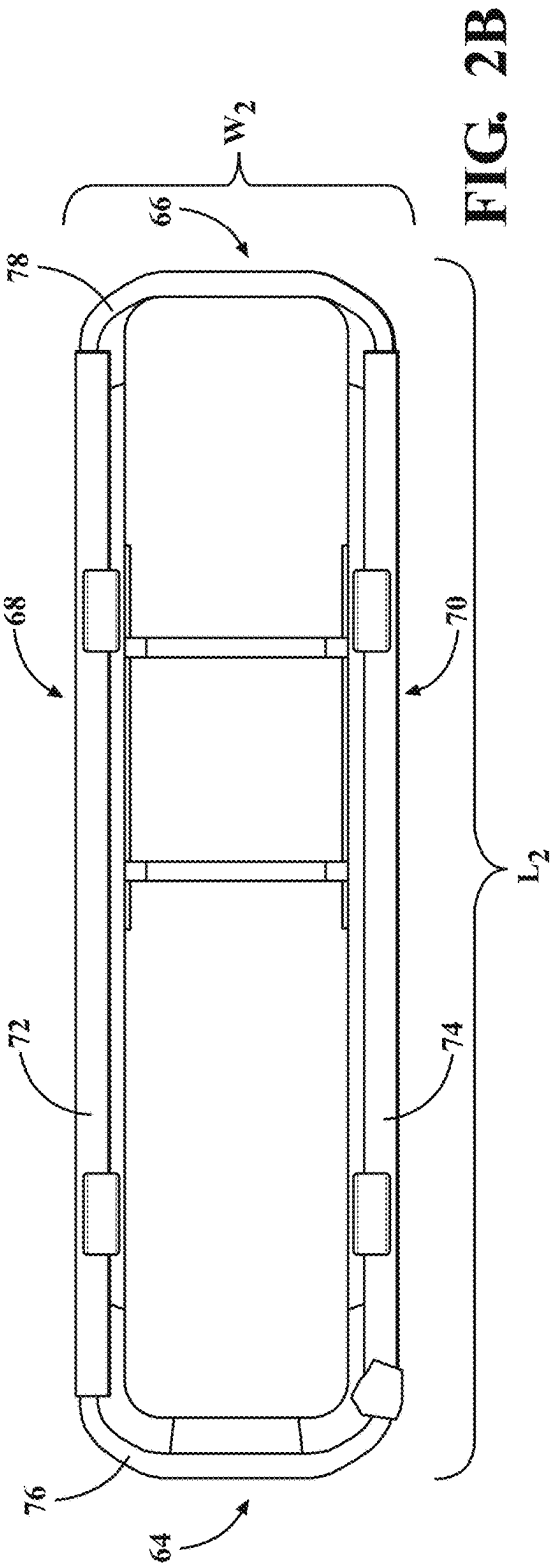
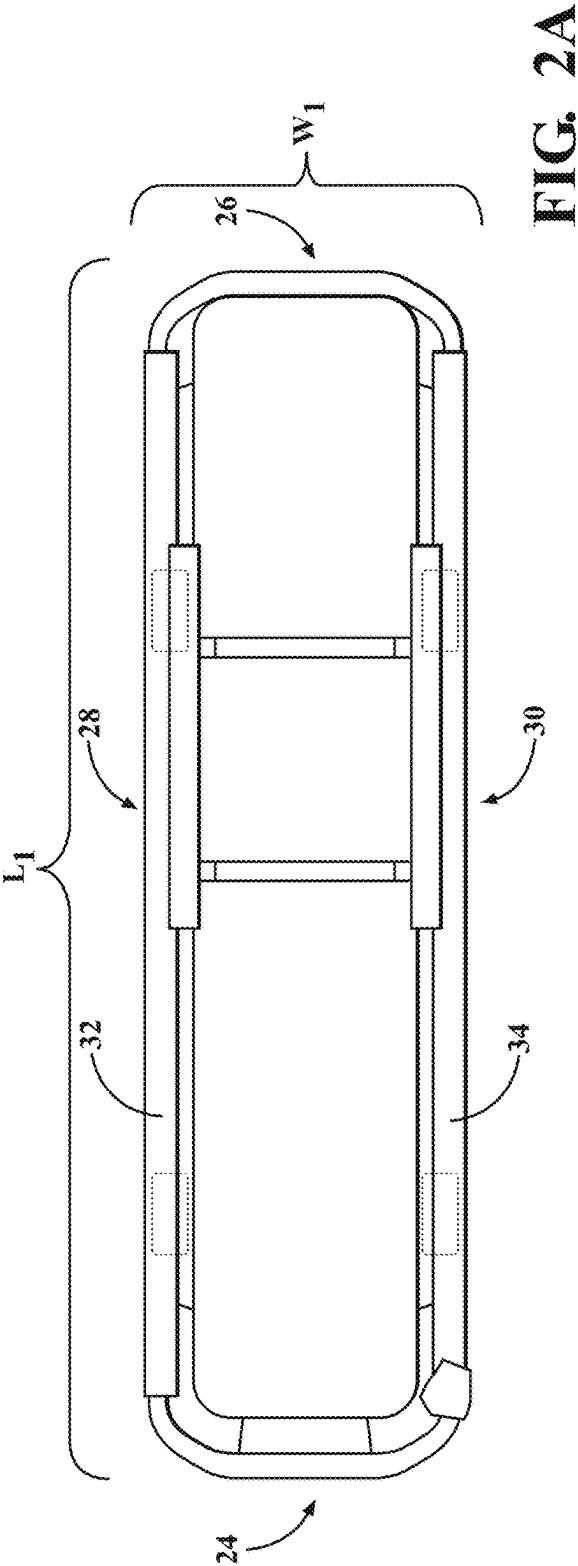
(60) Provisional application No. 62/754,773, filed on Nov. 2, 2018, provisional application No. 62/754,798, filed on Nov. 2, 2018, provisional application No. 62/754,836, filed on Nov. 2, 2018.

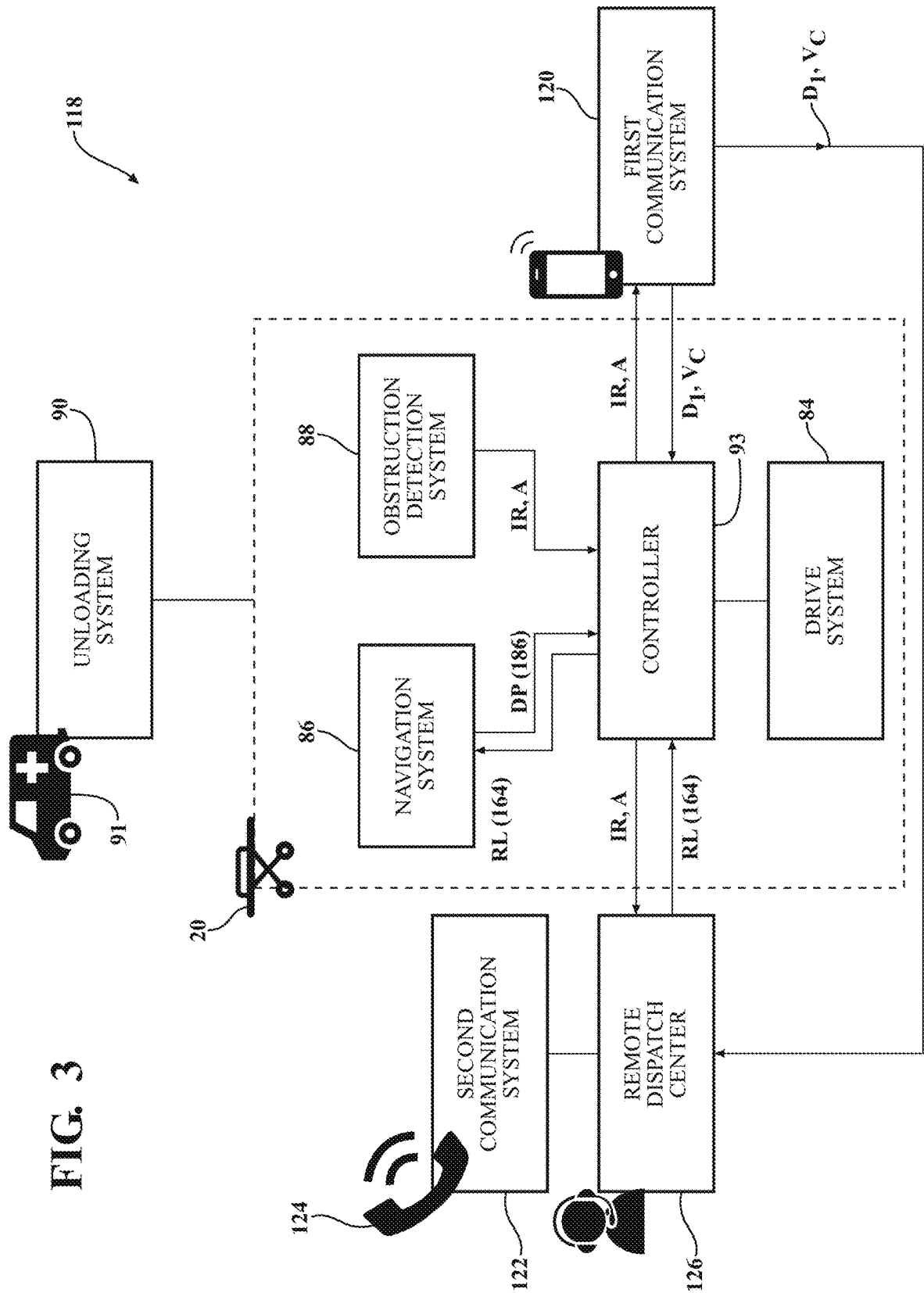
(57) **ABSTRACT**

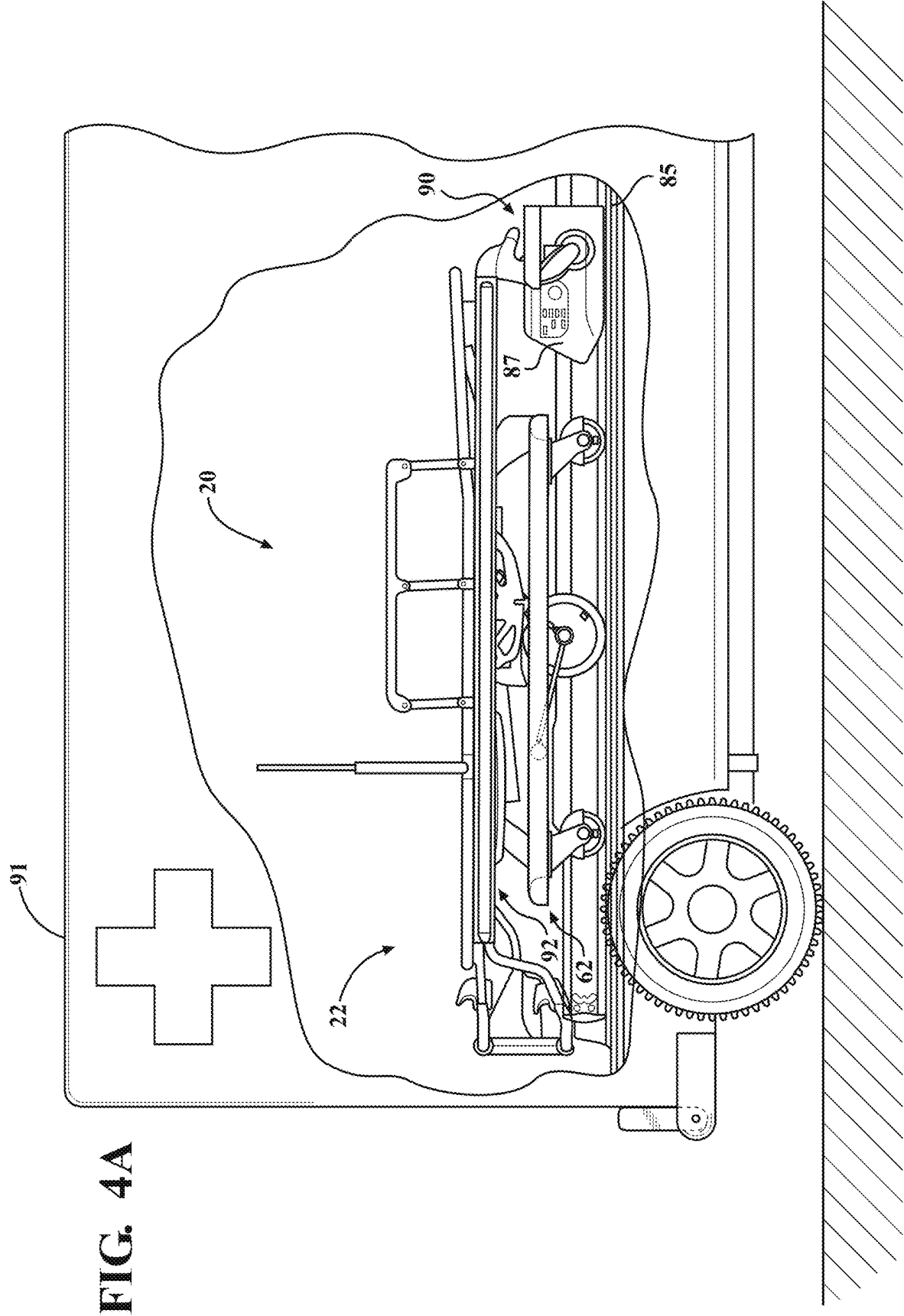
A method of transporting equipment modules to an incident scene with an comprises: determining an initial location of the incident scene; dispatching an ambulance loaded with the autonomous mobile response unit and a plurality of equipment modules to the initial location; determining a refined location of the incident scene; selecting a first equipment module; dispensing the first equipment module from the ambulance onto the autonomous mobile response unit; deploying the autonomous mobile response unit from the ambulance at the initial location; communicating the refined location of the incident scene to the autonomous mobile response unit; generating, with the navigation system, a drive path from the initial location to the refined location; and driving, with the drive system, the autonomous mobile response unit loaded with the first equipment module based on the drive path such that the autonomous mobile response unit travels from the initial location to the refined location.



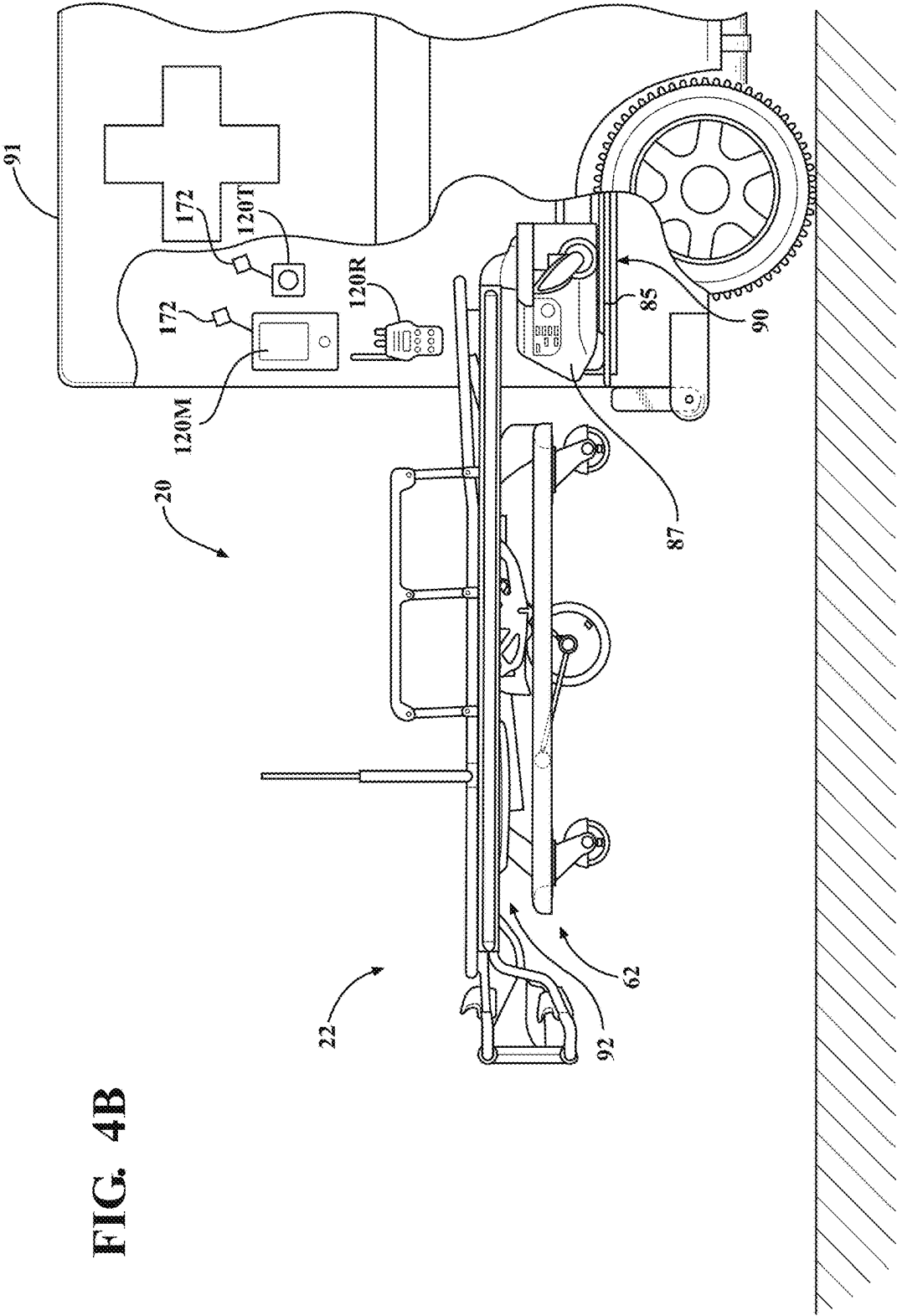


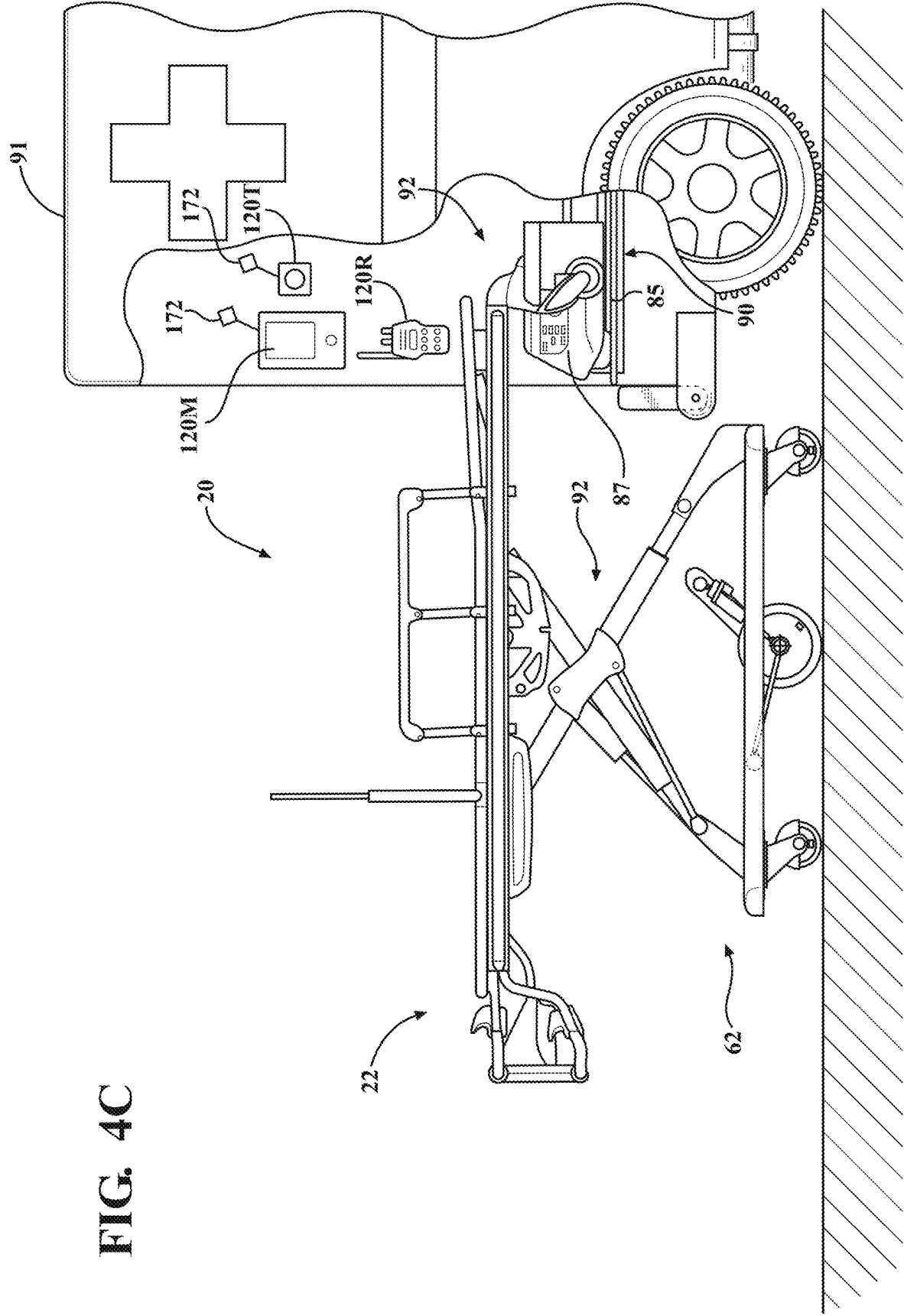






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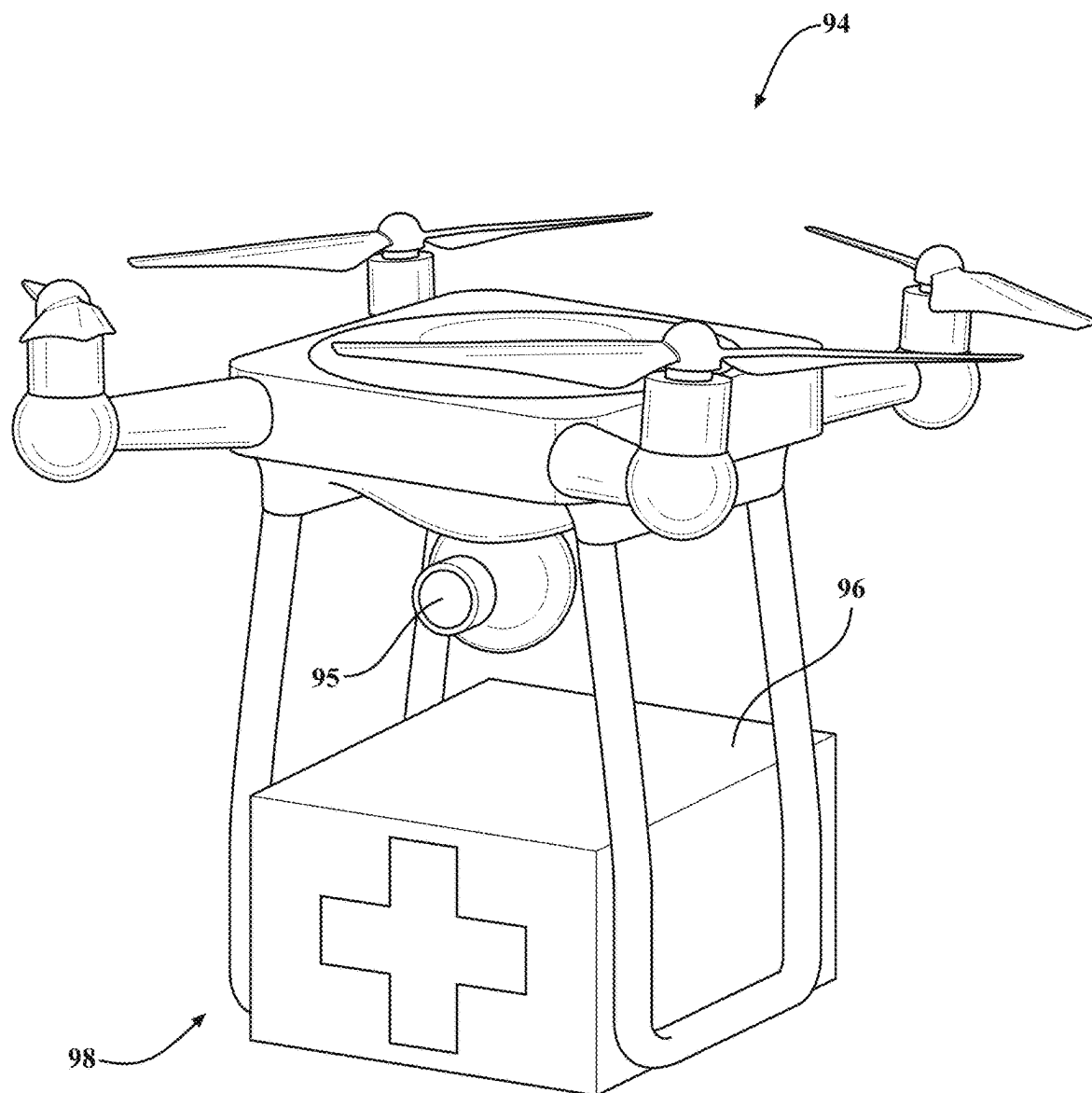
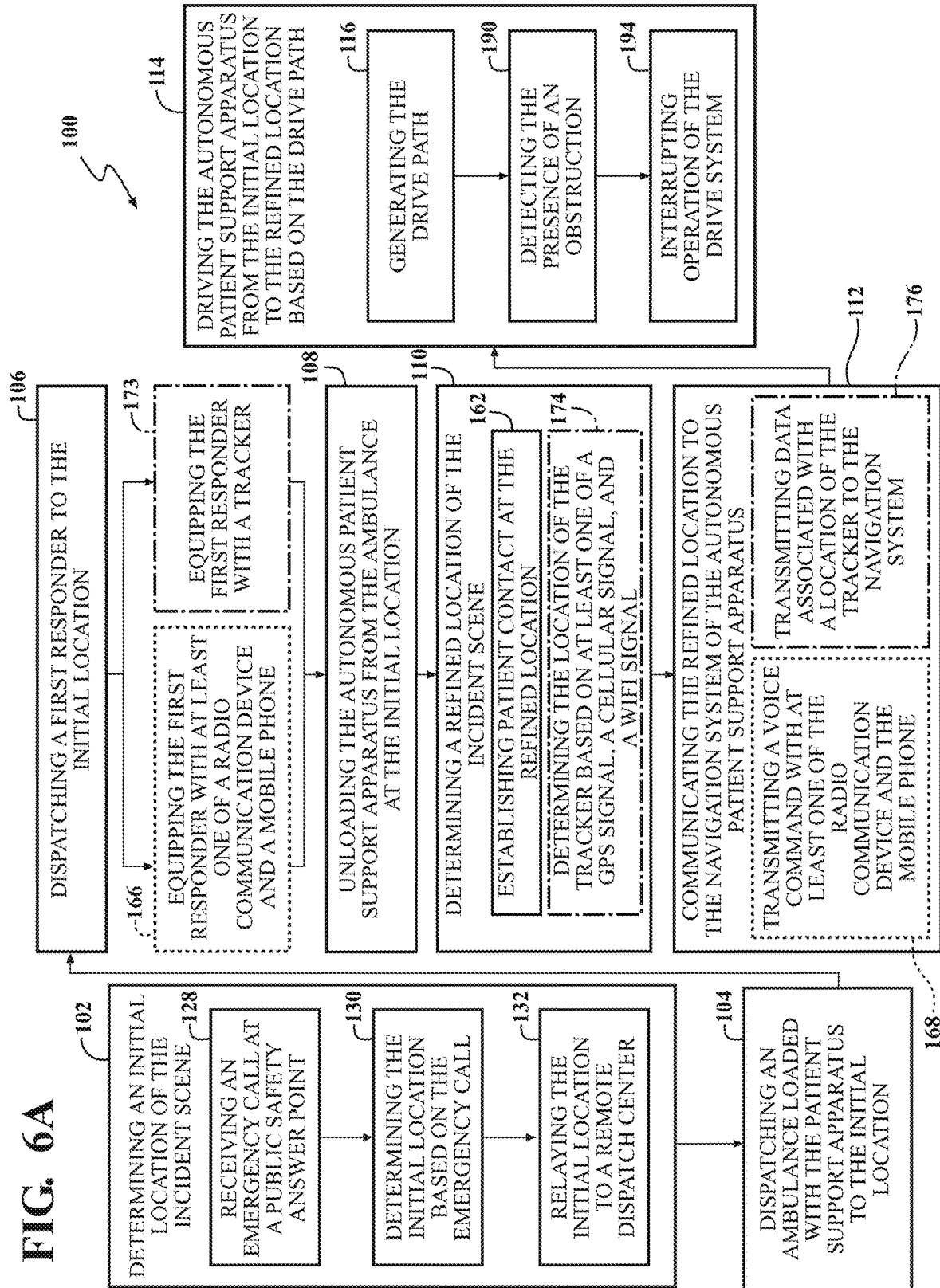


FIG. 5

FIG. 6A



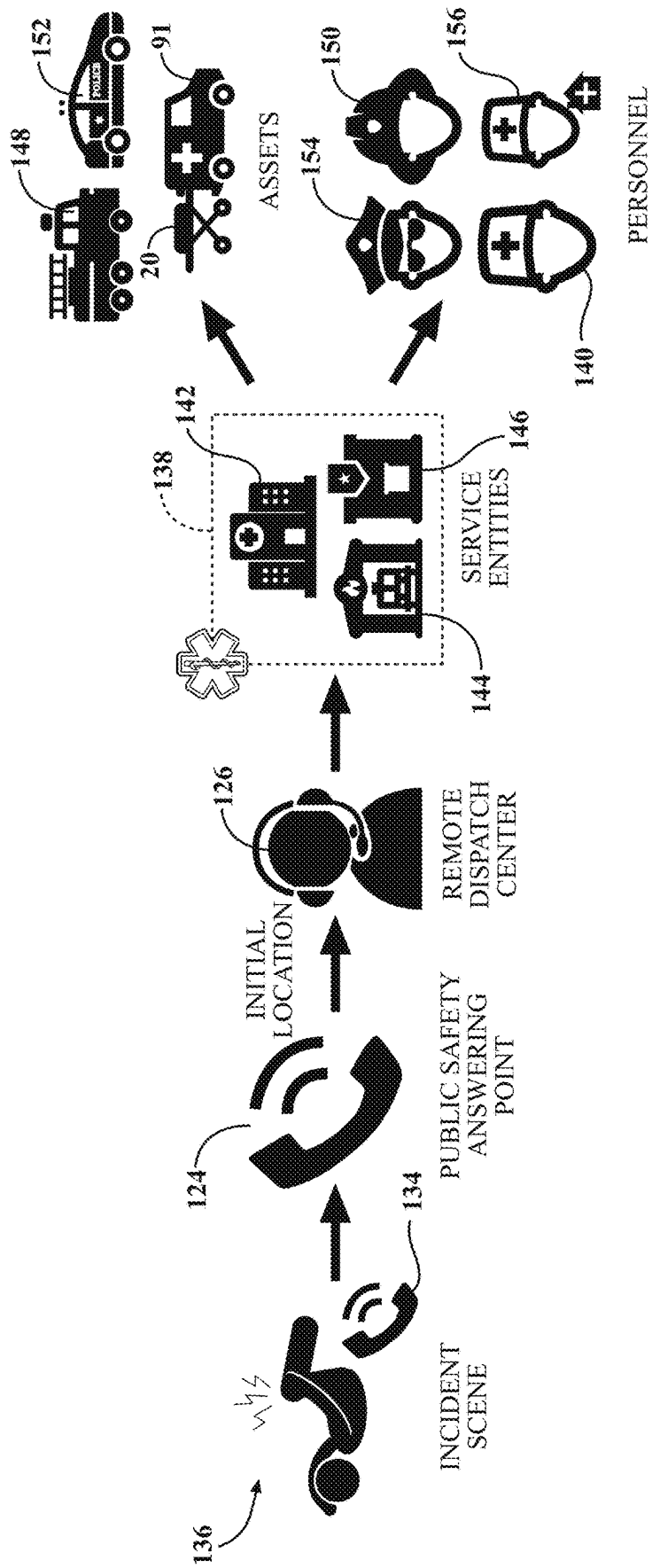
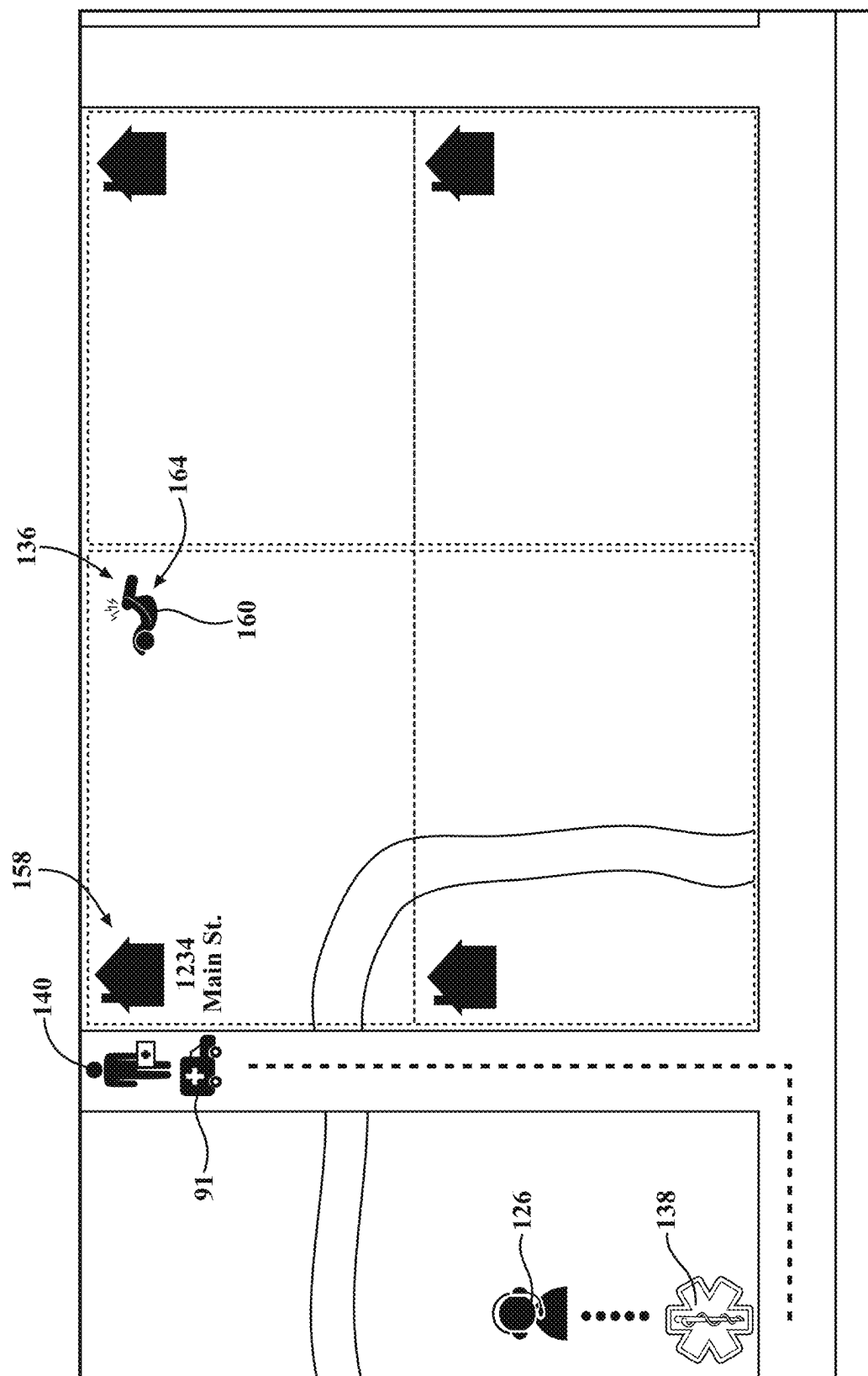


FIG. 6B



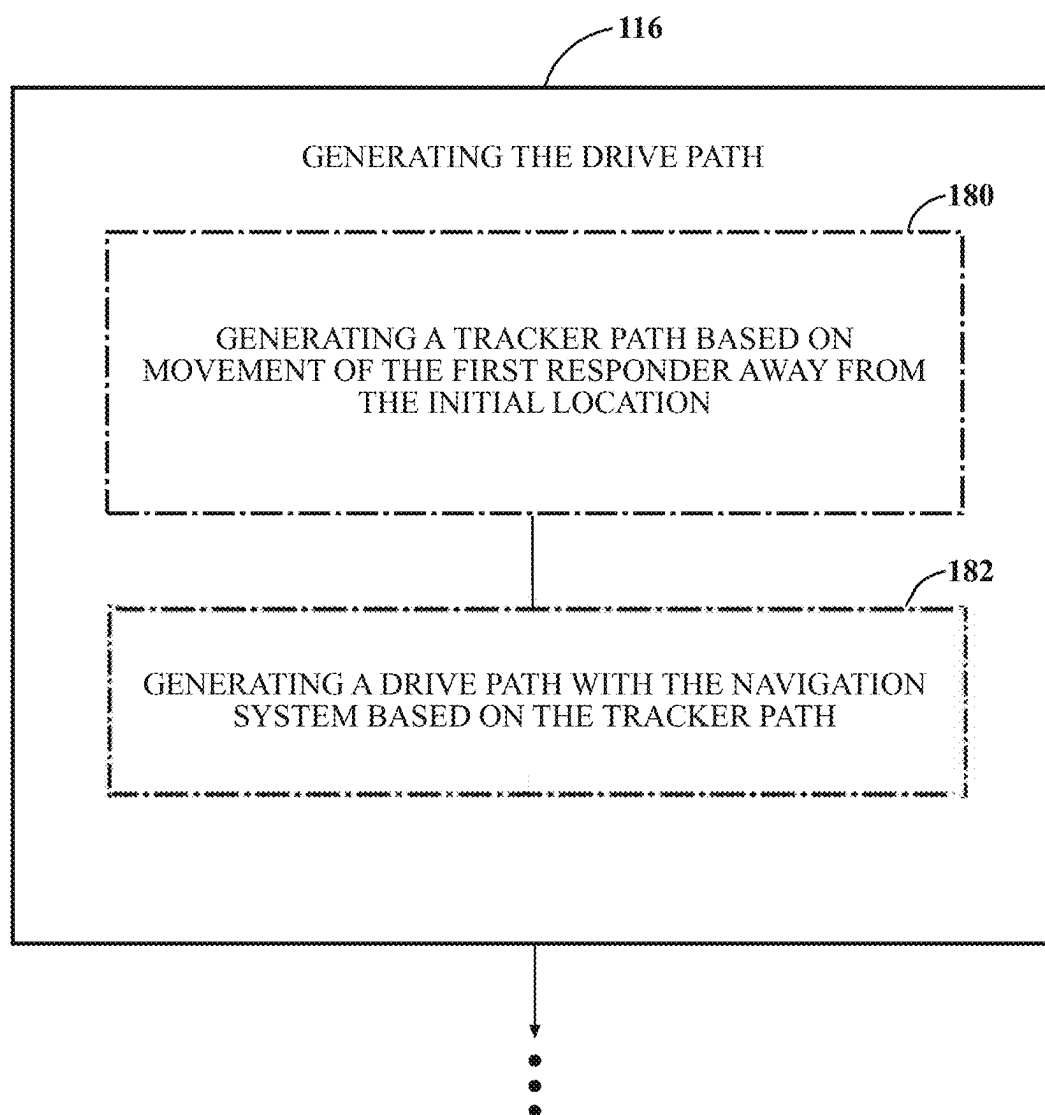


FIG. 6D

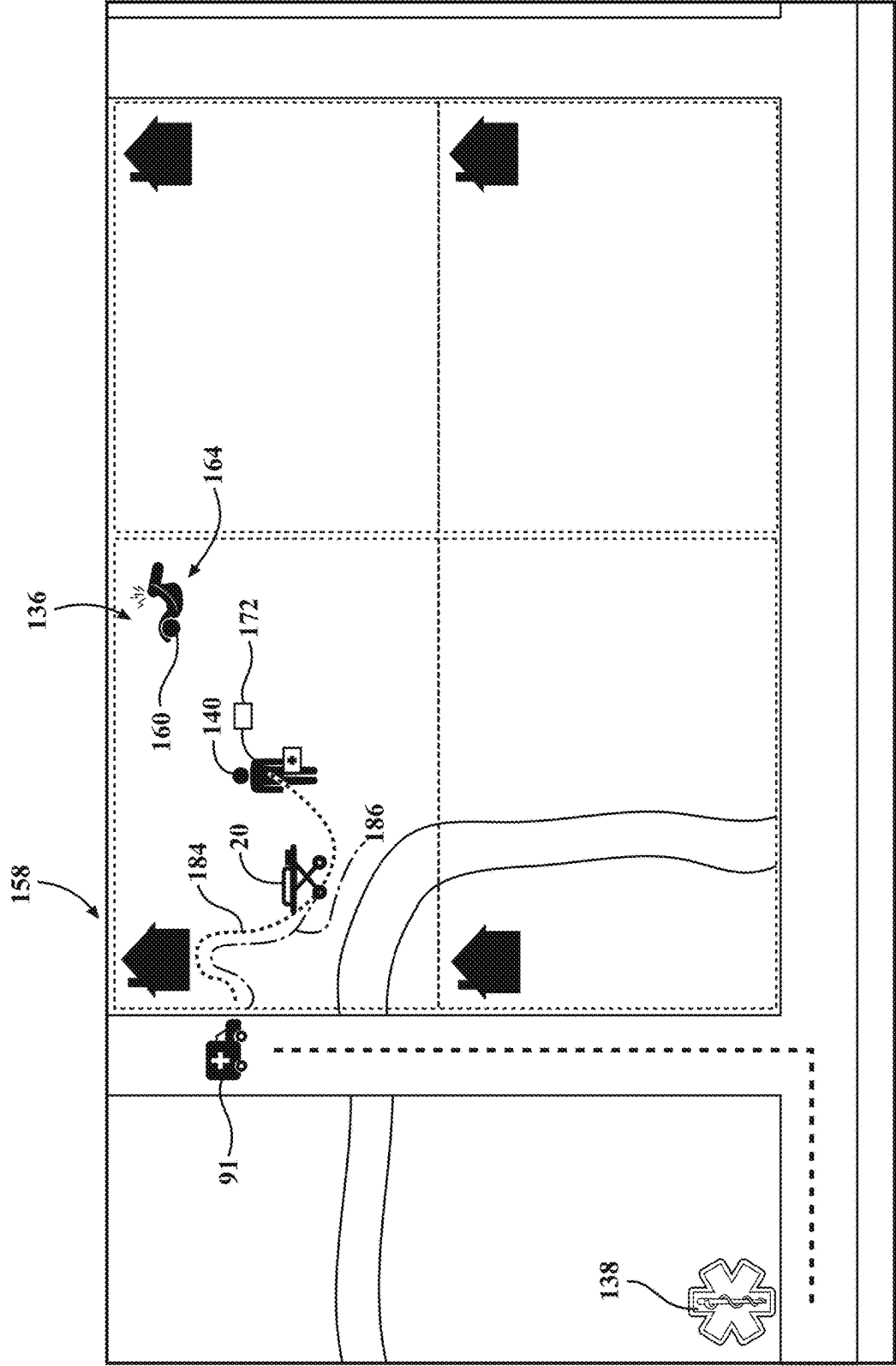


FIG. 6E

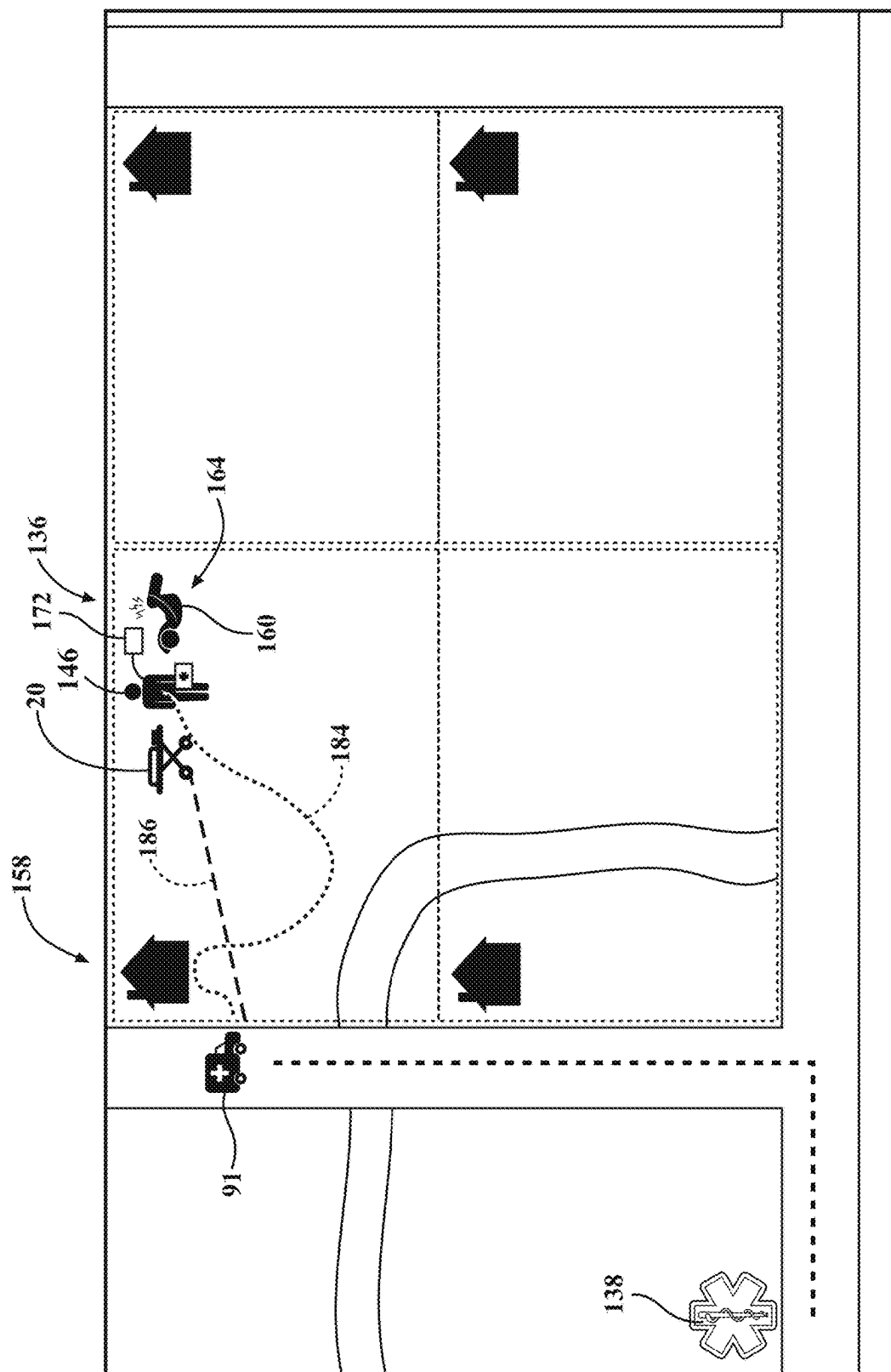


FIG. 6F

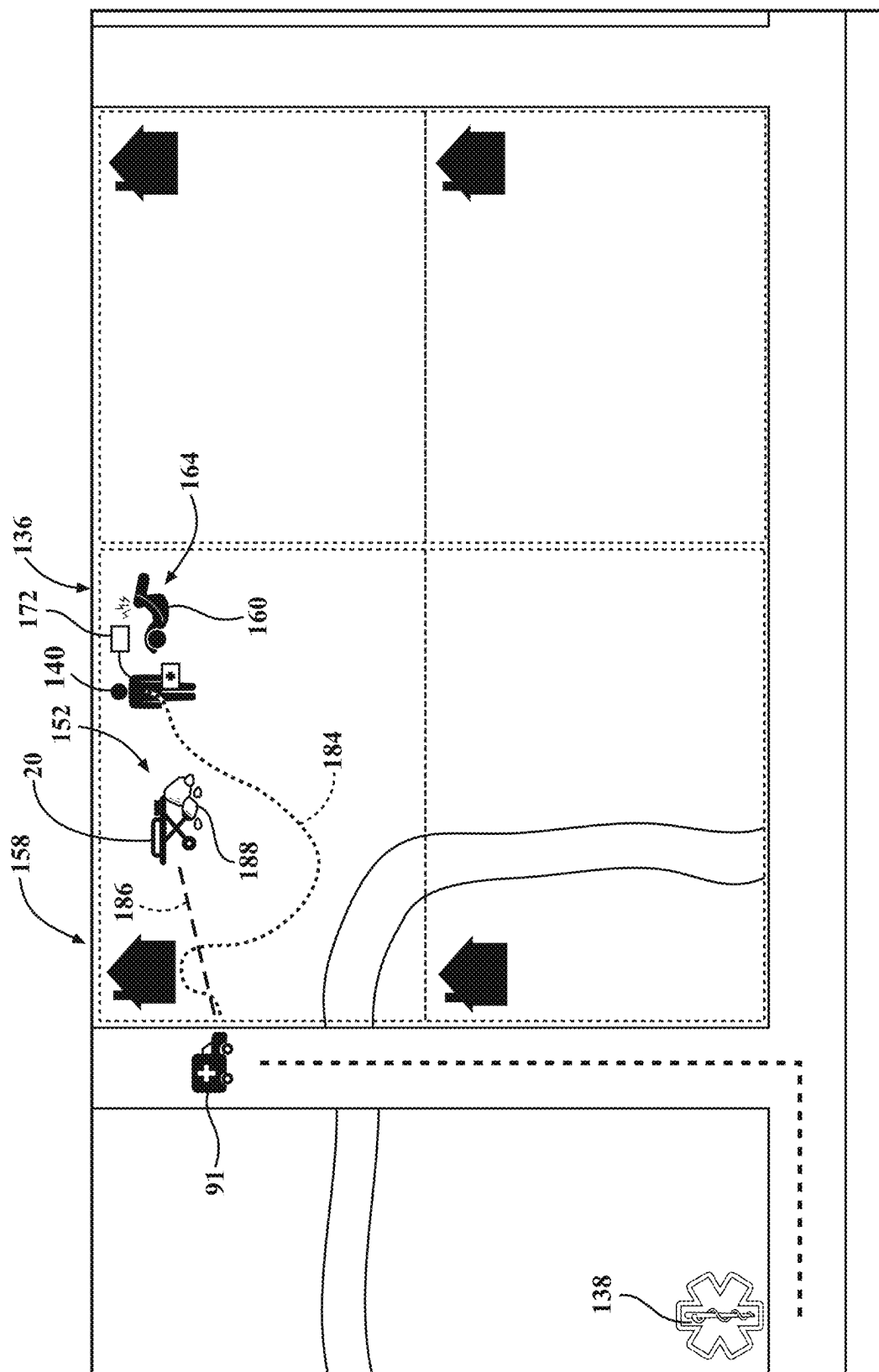
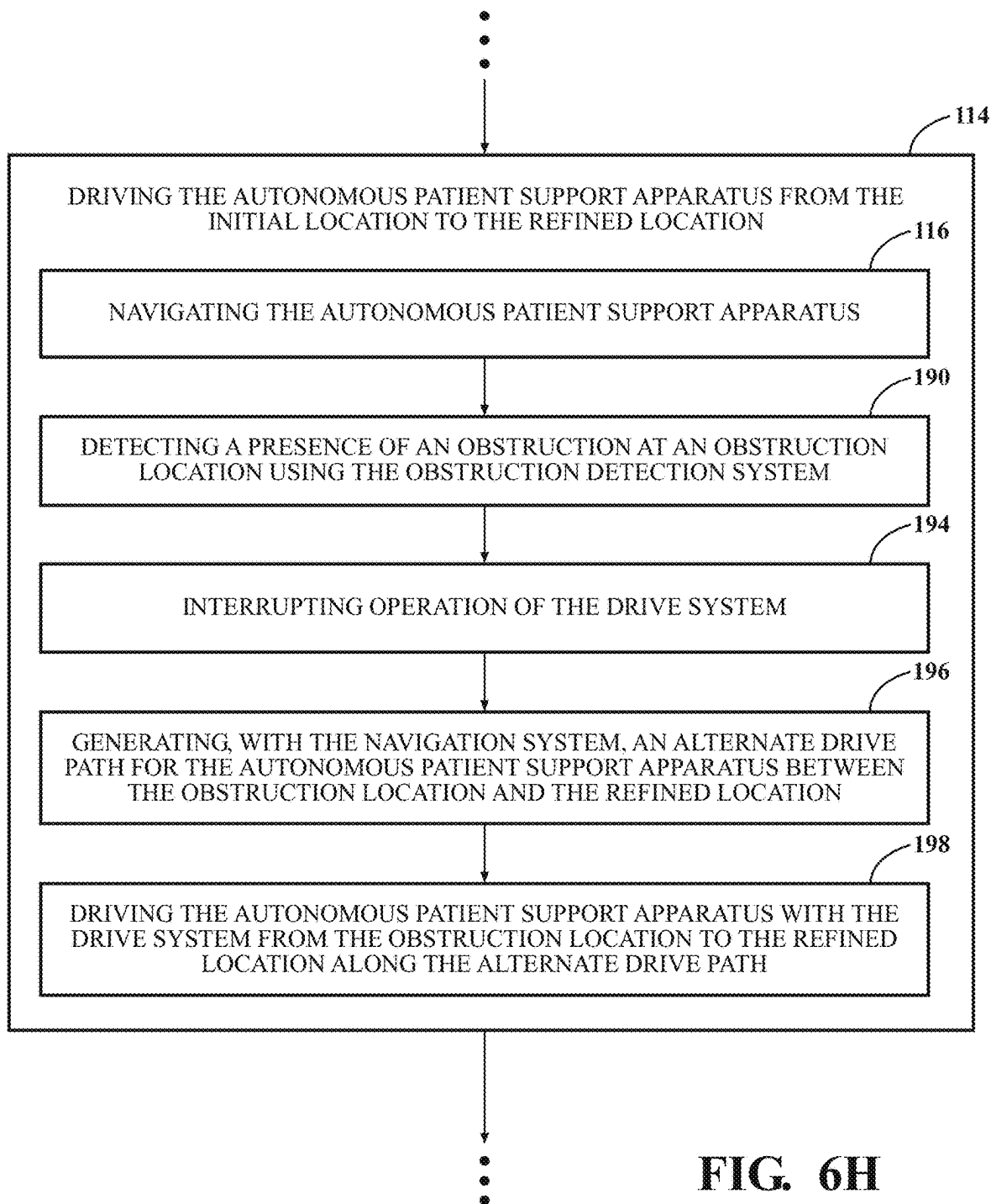
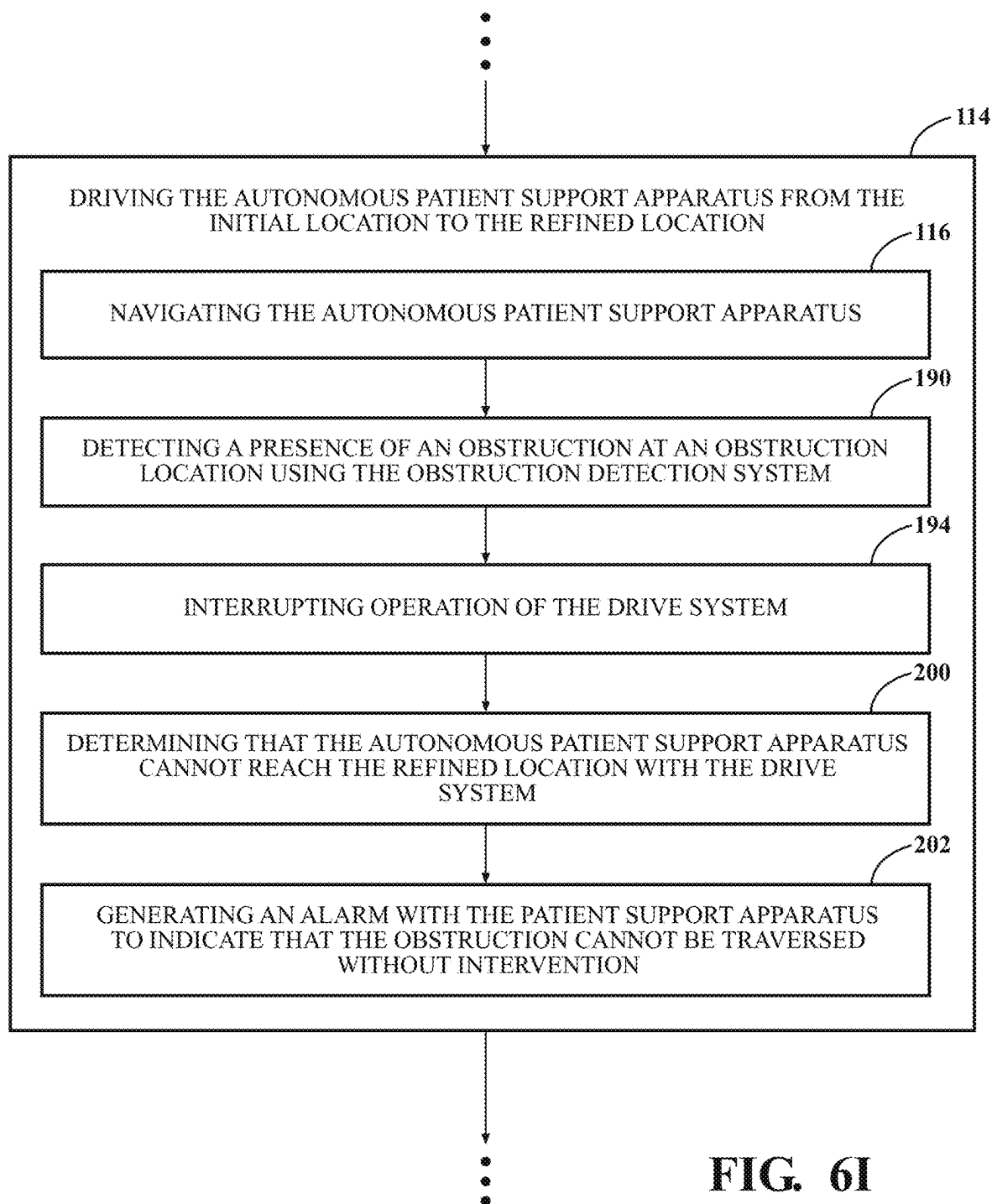


FIG. 6G





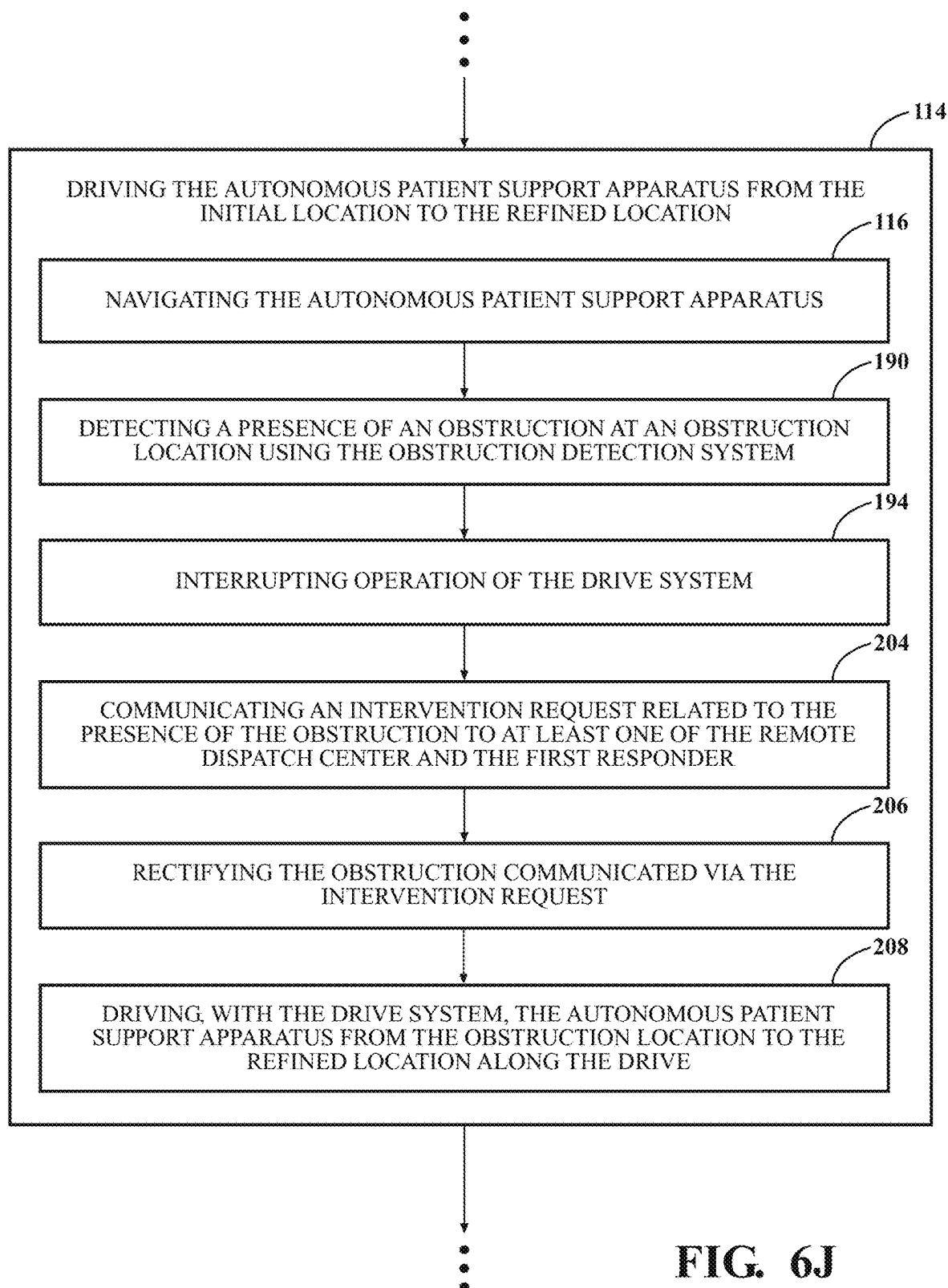


FIG. 6J

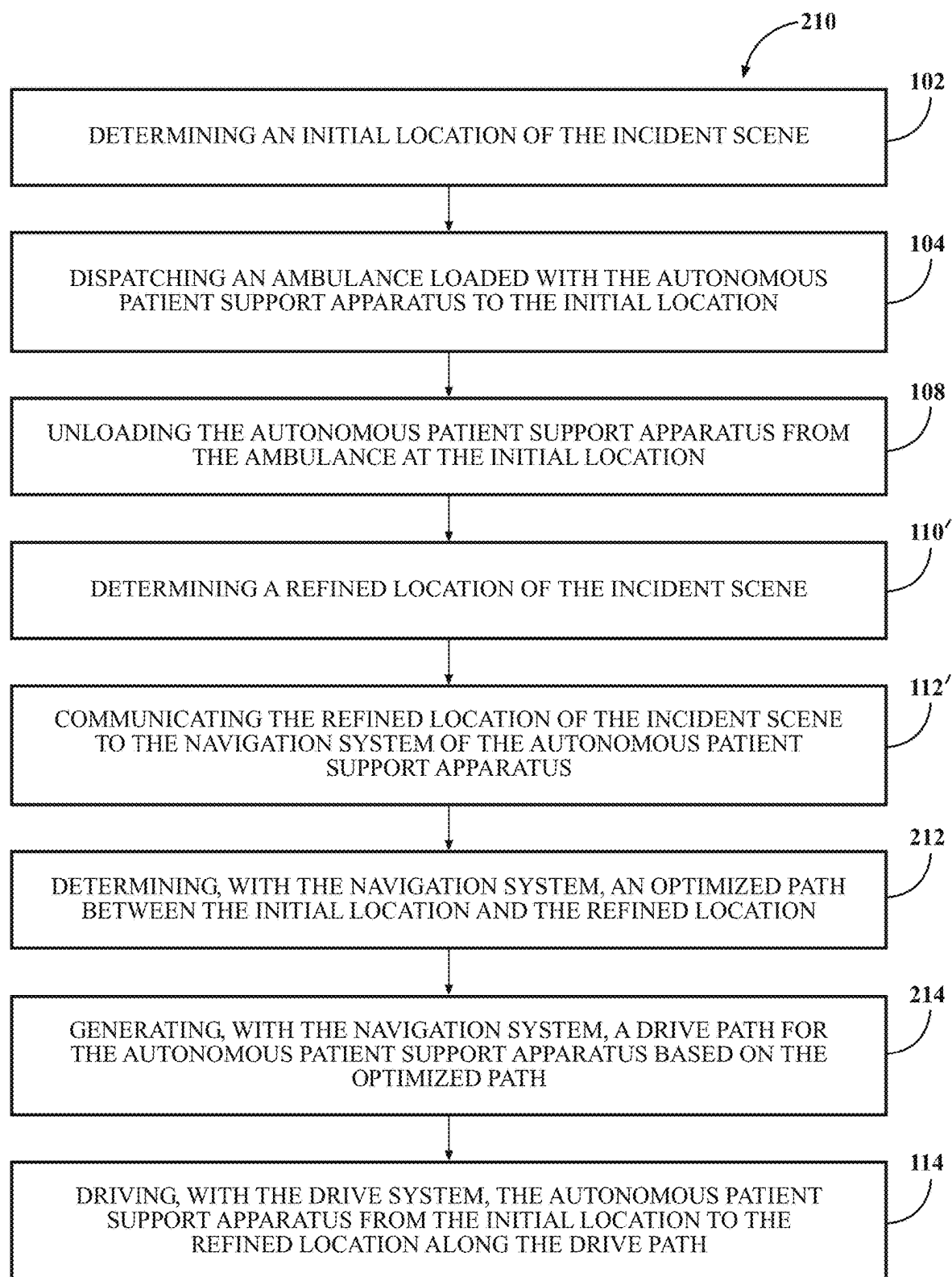
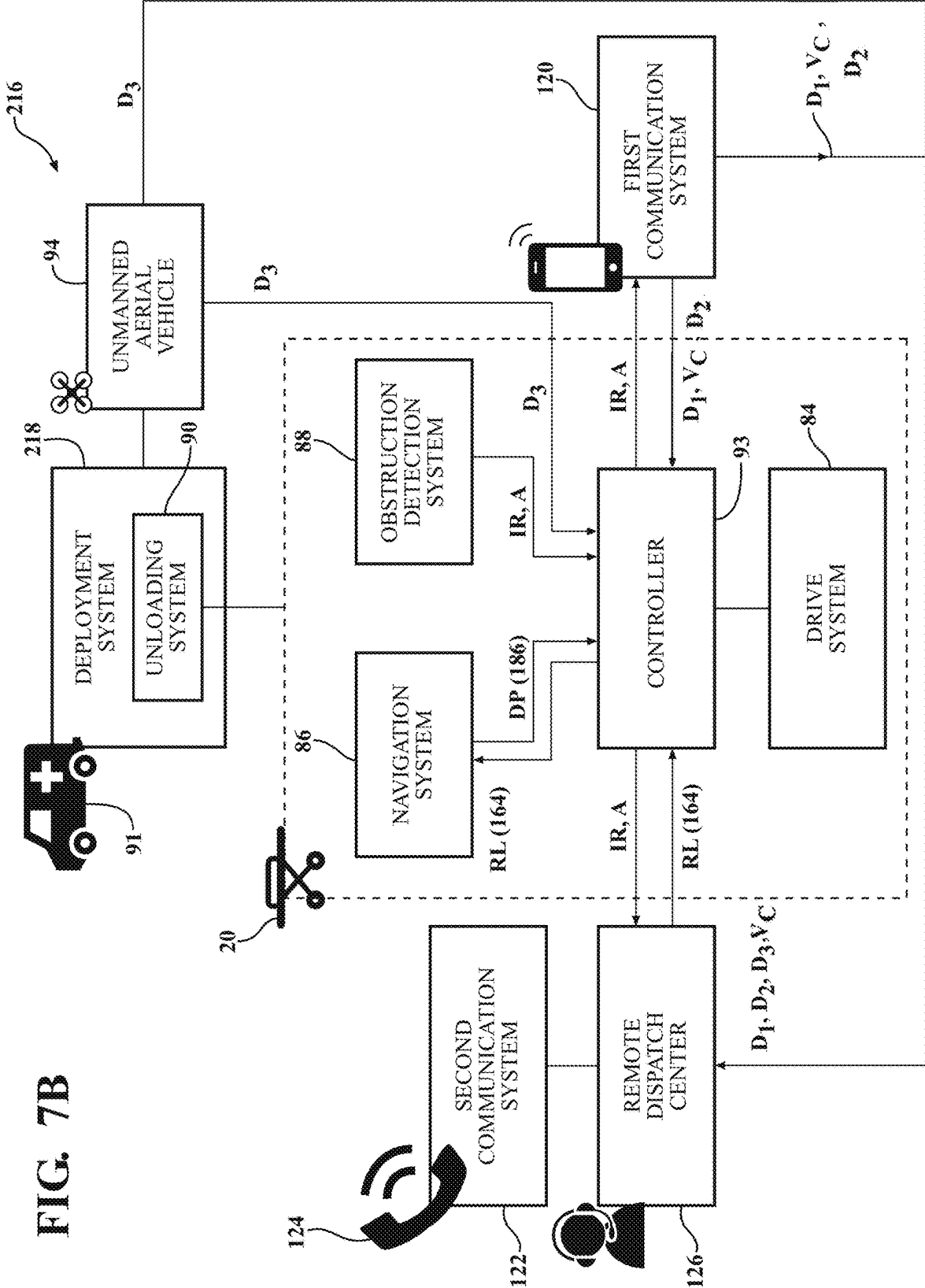


FIG. 7A

FIG. 7B



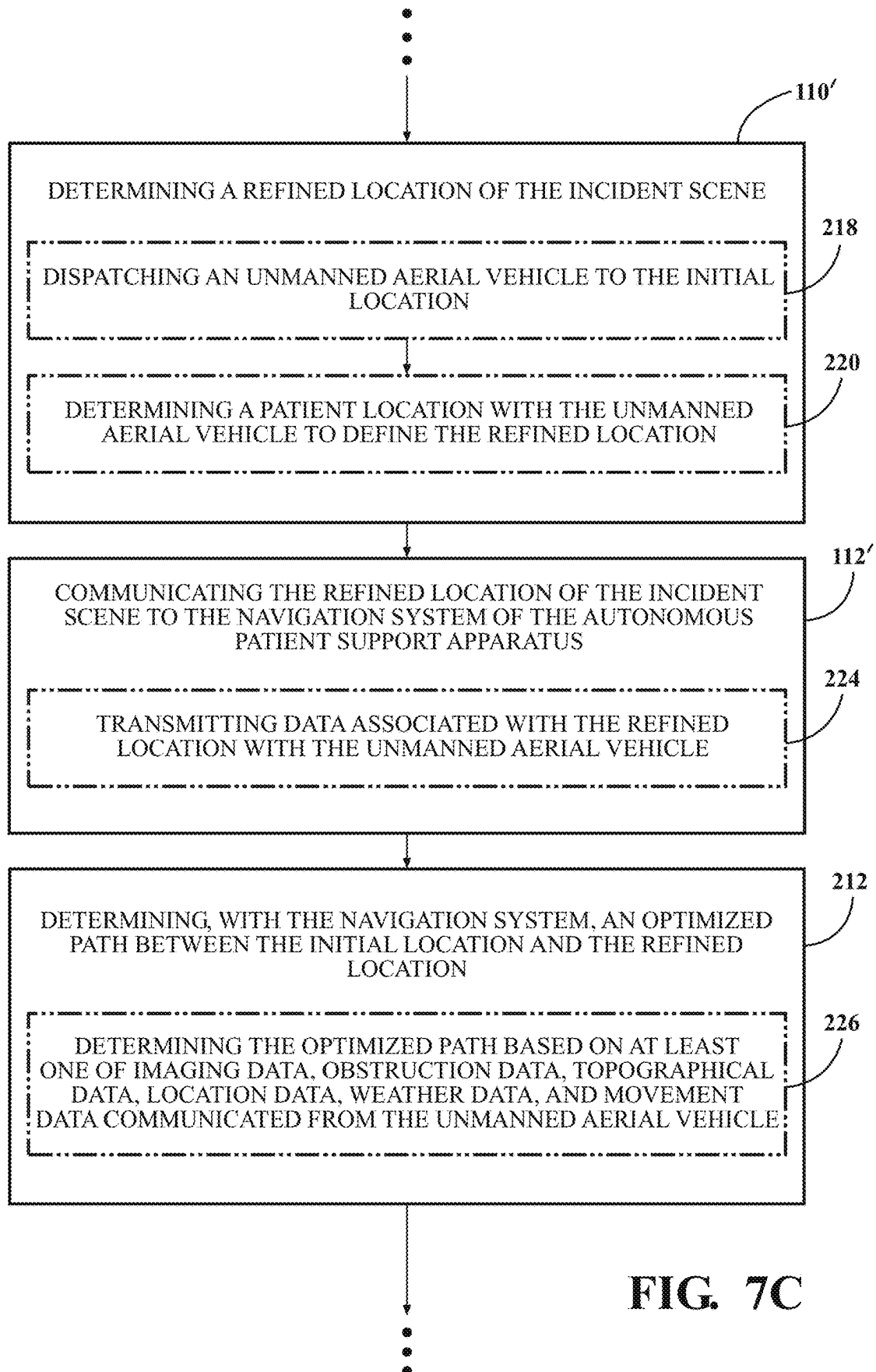


FIG. 7C

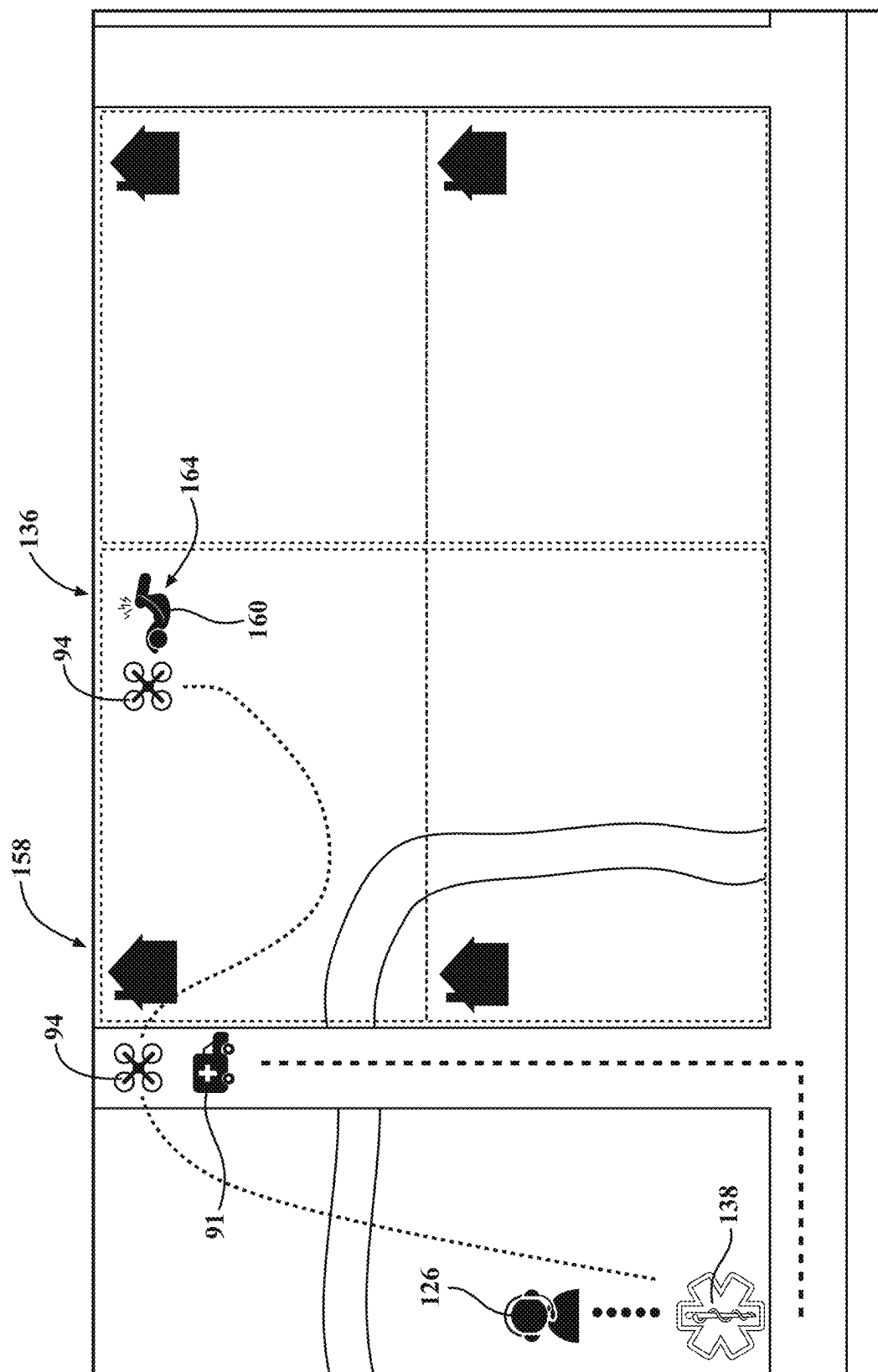


FIG. 7D

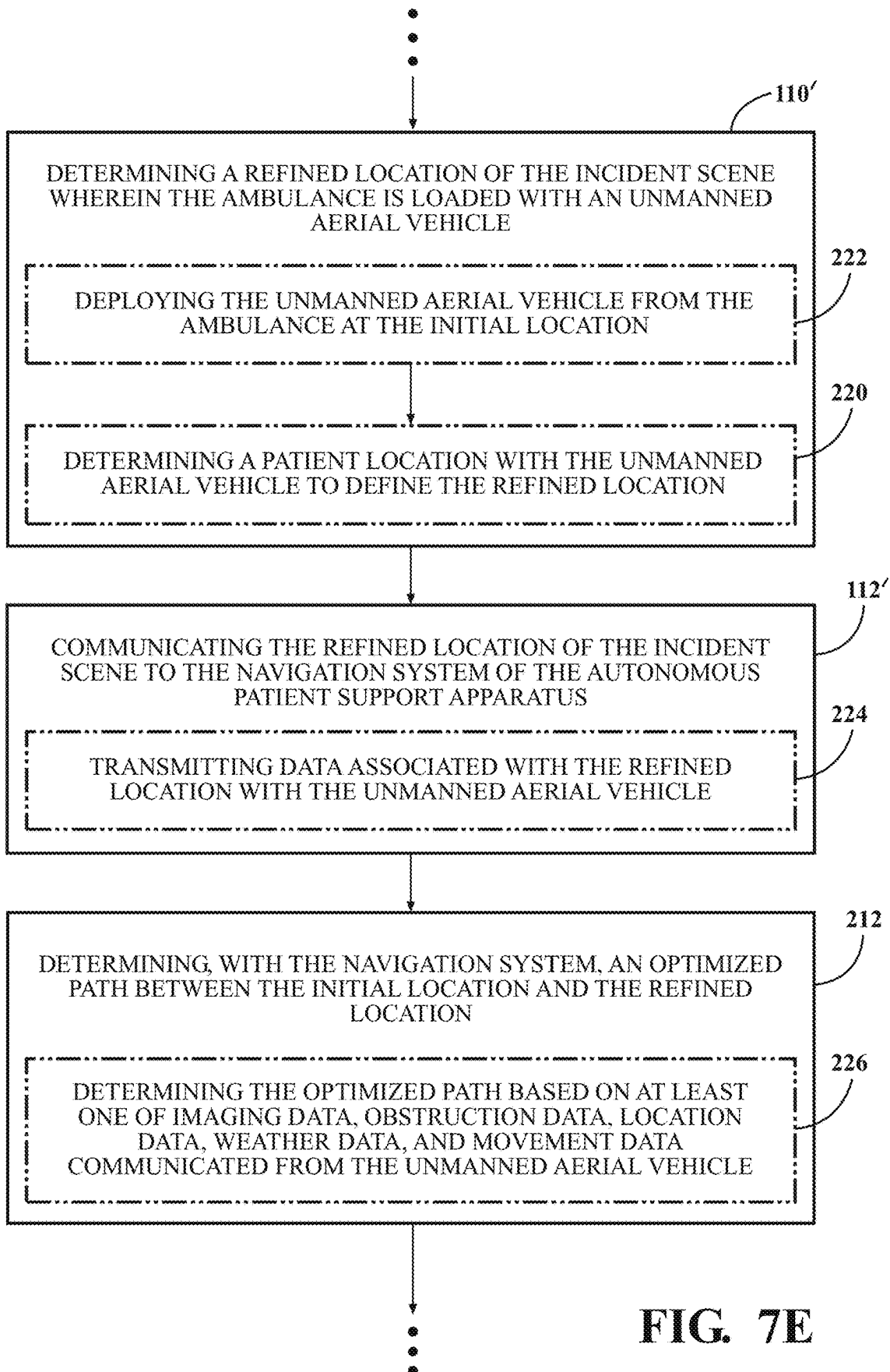


FIG. 7E

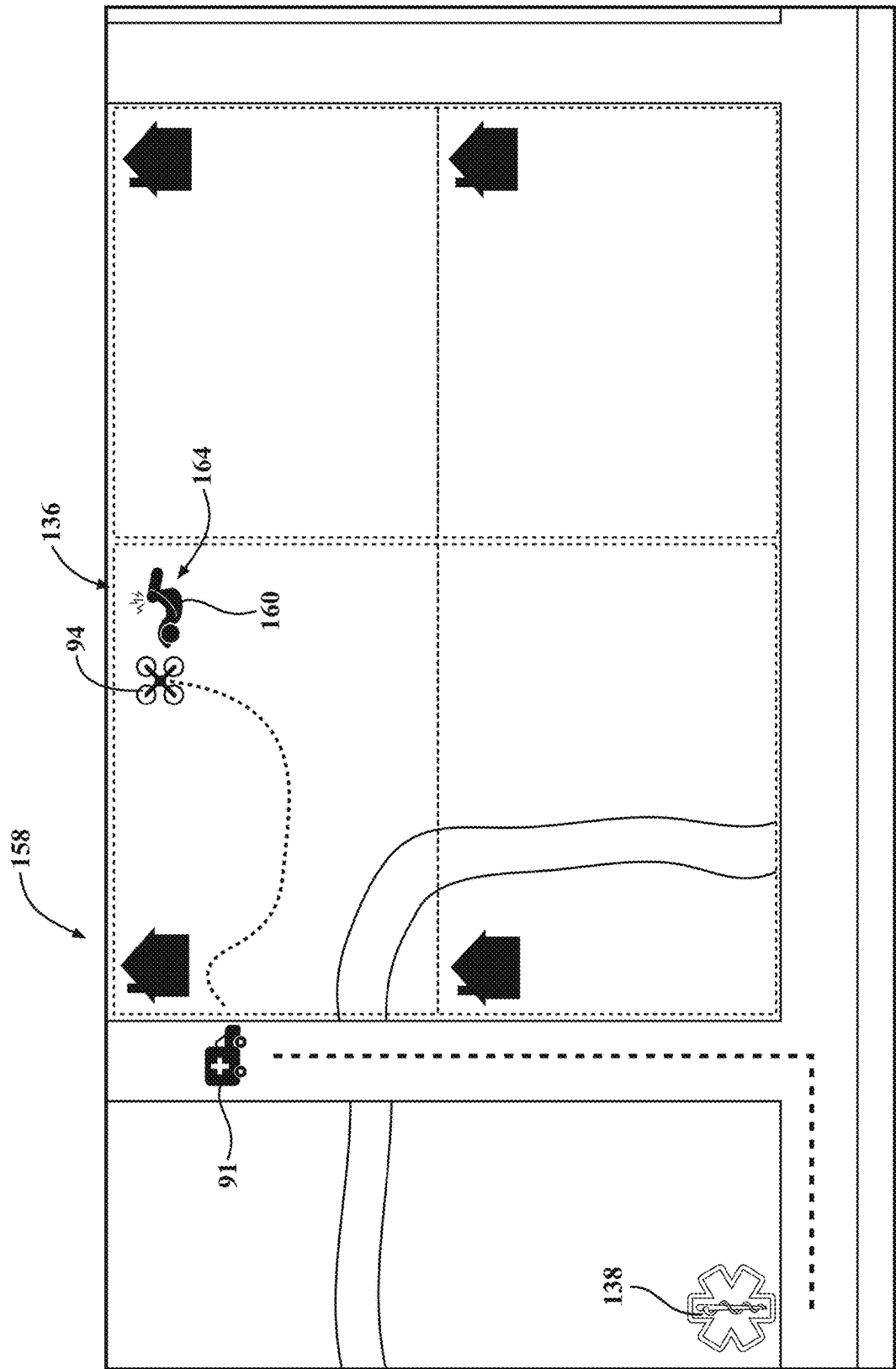


FIG. 7F

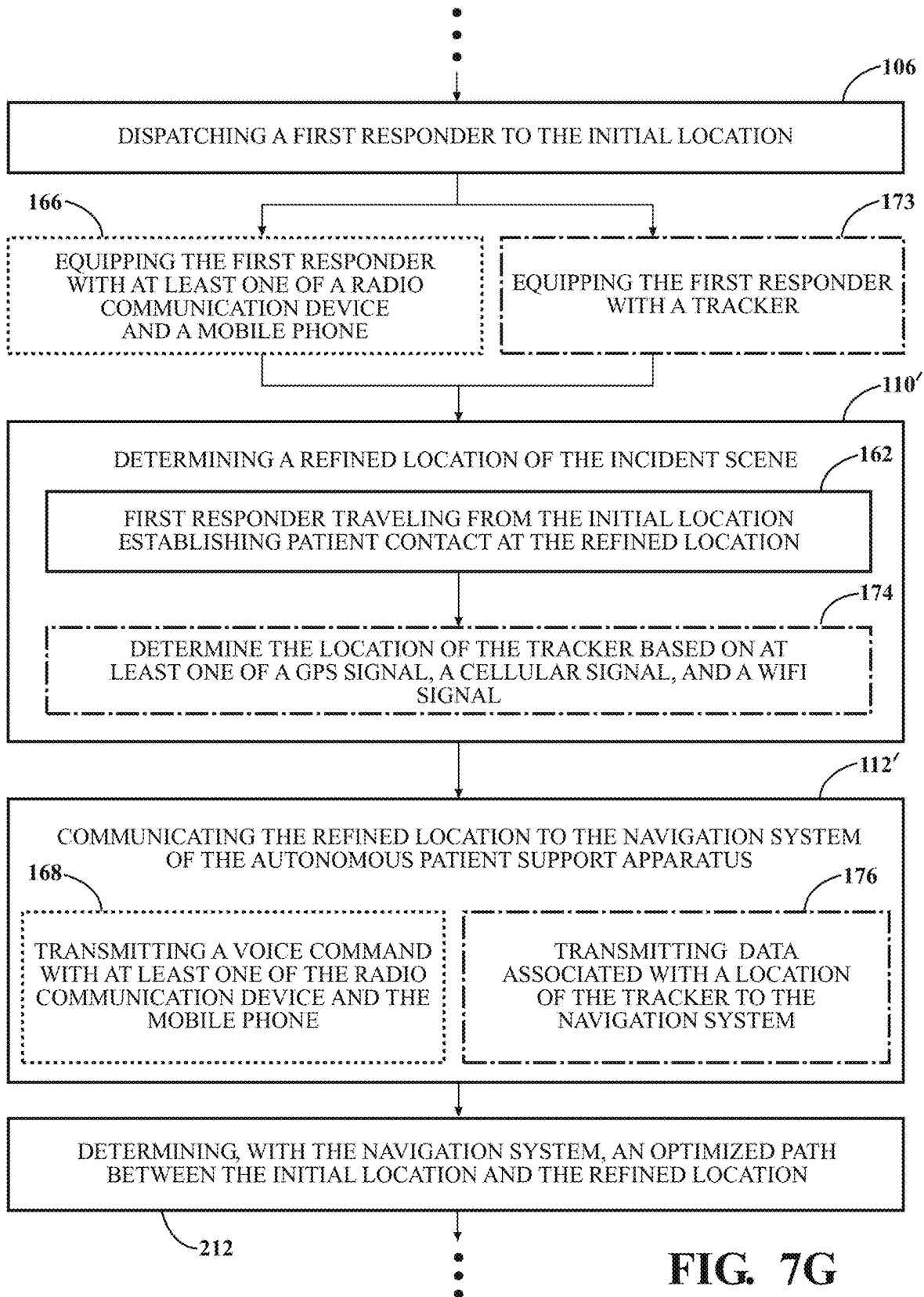


FIG. 7G

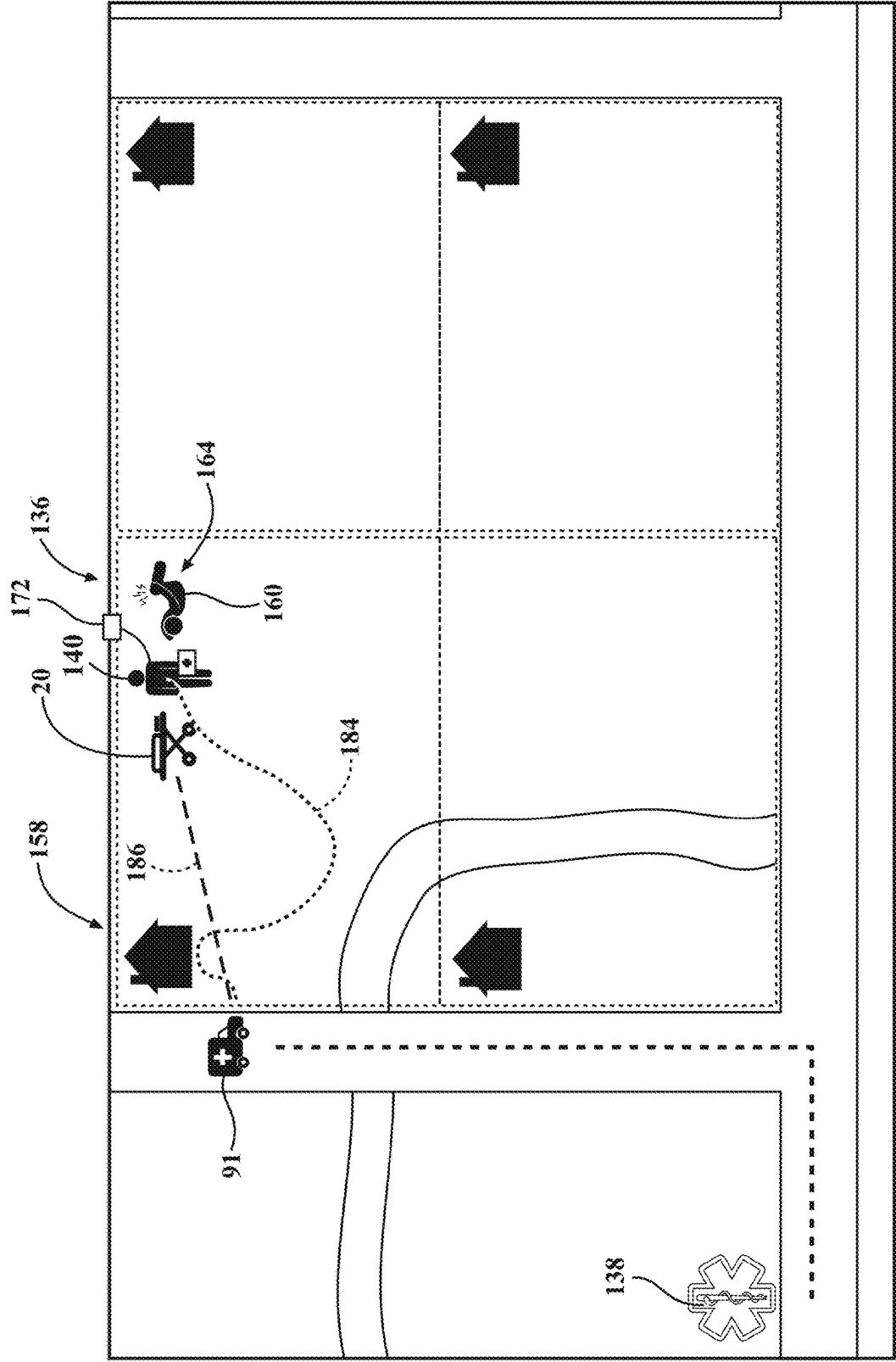


FIG. 7H

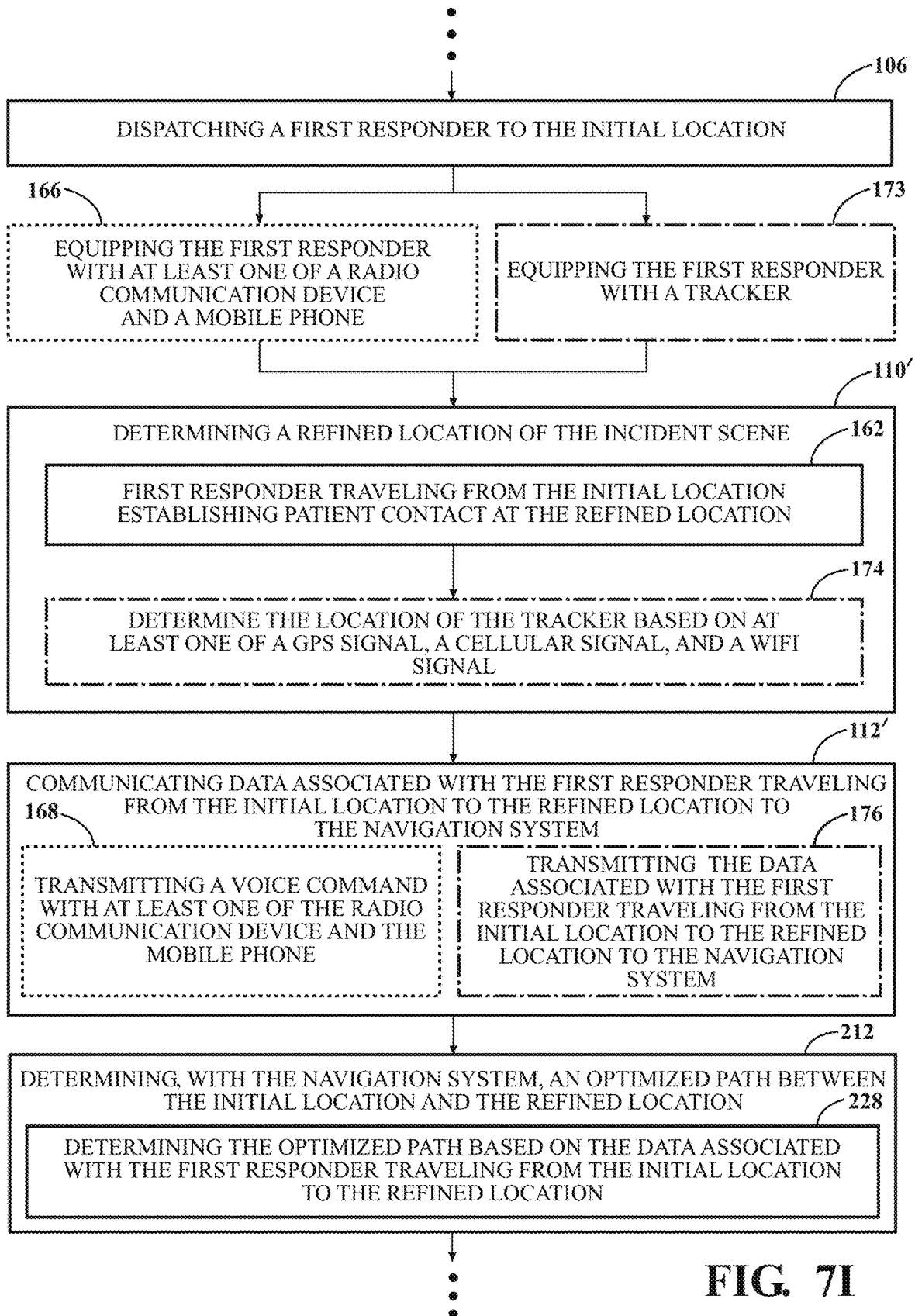


FIG. 7I

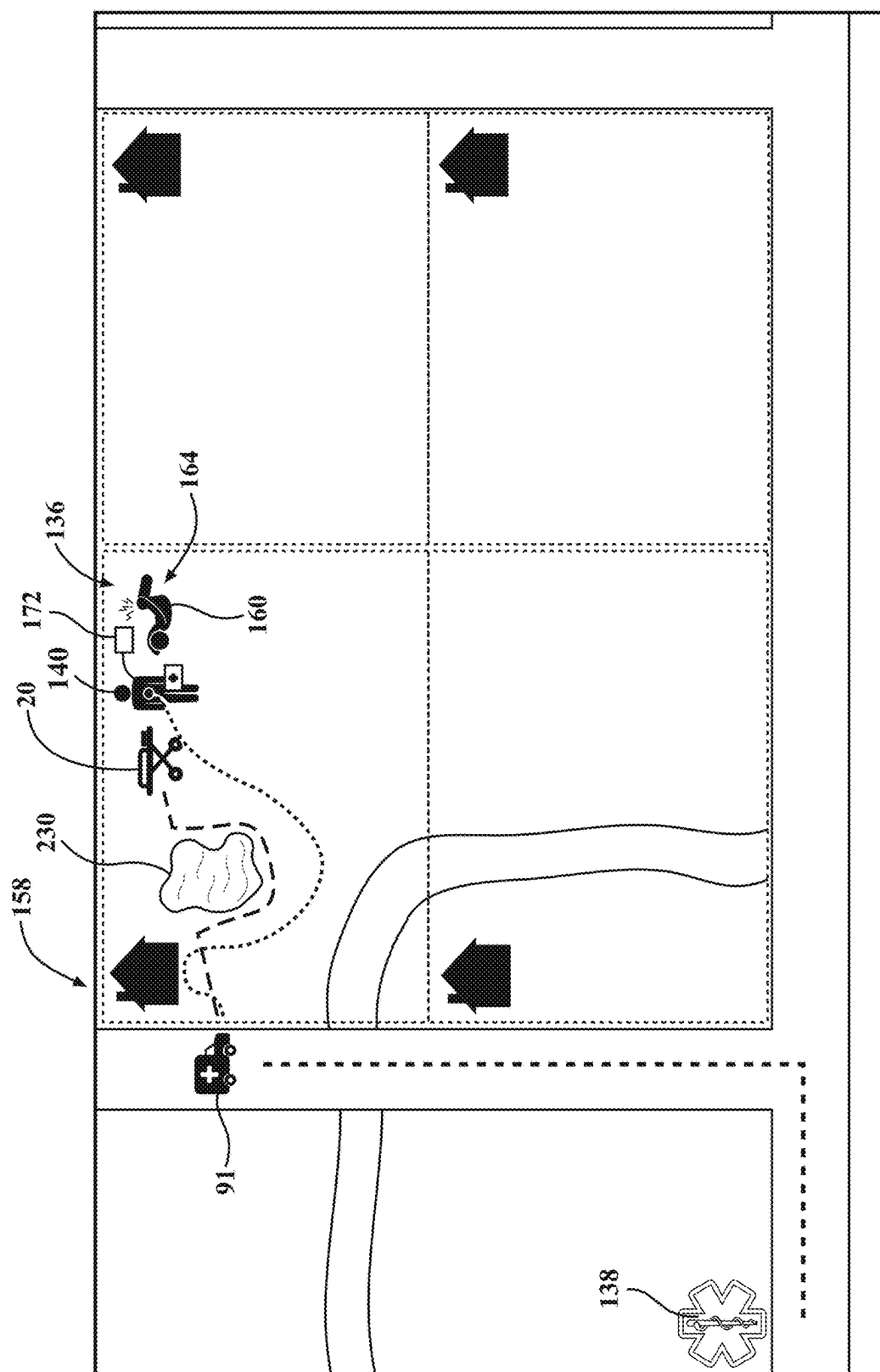


FIG. 7J

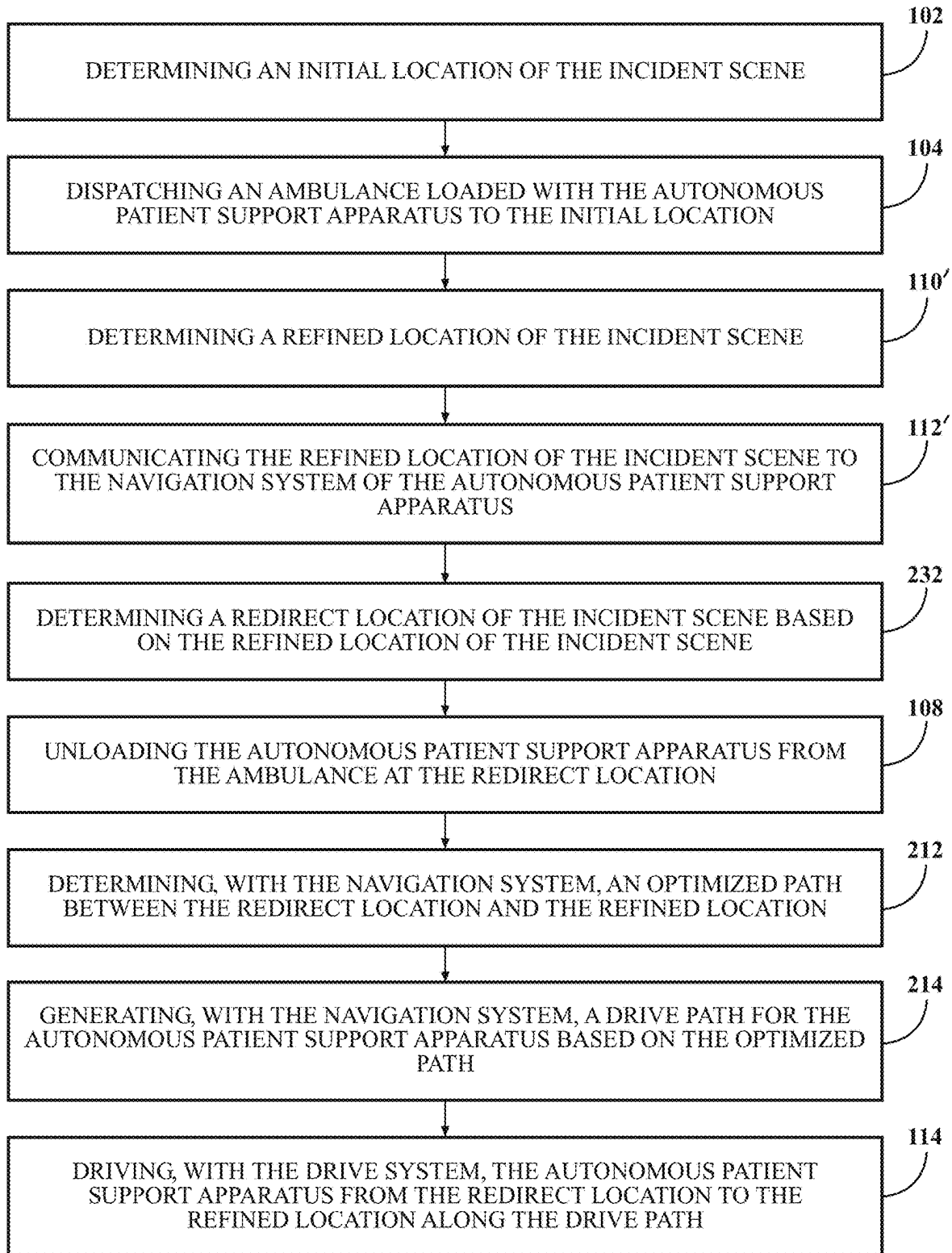


FIG. 7K

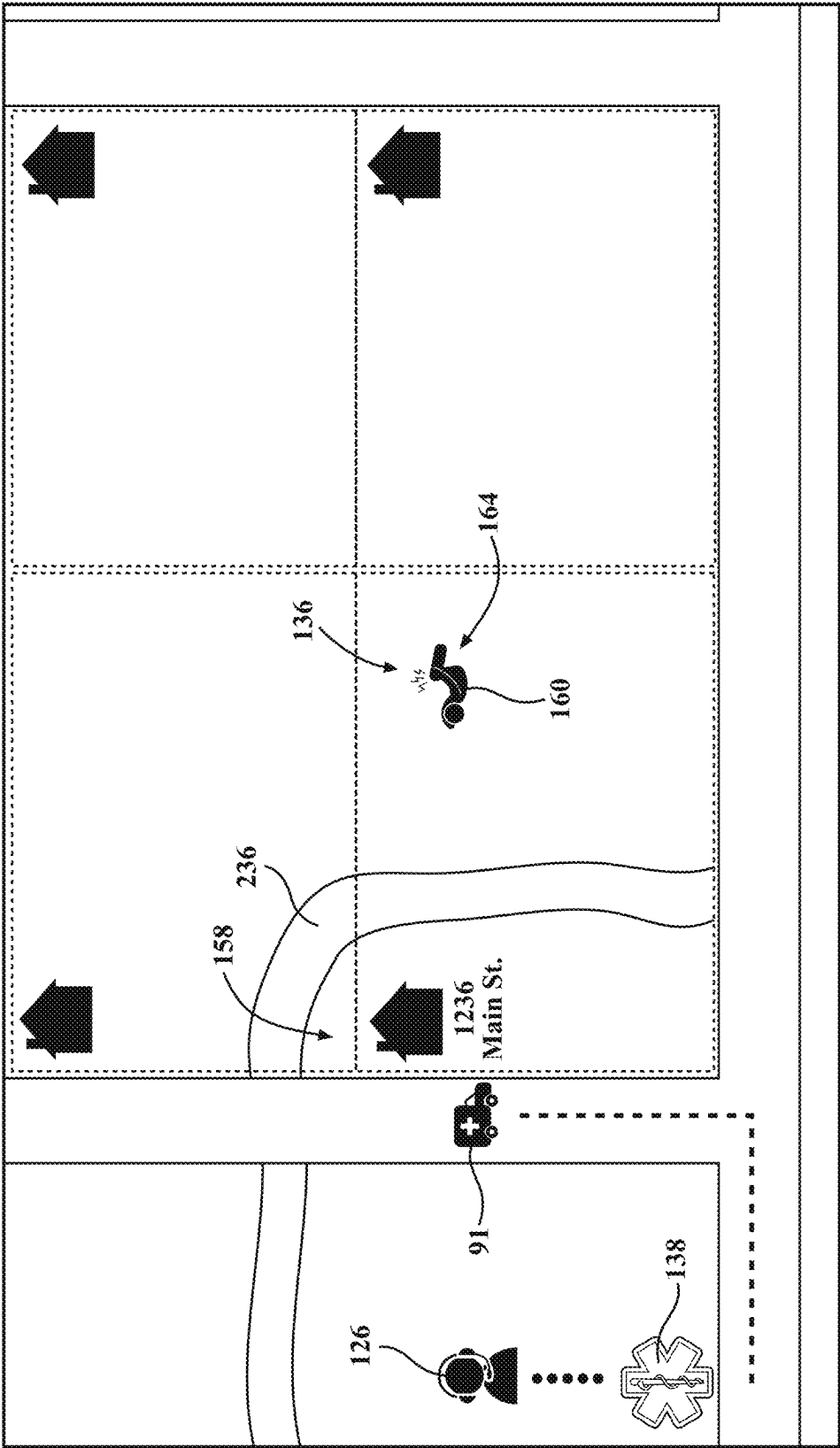


FIG. 7L

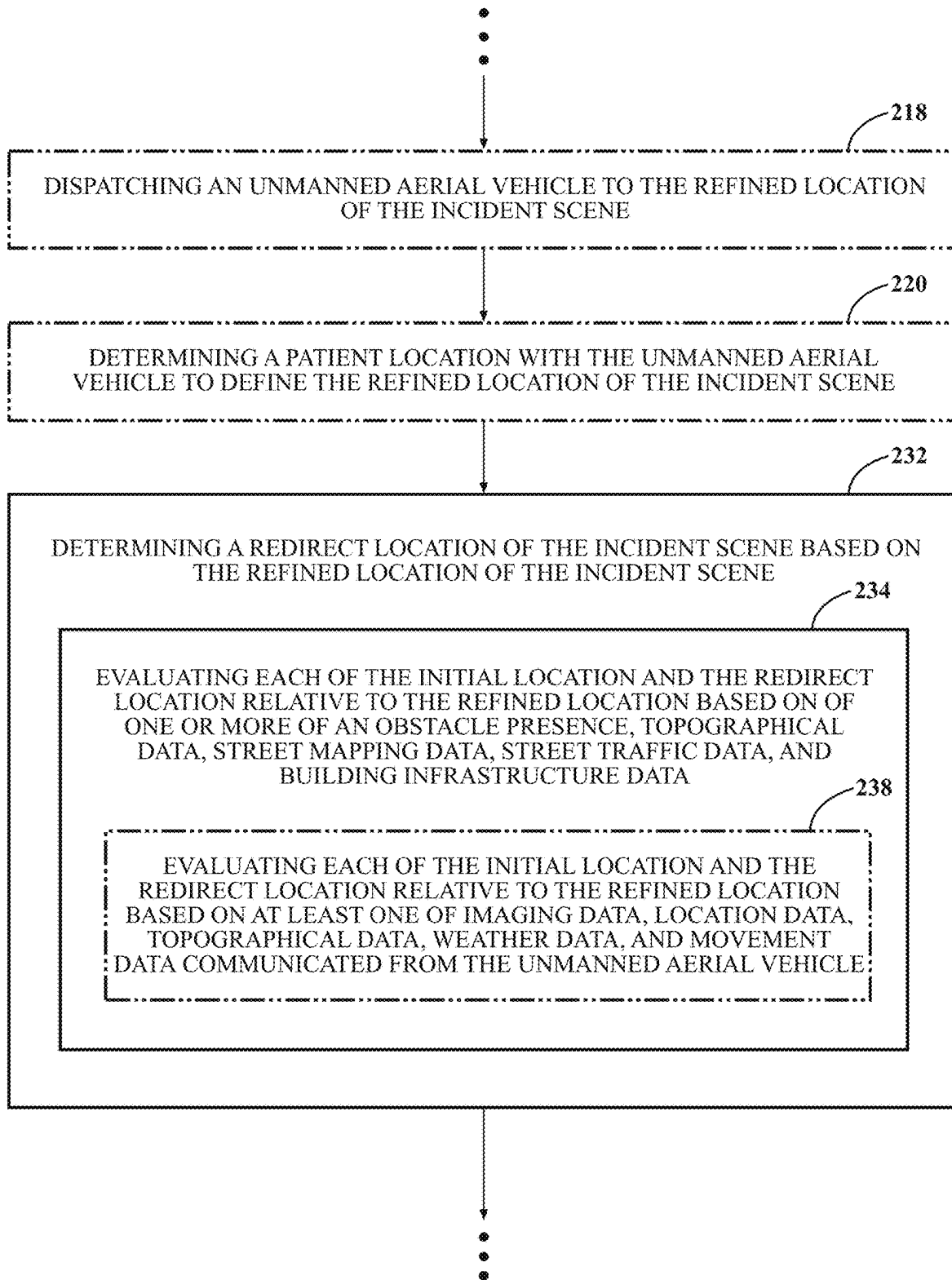


FIG. 7M

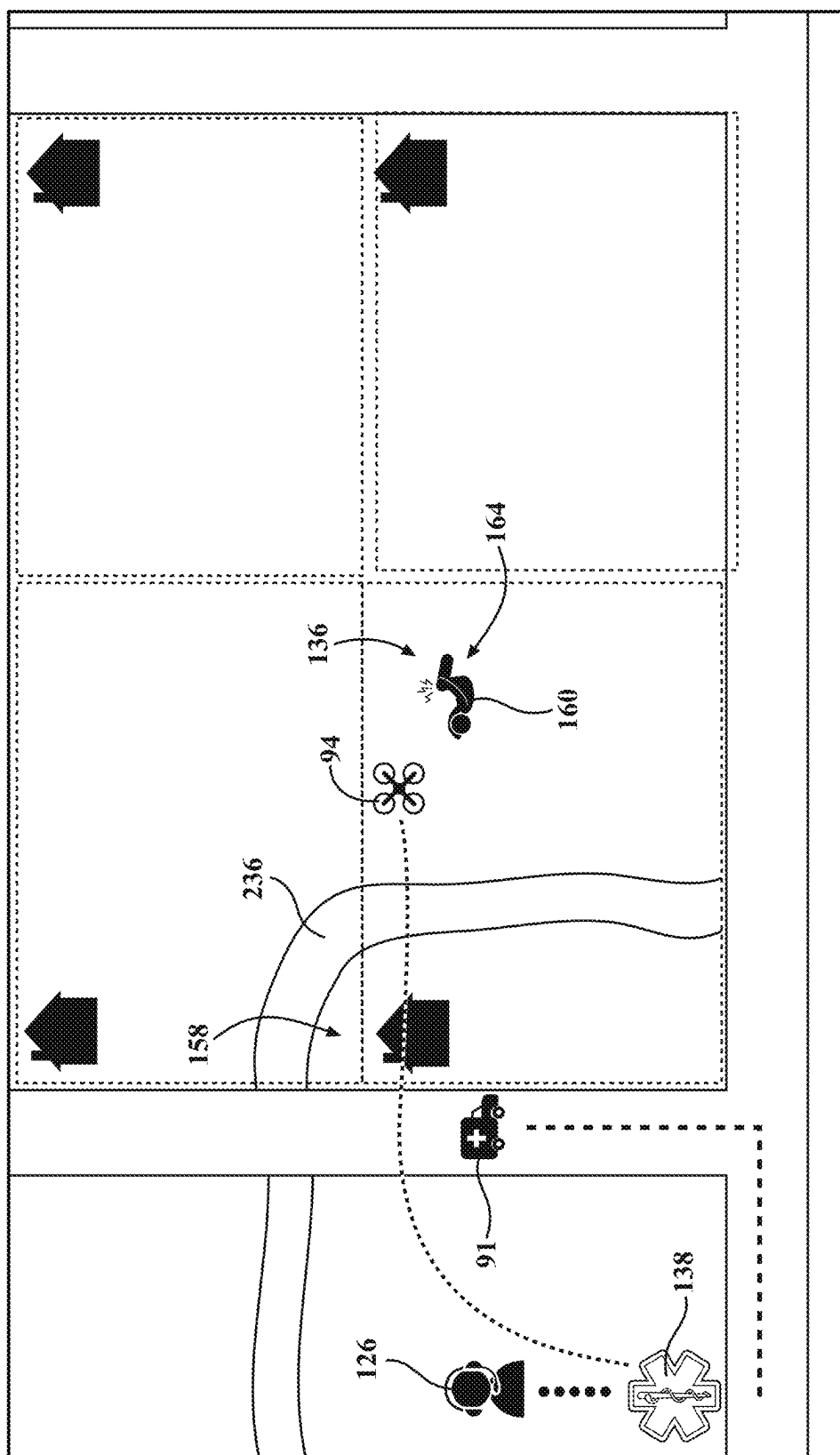


FIG. 7N

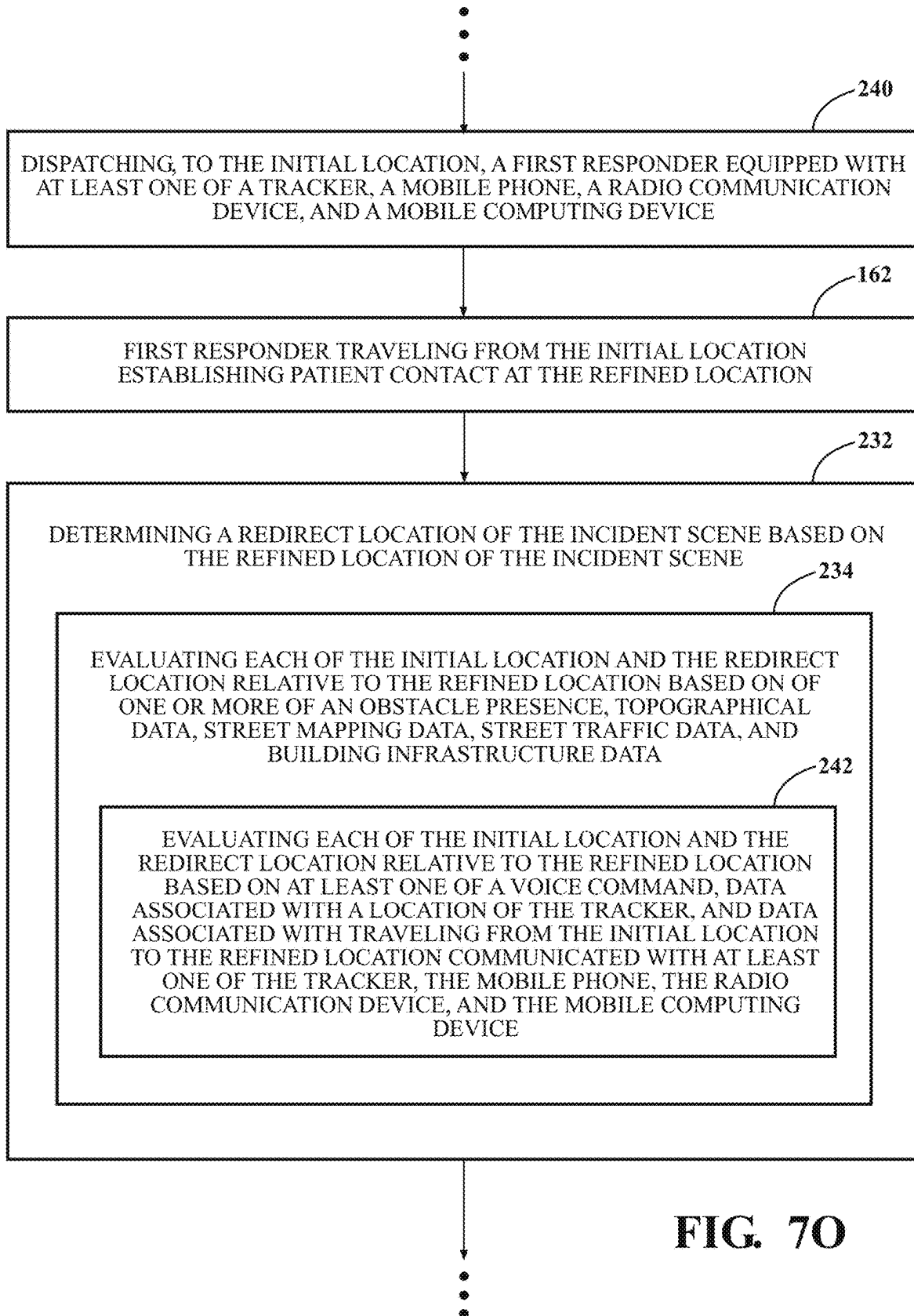


FIG. 70

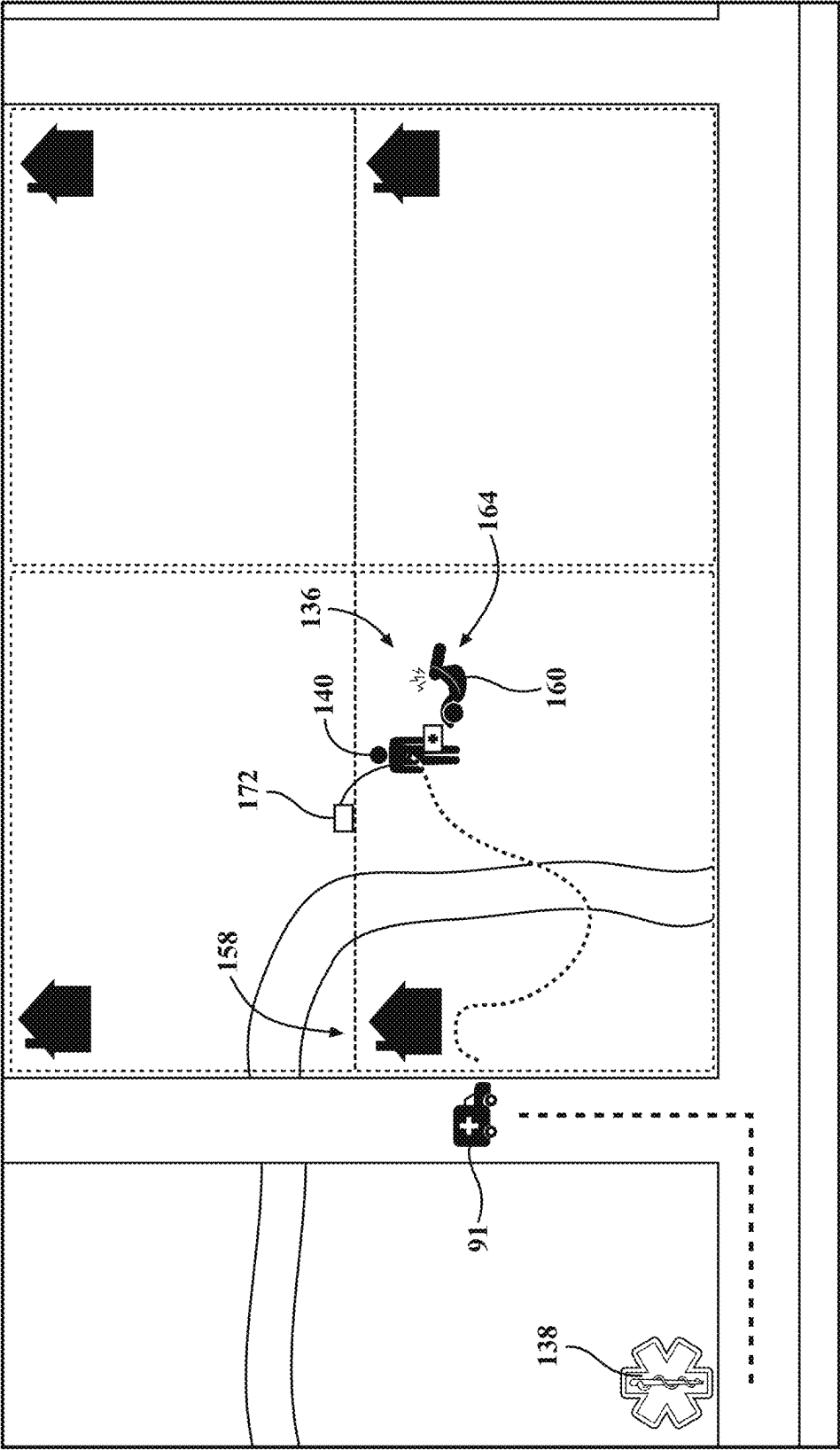


FIG. 7P

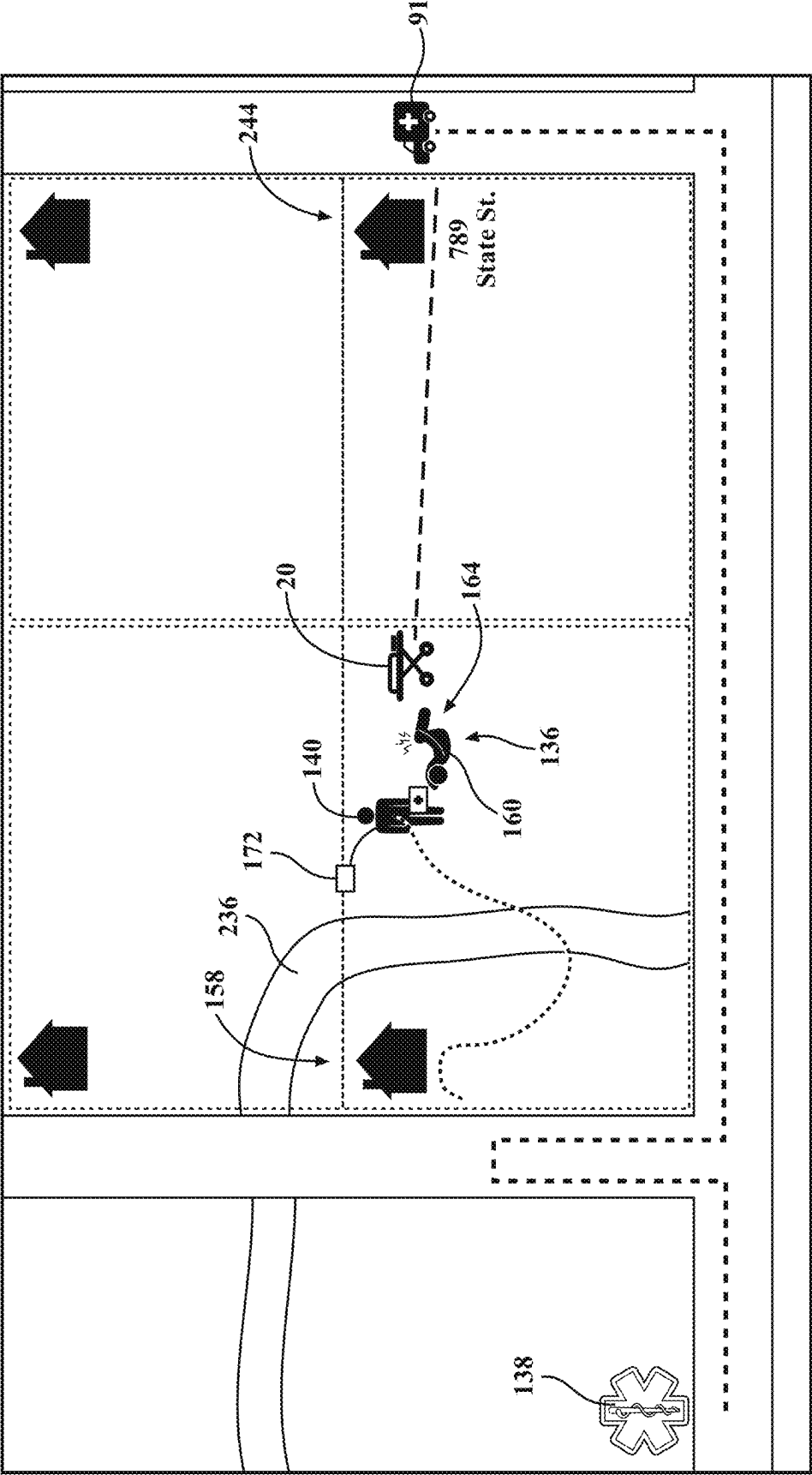


FIG. 7Q

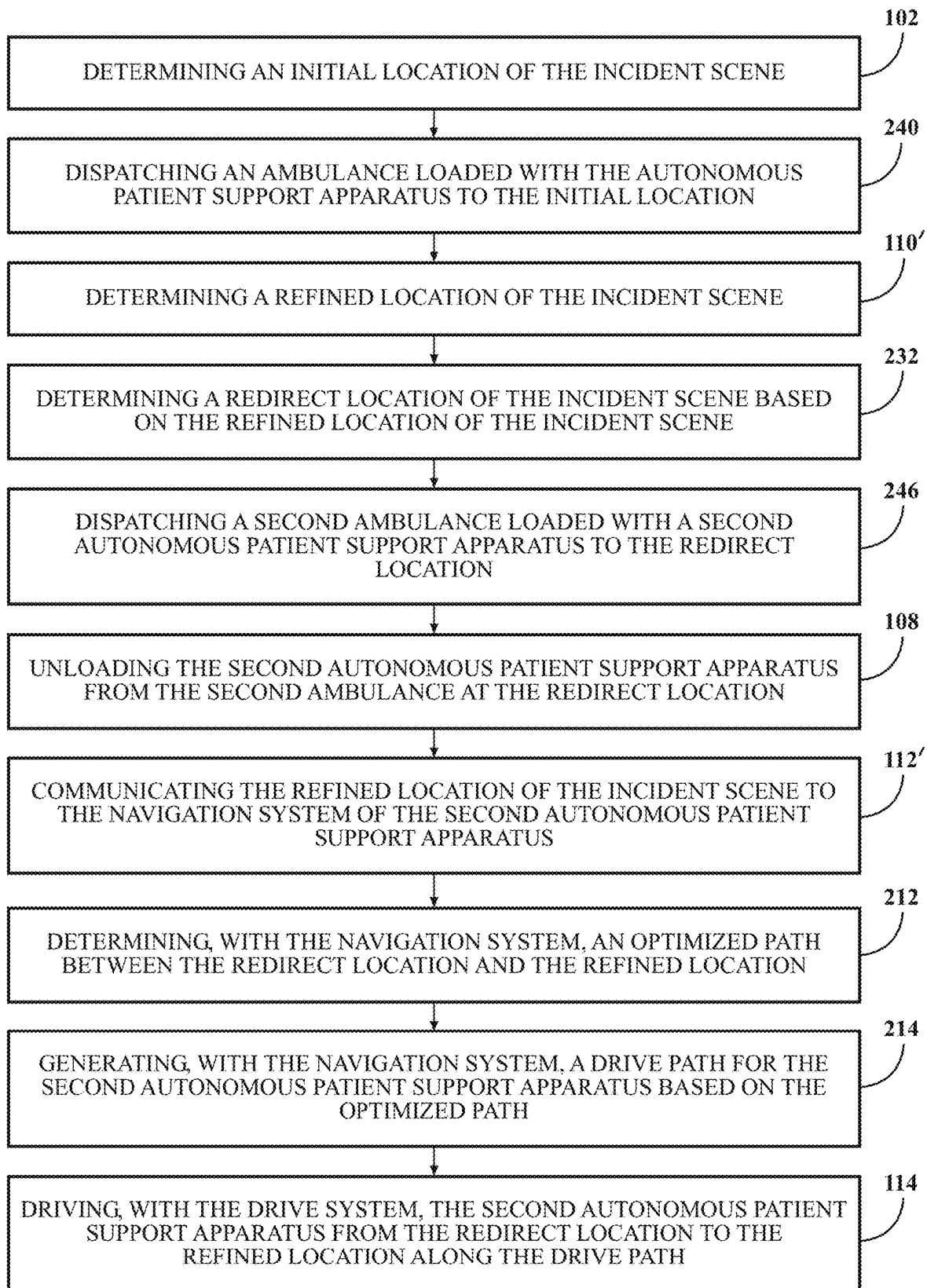


FIG. 7R

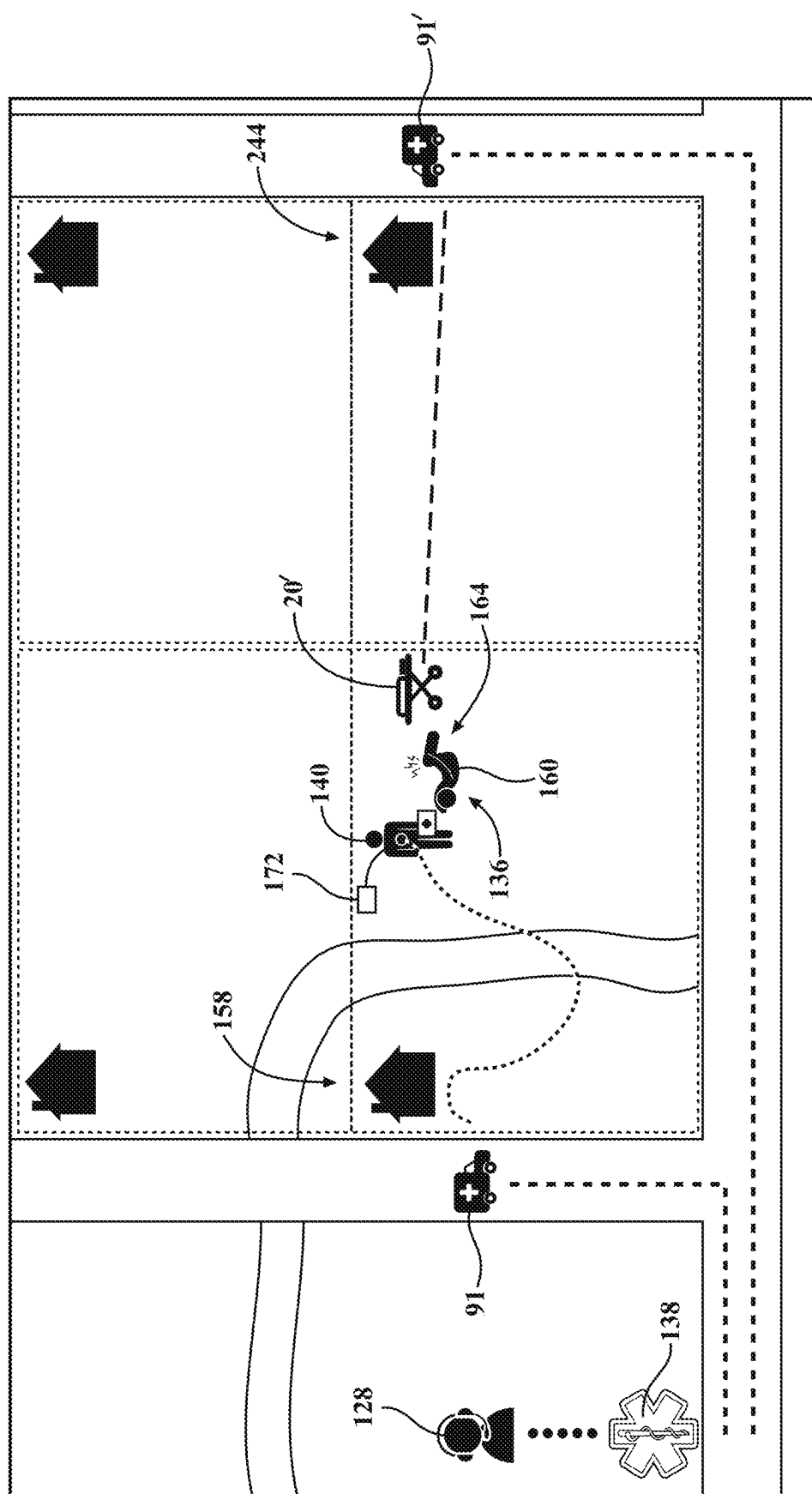


FIG. 7S

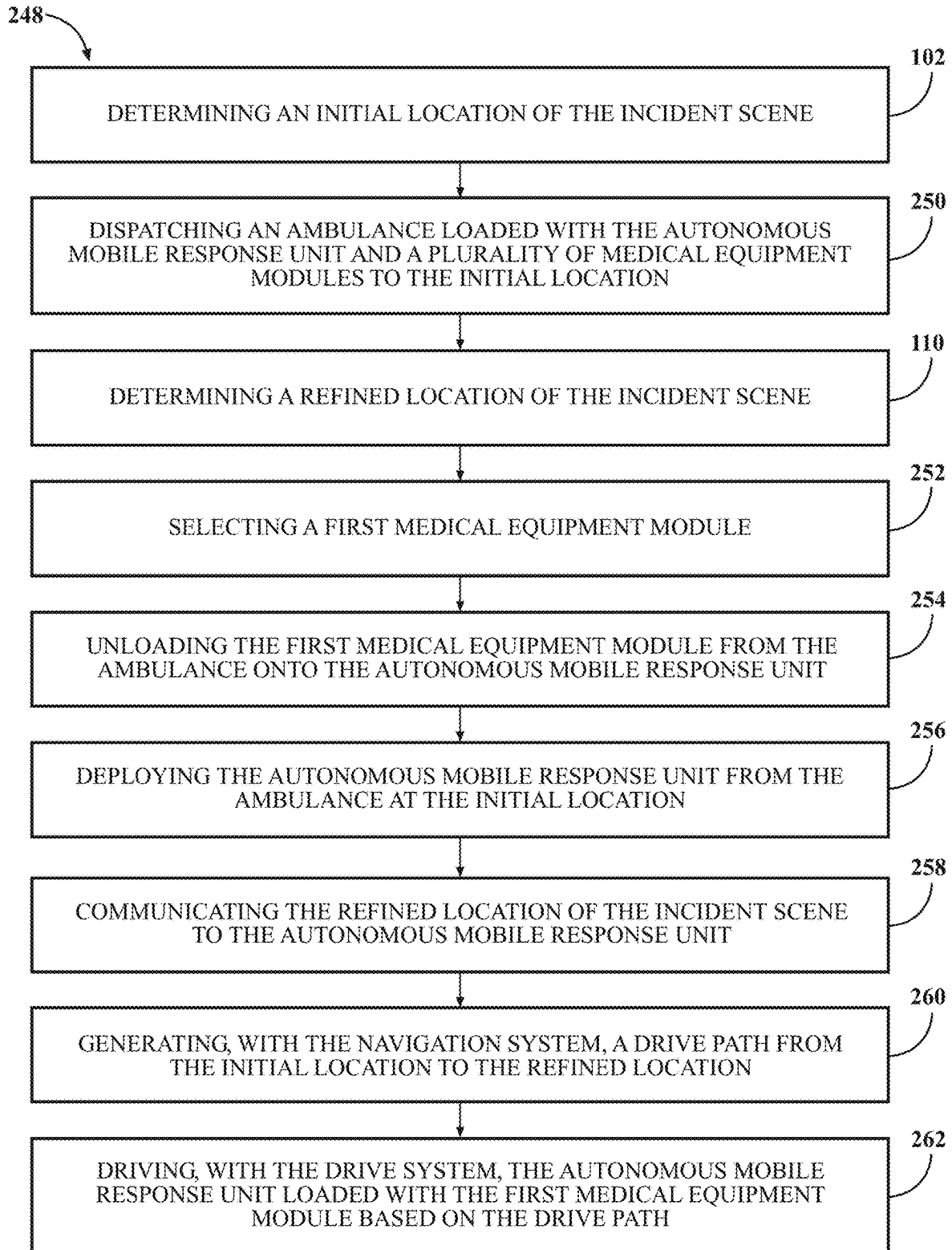
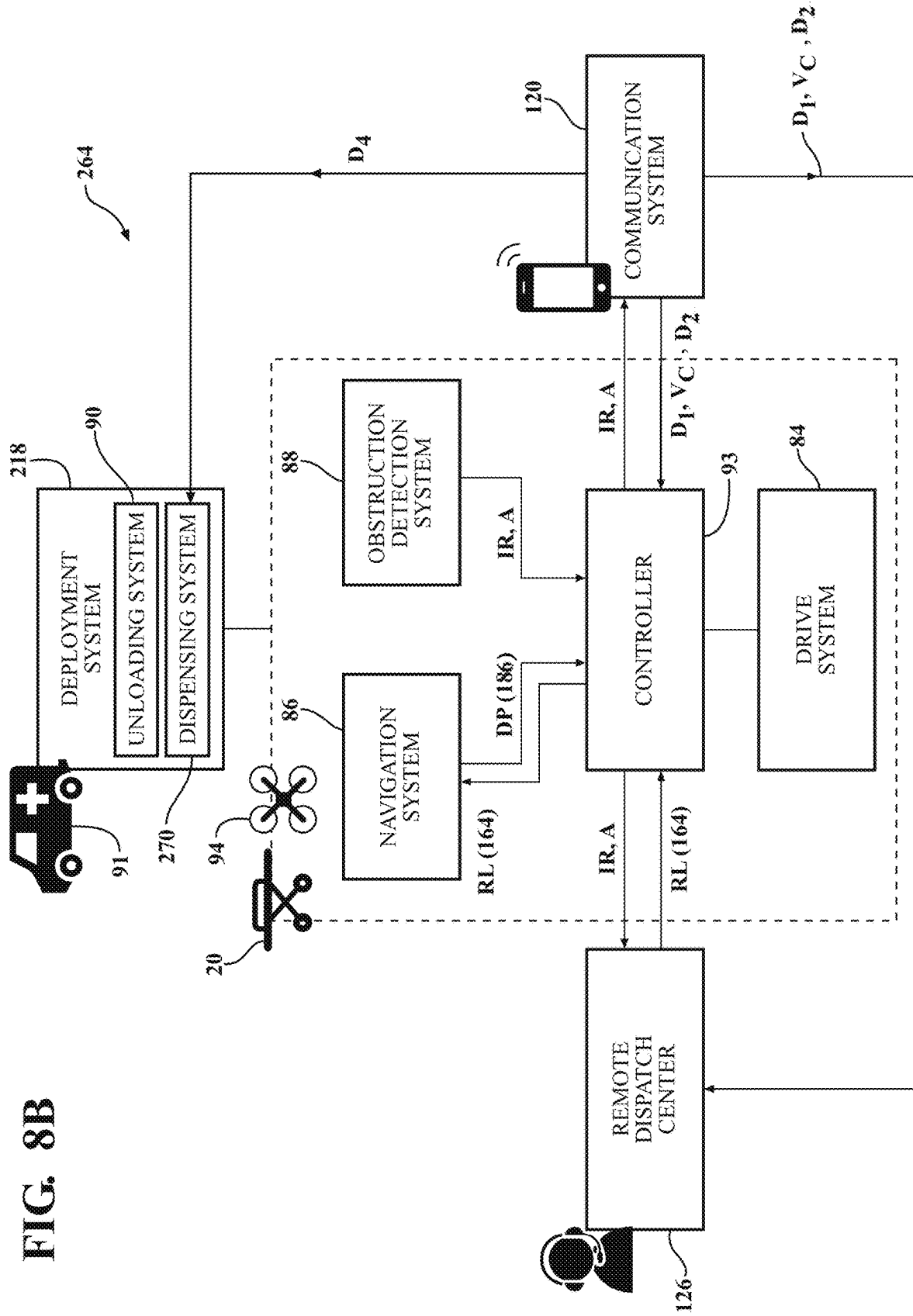
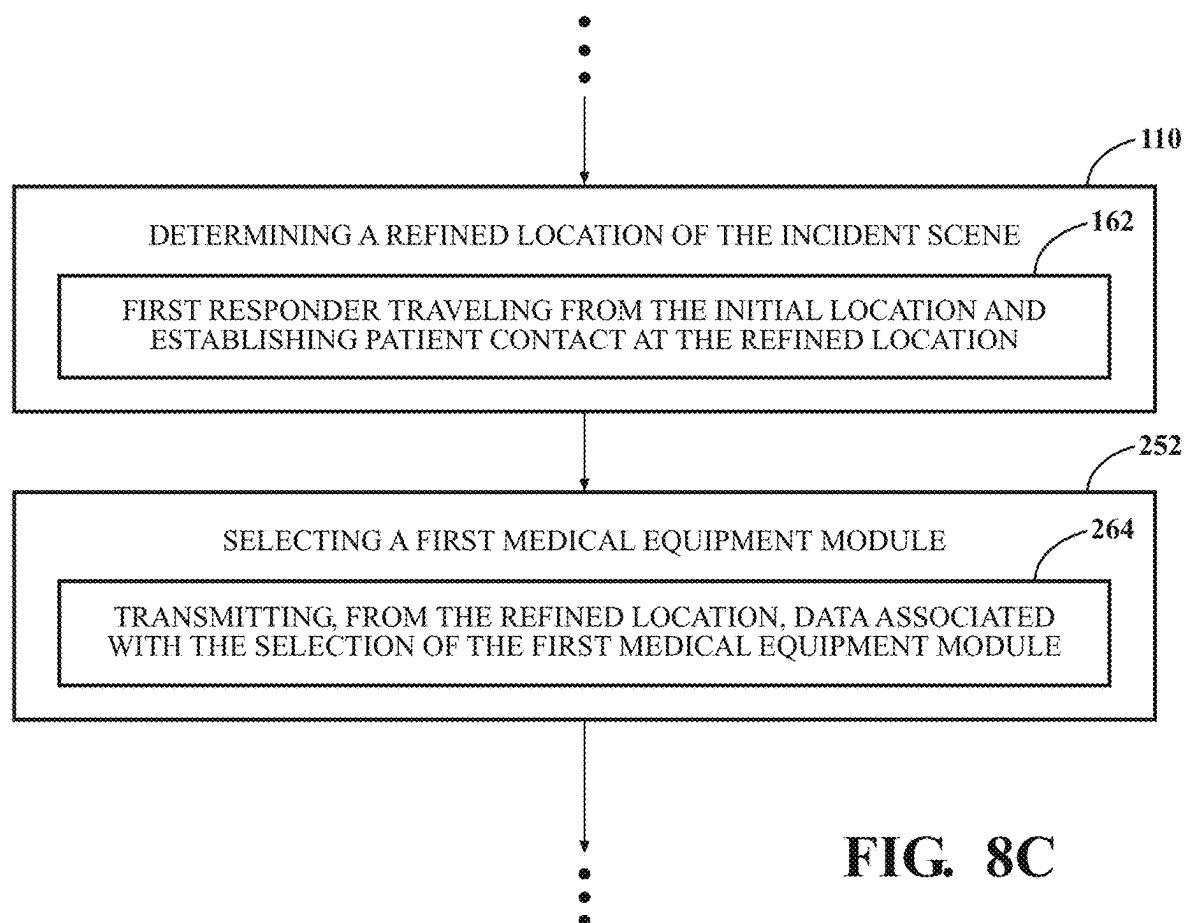
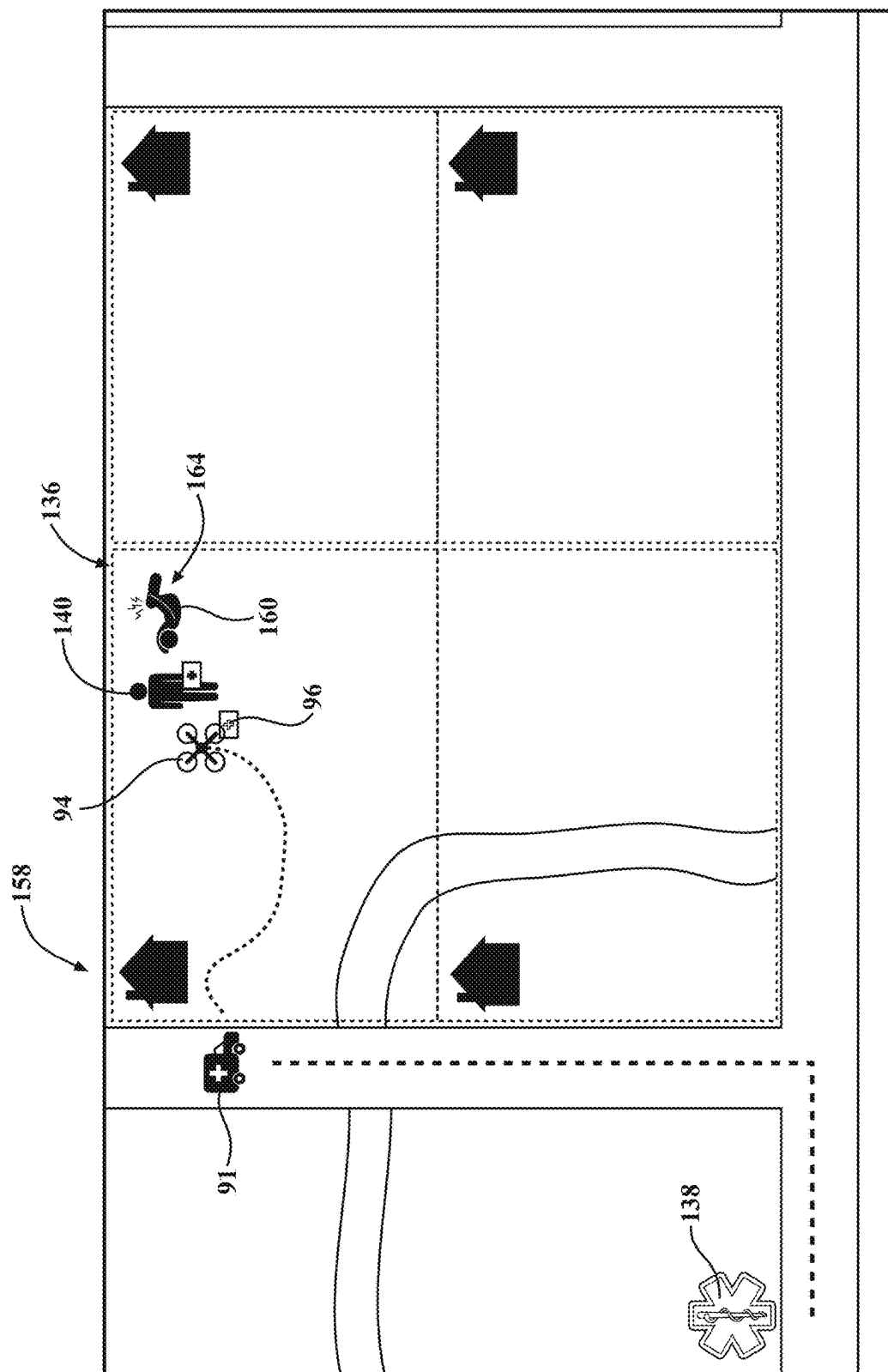


FIG. 8A

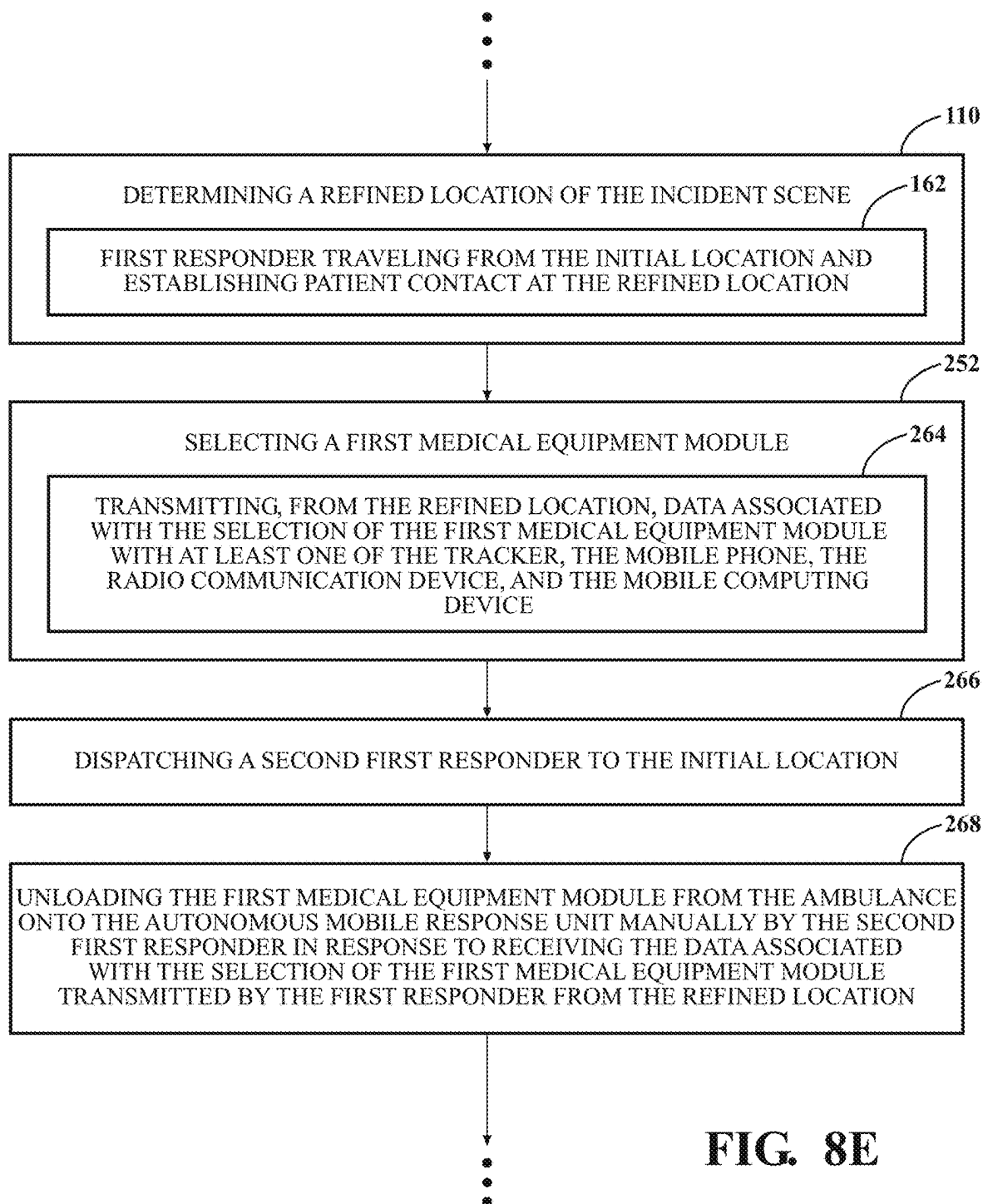
FIG. 8B







8 FIG.



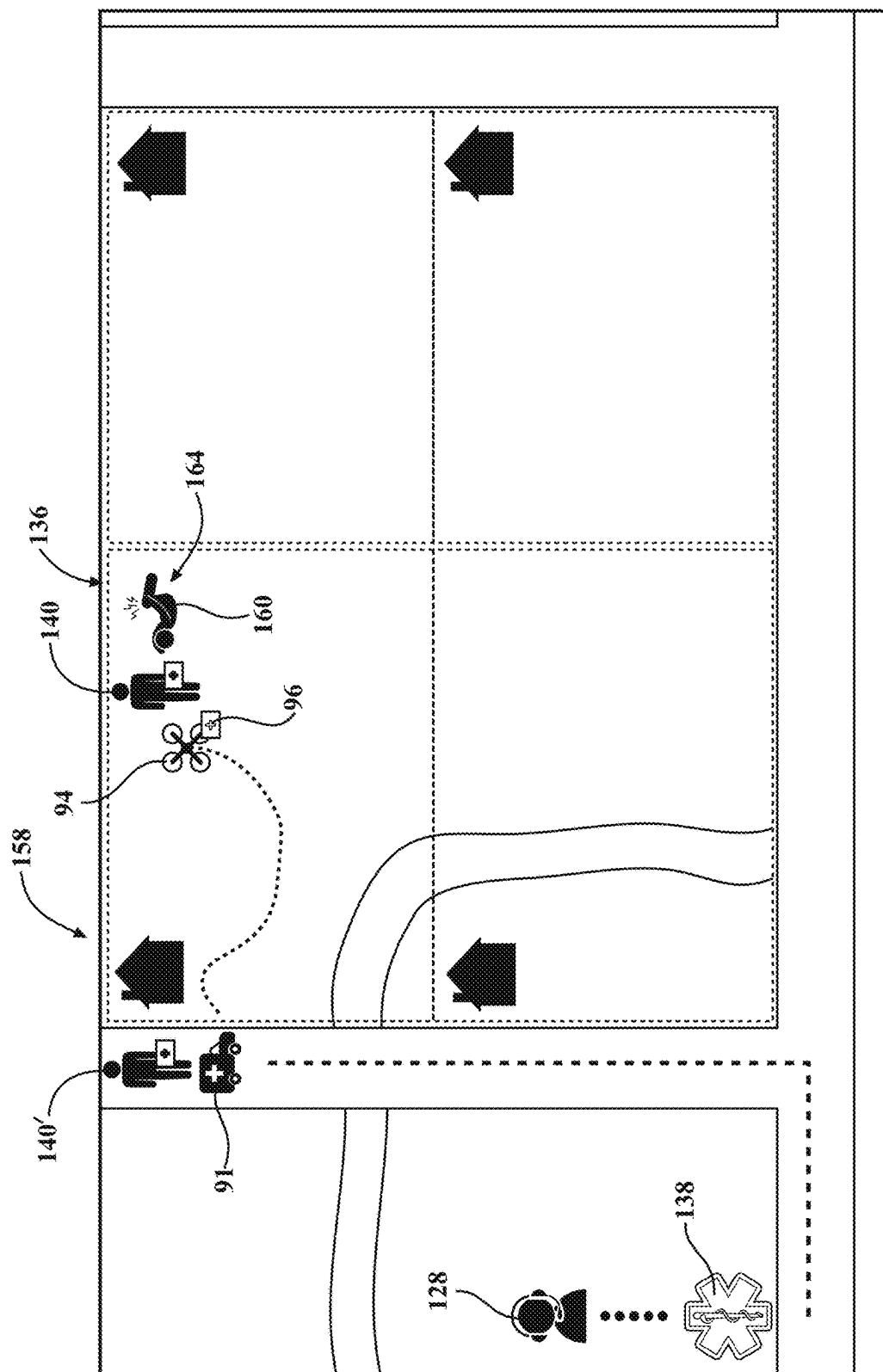


FIG. 8

TECHNIQUES FOR TRANSPORTING AUTONOMOUS PATIENT SUPPORT APPARATUSES AND MEDICAL EQUIPMENT TO AN INCIDENT SCENE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The subject patent application is a Continuation of U.S. patent application Ser. No. 18/436,077 filed on Feb. 8, 2024, which is a Continuation of U.S. patent application Ser. No. 16/671,723 filed on Nov. 11, 2019 and issued as U.S. Pat. No. 11,929,157 on Mar. 12, 2024, which claims priority to and all the benefits of U.S. Provisional Patent Application No. 62/754,773 filed on Nov. 2, 2018, U.S. Provisional Patent Application No. 62/754,798 filed on Nov. 2, 2018, and U.S. Provisional Patent Application No. 62/754,836 filed on Nov. 2, 2018, the disclosures of each of which are hereby incorporated by reference in their entirety.

BACKGROUND

[0002] When an emergency occurs at an incident scene, service entities such as fire departments typically dispatch a variety of assets, such as an ambulance or other vehicles loaded with a patient support apparatus, a trauma kit, a drug box, an O₂ bottle, a defibrillator, and/or a heart monitor, as well as personnel, such as a first responder, an emergency medical technician (EMT), a firefighter, and/or a police officer, to a location near the incident scene. In some situations, the incident scene is a location the dispatched assets and personnel may reach directly. For example, if the incident scene is a place of residence or a public building, the dispatched assets and personnel may be dispatched to an address associated with the place of residence or public building.

[0003] Sometimes, however, the incident scene is a location that may be difficult to reach for dispatched assets and personnel. For example, the incident scene may be a backyard of a place of residence, a location along a hiking trail, or a disaster zone. In such situations, the service entity may be required to dispatch multiple personnel to efficiently and successfully locate the incident scene and subsequently treat one or more patients involved in the emergency. For example, one first responder may locate the incident scene and another first responder may subsequently receive the location of the incident scene before transporting medical supplies to the incident scene. There remains a need in the art for dispatching personnel and/or equipment to incident scenes with improved accuracy and efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Advantages of the present disclosure will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings.

[0005] FIG. 1 is a perspective view of an autonomous patient support apparatus.

[0006] FIG. 2A is a top view of the autonomous patient support apparatus of FIG. 1.

[0007] FIG. 2B is a bottom view of the autonomous patient support apparatus of FIG. 1.

[0008] FIG. 3 is a schematic view of a system for transporting the autonomous patient support apparatus to an incident scene.

[0009] FIGS. 4A-4C are side views of the patient transport apparatus of FIG. 1 being unloaded from an emergency response vehicle.

[0010] FIG. 5 is a perspective view of an unmanned aerial vehicle.

[0011] FIG. 6A is a diagrammatic view of a method of transporting the autonomous patient support apparatus to the incident scene.

[0012] FIGS. 6B-6J are diagrammatic views of embodiments of the method of transporting the autonomous patient support apparatus to the incident scene.

[0013] FIG. 7A is a diagrammatic view of a method of transporting the autonomous patient support apparatus to the incident scene via an optimized path.

[0014] FIG. 7B is a schematic view of a system for transporting the autonomous patient support apparatus to the incident scene via the optimized path.

[0015] FIGS. 7C-7S are diagrammatic views of embodiments of the method of transporting the autonomous patient support apparatus to the incident scene via the optimized path.

[0016] FIG. 8A is a diagrammatic view of a method of transporting medical equipment to the incident scene with an autonomous mobile response unit.

[0017] FIG. 8B is a schematic view of a system for transporting medical equipment to the incident scene with the autonomous mobile response unit.

[0018] FIGS. 8C-8F are diagrammatic views of embodiments of the method of transporting medical equipment to the incident scene with the autonomous mobile response unit.

DETAILED DESCRIPTION

[0019] Herein, an autonomous mobile response unit is described. The autonomous mobile response unit may include an autonomous patient support apparatus 20, as shown in FIGS. 1-4C. The autonomous patient support apparatus 20 may be configured to support and autonomously transport a patient and/or a medical equipment module in a health care or emergency response setting. The autonomous patient support apparatus 20 illustrated in FIGS. 1-4C includes a cot. In other embodiments, however, the autonomous patient support apparatus 20 may include an autonomous hospital bed, stretcher, table, wheelchair, chair, or similar apparatus utilized in the autonomous transportation and care of a patient.

[0020] As shown in FIG. 1, the autonomous patient support apparatus 20 includes a support frame 22 configured to support a patient. The support frame 22 can be like that shown in U.S. Patent Application Publication No. 2018/0303689A1, which claims priority to U.S. Provisional Patent App. No. 62/488,441, filed on Apr. 21, 2017, entitled "Emergency Cot With A Litter Height Adjustment Mechanism," the disclosures of which are hereby incorporated by reference in their entirety.

[0021] The support frame 22 is further illustrated from a top view of the autonomous patient support apparatus 20 in FIG. 2A. As shown in FIG. 2A, the support frame 22 has a length L₁ defined extending longitudinally, and a width W₁ defined extending laterally, which is smaller than the length L₁. The support frame 22 may include two opposing lateral sides 24, 26 extending along the width W₁ coupled to two opposing end sides 28, 30 extending along the length L₁.

[0022] The support frame 22 may have various configurations and may include a variety of components. For example, in FIG. 1, end sides 28, 30 of the support frame 22 include hollow side rails 32, 34 (side rail 32 shown in FIG. 2A). In the example of FIG. 1, side 24 of the autonomous patient support apparatus 20 includes a foot end handle 36, which may include a pair of vertically spaced U-shaped frame members 38 and 40. The frame members 38, 40 may be joined together by frame brackets 42 (only one frame bracket 42 is shown in FIG. 1), which may be telescopingly affixed inside side rails 32, 34, as illustrated in FIG. 1. A fastener or pin (not illustrated) may be utilized to facilitate a connection of the frame brackets 42 to the interior of each of the respective side rails 32, 34. Furthermore, as shown, frame member 40 may diverge from frame member 38, providing pairs of vertically spaced hand grip areas 44, 46 on frame members 38, 40, respectively. Additionally, spacer brackets 48 may be connected to opposing portions of each of the frame members 38 and 40 to maintain the vertical spacing between the hand grip areas 44 and 46.

[0023] The support frame 22 may be coupled to a variety of components that aid in supporting and/or transporting the patient. For example, in FIG. 1, the support frame 22 is coupled to a patient support surface 50, upon which the patient directly rests. The patient support surface 50 may be defined by one or more articulable deck sections, for example, a back section 52 and a foot section 54, to facilitate care and/or transportation of the patient in various patient positions.

[0024] The support frame 22 may also be coupled to loading wheels 56. As shown in FIG. 1, the loading wheels 56 may extend from the support frame 22 proximal to the back section 52 of the patient support surface 50 and may facilitate loading and unloading of the autonomous patient support apparatus 20 from a vehicle. In one example, the loading wheels 56 may be positioned and configured to facilitate loading and unloading the autonomous patient support apparatus 20 into or from an ambulance.

[0025] The support frame 22 may also be coupled to hand rails 58. In FIG. 1, the hand rails 58 extend from opposing sides of the support frame 22 and provide egress barriers for the patient on the patient support surface 50. The hand rails 58 may also be utilized by an individual, such as a caregiver, an emergency medical technician (EMT), or another medical professional, to move or manipulate the autonomous patient support apparatus 20 manually. In some embodiments, the hand rails 58 may include a hinge, pivot or similar mechanism to allow the hand rails 58 to be folded or stored adjacent to or below the patient support surface 50. The support frame 22 may also be coupled to a vertical support member 60. The vertical support member 60 may be configured to hold a medical device or medication delivery system, such as a bag of fluid to be administered via an IV. The vertical support member 60 may also be configured for the operator of the autonomous patient support apparatus 20 to push or pull on the vertical support member 60 to manipulate or move the autonomous patient support apparatus 20.

[0026] The autonomous patient support apparatus 20 may include a base 62. As shown in FIG. 2B, the base 62 has a length L_2 defined longitudinally, and a width W_2 , which is smaller than the length L_2 . The base 62 may include two opposing lateral base sides 64, 66 extending along the width W_2 coupled to two opposing longitudinal base sides 68, 70

extending along the length L_2 . As shown in FIG. 1, the longitudinal base sides 68, 70 may include longitudinally-extending rails 72, 74 and the lateral base sides 64, 66 may include crosswise-extending rails 76, 78 which may be coupled at the ends thereof to the rails 72, 74.

[0027] The base 62 may further include a plurality of caster wheel assemblies 80 operatively connected adjacent to each corner of the base 62 defined by the longitudinally-extending rails 72, 74 and the crosswise-extending rails 76, 78. As such, the autonomous patient support apparatus 20 of FIG. 1 may include four caster wheel assemblies 80. The wheel assemblies 80 may be configured to swivel to facilitate turning of the autonomous patient support apparatus 20. The wheel assemblies 80 may include a swivel locking mechanism to prevent the wheel assemblies 80 from swiveling when engaged. The wheel assemblies 80 may also include wheel brakes 82 to prevent rotation of the wheel.

[0028] The base 62 may also include at least one auxiliary wheel 81. The auxiliary wheel 81 may be configured to swivel to steer the autonomous patient support apparatus 20. In instances where the base 62 includes more than one auxiliary wheel 81, the auxiliary wheels 81 may be configured to swivel about their own, separate swivel axes, or a common swivel axis in order to steer the autonomous patient support apparatus 20. Additionally, in some instances, the auxiliary wheel may be deployed from the base 62 in a deployed position or stowed within the base 62 in a stowed position. The auxiliary wheels 81 can be like that shown in U.S. Pat. No. 10,045,893, which claims priority to U.S. Provisional Patent App. No. 62/270,704, filed on Dec. 22, 2015, entitled "Patient Transport Apparatus With Controllable Auxiliary Wheel Assembly," the disclosures of which are hereby incorporated by reference in their entirety.

[0029] Referring to FIGS. 1 and 3, the autonomous patient support apparatus 20 may include a drive system 84 configured to drive the autonomous patient support apparatus 20 by driving the at least one auxiliary wheel 81. As shown in the embodiment of FIG. 1, the drive system 84 may be coupled to the at least one auxiliary wheel 81. The drive system 84 may be configured to drive the patient support apparatus 20 by driving, steering, deploying, and/or stowing the at least one auxiliary wheel 81. In some instances, the drive system 84 may also be configured to move the auxiliary wheel 81 between the deployed position and the stowed position. The drive system 84 may include an electric actuator, a hydraulic actuator, and/or a pneumatic actuator. The drive system 84 may also include rotary actuators, linear actuators, or any other suitable actuators for moving the at least one auxiliary wheel 81. Additionally, the drive system 84 may include reversible, DC motors, or other types of motors. The drive system 84 can be like that shown in U.S. Patent Application Publication No. 2016/0367415A1, which claims priority to U.S. Provisional Patent App. No. 62/184,911, filed on Jun. 22, 2015, entitled "Patient Support Apparatuses With Navigation And Guidance Systems," the disclosures of which are hereby incorporated by reference in their entirety.

[0030] As shown in FIG. 3, the autonomous patient support apparatus 20 may include a navigation system 86 configured to generate a drive path (shown as "DP (186)" in FIG. 3) for the autonomous patient support apparatus 20. The navigation system 86 may include a variety of sensors that provide a variety of inputs, which the navigation system 86 may use to generate the drive path 186. For example, the

navigation system **86** may include an accelerometer for detecting accelerations of the autonomous patient support apparatus **20**, including both the magnitude and direction of the accelerations. The navigation system **86** may also include a magnetometer for detecting a geographical orientation of the autonomous patient support apparatus **20** with respect to the Earth's magnetic field. A wheel counting sensor may also, or alternatively, be included that detects revolutions of at least one of the caster wheel assemblies **80** and/or auxiliary wheels **81**. Still further, the navigation system **86** may include an altimeter adapted to detect an elevation of the autonomous patient support apparatus **20**. In this way, the navigation system **86** can be like the navigation system shown in U.S. Patent Application Publication No. 2016/0367415A1.

[0031] Additionally, the navigation system **86** may generate the drive path **186** for the autonomous patient support apparatus **20** based on the variety of sensors. For example, the navigation system **86** may generate the drive path **186** based on a location and an acceleration of the autonomous patient support apparatus **20** received from the accelerometer and the magnetometer. Furthermore, the navigation system **86** may generate the drive path **186** prior to or concurrent with the autonomous patient support apparatus **20** being driven by the drive system **84**.

[0032] Referring to FIG. 3, the autonomous patient support apparatus **20** may also include an obstruction detection system **88** configured to detect a presence of an obstruction. An obstruction may be defined as an object preventing, or that will prevent, the drive system **84** from driving the autonomous patient support apparatus **20** along the drive path **186** generated by the navigation system **86**. As such, the obstruction detection system **88** may include a variety of sensors, such as an impact sensor, a proximity sensor, and/or a wheel position sensor configured to detect the presence of an obstruction. For example, an impact sensor, such as a strain gauge, may detect a force applied to a component, such as a wheel assembly **80**, an auxiliary wheel **81**, or the base **62** of the autonomous patient support apparatus **20**, which may indicate the presence of an obstruction. In another example, a proximity sensor may use sonar, LiDAR, or imaging technology to determine a proximity of an obstruction. For instance, the proximity sensor may be a camera configured to capture an image, which the obstruction detection system **88** may process to determine the presence of an obstruction. In yet another example, the obstruction detection system **88** may include wheel position sensors configured to detect an actual speed of the autonomous patient support apparatus **20**. The obstruction detection system **88** may then compare the actual speed to a commanded speed to determine the presence of an obstruction. The obstruction detection system **88** can be like the object/landmark detection system shown in U.S. Patent Application Publication No. 2016/0367415A1.

[0033] Also shown in FIG. 3, the autonomous patient support apparatus **20** may include a controller **93** configured to control the drive system **84** based on the drive path **186** generated by the navigation system **86**. As such, the controller **93** may be coupled to the navigation system **86** and to the drive system **84**, as shown in FIG. 3. Furthermore, the controller **93** may serve as a hub, allowing for communication between the drive system **84**, the navigation system **86**, and the obstruction detection system **88**. For example, the controller **93** may be coupled to the obstruction detection

system **88**, which allows the obstruction detection system **88** to communicate a presence of an obstruction to the navigation system **86** via the controller **93**. Additionally, the controller **93** may allow the drive system **84**, the navigation system **86**, and the obstruction detection system **88** to communicate with a first communication system **120** (described in further detail below), a remote dispatch center **126** (described in further detail below), and an unmanned aerial vehicle **94** (described in further detail below). The controller **93** can be like the controller shown in U.S. Patent Application Publication No. 2016/0367415A1.

[0034] The autonomous patient support apparatus **20** may be loaded in an ambulance **91**. Furthermore, as shown in FIG. 3, the ambulance **91** loaded with the autonomous patient support apparatus **20** may include an unloading system **90** for unloading the autonomous patient support apparatus **20** from an ambulance **91**. An operation of the unloading system **90** is shown in FIGS. 4A-4C. As shown in FIGS. 4A-4C, the autonomous patient support apparatus **20** may be coupled to a trolley **87** and a track **85** of the unloading system **90**. The trolley **87** may then move along the track **85** such that the autonomous patient support apparatus **20** may be positioned within the ambulance **91** (as shown in FIG. 4A) and unloaded from the ambulance (as shown in FIGS. 4B and 4C). The unloading system **90**, the trolley **87**, and the track **85** can be like the unloading apparatus, the trolley, and the track shown in U.S. Pat. No. 8,439,416, which claims priority to U.S. Provisional Patent App. No. 61/248,374, filed on Oct. 2, 2009, entitled "Ambulance Cot and Loading and Unloading System," the disclosures of which are hereby incorporated by reference in their entirety.

[0035] The unloading system **90** may also include a lift mechanism **92**, which may be configured to move between a plurality of vertical configurations including a retracted configuration, as shown in FIGS. 4A and 4B, and an extended configuration, as shown in FIG. 4C. The lift mechanism **92** may be configured to facilitate movement of the support frame **22** relative to the base **62**. When the autonomous patient support apparatus **20** is being unloaded from the ambulance **91**, the lift mechanism **92** moves from the retracted configuration to the extended configuration by moving the base **62**. When the autonomous patient support apparatus **20** has been unloaded from the ambulance **91**, the lift mechanism **92** can be utilized to move from the extended configuration back to the retracted configuration, or to other configurations therebetween, to position the support frame **22** closer to the base **62**. The lift mechanism **92** can be like that shown in the U.S. Patent Application Publication No. 2018/0303689A1.

[0036] The unloading system **90** may be operated manually or autonomously. For example, a first responder may manually operate the unloading system **90** when unloading the autonomous patient support apparatus **20** from the ambulance **91**. In another instance, the first responder may operate the unloading system **90** by physically depressing a button to activate the unloading system **90**. In yet another instance, the unloading system **90** may unload the autonomous patient support apparatus **20** autonomously after the ambulance **91** reaches a location or after receiving an input from a remote computing device.

[0037] The autonomous mobile response unit may also include the unmanned aerial vehicle **94**, as shown in FIG. 5. The unmanned aerial vehicle **94** may be configured to

autonomously transport a medical equipment module **96** to an incident scene, from the ambulance **91** or from another location, in a health care or emergency response setting. The unmanned aerial vehicle **94** shown in FIG. **5** is realized as a multirotor drone; however, the unmanned aerial vehicle **94** may comprise a fixed wing drone or a single rotor drone, or a wheeled vehicle in some embodiments. Additionally, the unmanned aerial vehicle **94** may also include the navigation system **86**, the drive system **84**, the controller **93**, and the obstruction detection system **88**.

[0038] Furthermore, the unmanned aerial vehicle **94** may include a variety of sensors. For example, the unmanned aerial vehicle **94** may include a variety of imaging sensors, location sensors, and environmental sensors, which may be used to collect imaging data, obstruction data, topographical data, location data, movement data, and weather data. In one example, the unmanned aerial vehicle **94** may include a camera **95**, as shown in FIG. **5**. The camera **95** may collect imaging data, which may be used to determine a presence of an obstruction, topographical data, and a location of the incident scene.

[0039] As shown in FIGS. **1** and **5**, the autonomous mobile response unit, realized as the autonomous patient support apparatus **20** in FIG. **1** and the unmanned aerial vehicle **94** in FIG. **5**, may be configured to transport a medical equipment module **96**. For example, in FIG. **1**, the medical equipment module **96** is disposed on and affixed to the patient support surface **50** while being transported by the autonomous patient support apparatus **20**. In FIG. **5**, a retaining system **98** of the unmanned aerial vehicle **94** retains the medical equipment module **96** while the unmanned aerial vehicle **94** transports the medical equipment module **96**, and can be released automatically or manually. In other instances, alternative mechanisms may be employed for transporting the medical equipment module **96**. For example, the autonomous patient support apparatus **20** may include a dedicated compartment for housing the medical equipment module **96** during transport. As another example, the retaining system **98** of the unmanned aerial vehicle **94** may include a variety of components, such as a crate, a rope, adhesive, or any other components suitable for retaining and transporting the medical equipment module **96**.

[0040] A method **100** of transporting an autonomous patient support apparatus, such as the above-described autonomous patient support apparatus **20**, to an incident scene is represented as a flow chart in FIG. **6A**. As shown, the method **100** includes a step **102** of determining an initial location of the incident scene; a step **104** of dispatching an ambulance (such as the above-described ambulance **91**) loaded with an autonomous patient support apparatus (such as the above-described autonomous patient support apparatus **20**) to the initial location; a step **106** of dispatching a first responder to the initial location; a step **108** of unloading the autonomous patient support apparatus **20** from the ambulance **91** at the initial location; a step **110** of determining a refined location of the incident scene; a step **112** of communicating the refined location of the incident scene to the navigation system **86** of the autonomous patient support apparatus **20**; a step **114** of driving, with the drive system **84**, the autonomous patient support apparatus **20** based on a drive path **186** such that the autonomous patient support apparatus **20** travels from the ambulance **91** to the refined

location; and a step **116** of generating, with the navigation system **86**, the drive path **186** from the initial location to the refined location.

[0041] The steps of the method **100**, and the steps of any other method described herein, may be ordered differently in some embodiments. For example, the step **104** of dispatching an ambulance **91** to the initial location may occur after the step **106** of dispatching a first responder to the initial location. As another example, the step **116** of generating the drive path **186** may occur prior to the step **114** of driving the drive system **84**. In such an example, the navigation system **86** may generate the drive path **186** and provide the drive system **84** with the drive path **186**, which the drive system **84** subsequently follows to drive the autonomous patient support apparatus **20** during step **114**.

[0042] Additionally, the steps of the method **100** may include other steps. For instance, referring to the embodiment of FIG. **6A**, the step **114** of driving the autonomous patient support apparatus **20** may also include the step **116** of generating the drive path **186**. In such an embodiment, the navigation system **86** may be configured to generate the drive path **186** while the drive system **84** is driving the autonomous patient support apparatus **20**. As such, the navigation system **86** may generate the drive path **186** based on inputs received while the drive system **84** is driving. Similarly, the steps of any other method described herein may include other steps of the method illustrated in FIG. **6A**. For example, in any method described herein, any step of generating a drive path **186** may be included in any step of driving an autonomous mobile response unit, such as the autonomous patient support apparatus **20** or the unmanned aerial vehicle **94**.

[0043] Referring back to FIG. **3**, the steps **102-116** of the method **100** may be executed by components of a system **118** configured to facilitate transporting the autonomous patient support apparatus **20** to the incident scene. As shown, the system **118** includes the unloading system **90** of the ambulance **91**, the autonomous patient support apparatus **20**, as well as the navigation system **86**, drive system **84**, obstruction detection system **88**, and controller **93**. The system **118** also includes a first communication system **120** in communication with the navigation system **86** of the autonomous patient support apparatus **20**, a second communication system **122** corresponding to a public safety answering point **124**, and a remote dispatch center **126** in communication with the navigation system **86** and the obstruction detection system **88** of the autonomous patient support apparatus **20**. In some embodiments, certain components of the system **118** may be omitted.

[0044] As shown in FIG. **6A**, the step **102** of determining the initial location of the incident scene may include a step **128** of receiving an emergency call at the public safety answering point **124**; a step **130** of determining the initial location based on the emergency call; and a step **132** of relaying the initial location from the public safety answering point **124** to the remote dispatch center **126** in communication with the navigation system **86** of the autonomous patient support apparatus **20**. Once the initial location is determined during step **102**, the method proceeds to steps **104** and **106** of dispatching the ambulance **91** loaded with the autonomous patient support apparatus **20** and the first responder to the initial location.

[0045] Additional aspects of step **102** of the method **100**, including additional steps **128**, **130**, and **132**, are illustrated

in FIG. 6B. As shown, the public safety answering point 124 receives an emergency call 134 from an incident scene 136. For example, in some instances, a call-taker operating the second communication system 122, such as a landline telephone system, at the public safety answering point 124 may receive the emergency call 134 from someone “dialing 9-1-1” or another emergency telephone number. In such instances, after the call-taker receives the emergency call 134, the call-taker may begin collecting information regarding the incident scene 136, such as what type of emergency has occurred at the incident scene 136, an approximate location of the incident scene 136, and/or a nearby address of the incident scene 136. In this way, the call-taker may determine the initial location during step 130 based on the approximate location of the emergency. For example, the call-taker may determine an address and/or GPS coordinates of the initial location during step 130 based on the approximate location of the emergency. The call-taker then relays the initial location and any other information regarding the incident scene to the remote dispatch center 126 during step 132. In some instances, the call-taker routes the emergency call to the remote dispatch center 126 via the second communication system 122 and the remote dispatch center 126 continues collecting information regarding the incident scene.

[0046] Steps 104 and 106 are also illustrated in FIG. 6B. As shown, the remote dispatch center 126 may communicate with a service entity 138 to dispatch the ambulance 91 loaded with the autonomous patient support apparatus 20 to the incident scene 136 during step 104. Also shown, the remote dispatch center 126 may communicate with the service entity 138 to dispatch the first responder 140 to the incident scene 136 during step 106.

[0047] As shown in FIG. 6B, the service entity 138 may comprise one or more of a variety of different types, such as a hospital 142, a fire department 144, a police station 146, or any other suitable type of service entity. Additionally, in various instances, the service entity 138 may have access to or may otherwise comprise a variety of different types of assets, which may be positioned at a physical location, such as at a station or department associated with a service entity 138. The service entity 138 may also communicate with a variety of personnel, who may be “on duty” at a station or department associated with a service entity 138, or may be “off duty” but nevertheless may dispatch or otherwise respond from their place of residence or another location. In one instance, the remote dispatch center 126 may communicate with the fire department 144 to dispatch the ambulance 91, a fire truck 148, a firefighter 150, and the first responder 140 to the incident scene 136. In another instance, the remote dispatch center 126 may communicate with the police station 146 to dispatch the ambulance 91, a police vehicle 150, and a police officer 154 to the incident scene 136. In yet another instance, the remote dispatch center 126 may communicate with the hospital 142 to dispatch the ambulance 91, and a first responder 156 responding from their place of residence. It will be appreciated that the forgoing examples are illustrative and non-limiting. Other instances, including dispatching various types of assets and/or personnel from various locations and/or types of service entities, are contemplated.

[0048] Aspects of steps 104 and 106 are illustrated in FIG. 6C. As shown in this illustrative instance, the remote dispatch center 126 communicates with the service entity 138

to dispatch the ambulance 91 loaded with the autonomous patient support apparatus 20 and the first responder 140 to the initial location 158 of the incident scene 136. In the embodiment of FIG. 6C, four homes are shown, each of which include a respective property area illustrated by dotted lines. In this illustrative instance, the incident scene 136 corresponds to a leg injury to a patient 160 located within a property area of a home with an address of 1234 Main St. As such, the initial location 158 corresponds to the home and the ambulance 91 and the first responder 140 are dispatched to the associated address, 1234 Main St.

[0049] Referring back to FIG. 6A, after steps 104 and 106, the method 100 proceeds to the step 108 of unloading the autonomous patient support apparatus 20 from the ambulance 91 at the initial location 158. As previously stated, the autonomous patient support apparatus 20 may be unloaded from the ambulance 91 by the unloading system 90. Here, the unloading system 90 may be manually operated by the first responder 140, or the unloading system 90 may autonomously unload the autonomous patient support apparatus 20 after the ambulance 91 reaches the initial location 158. In still other instances, the unloading system 90 may unload the autonomous patient support apparatus 20 after the unloading system 90 is manually activated by the first responder 140 or remotely activated by the remote dispatch center 126.

[0050] The method 100 also includes the step 110 of determining the refined location of the incident scene 136, which may include a step 162 of establishing patient contact at the refined location 164 with the first responder 140. Referring to FIG. 6C, in this illustrative instance, the refined location 164 of the incident scene 136 corresponds to a location suitable for treating the patient 160. For example, in FIG. 6C, the refined location 164 corresponds to a location within the property area of 1234 Main St. where the patient 160 was found by the first responder 140. In some embodiments, step 110 includes the step 162 of establishing contact between the patient 160 at the refined location 164 and the first responder 140. In such an embodiment, the first responder 140 may travel from the initial location 158 while searching for the patient 160 within the property area. Here, establishing contact with the patient 160 when found by the first responder 140 would then define the refined location 164.

[0051] The method also includes the step 112 of communicating the refined location 164 of the incident scene 136 to the navigation system 86 of the autonomous patient support apparatus 20. In some instances, the first communication system 120 may be configured to communicate the refined location 164 to the navigation system 86 during step 112. For example, in some embodiments, the method 100 may include a step 166 of equipping the first responder 140 with at least one of a radio communication device and a mobile phone. In such embodiments, the first communication system 120 includes the radio communication device and/or the mobile phone. As shown in FIG. 4B, the radio communication device 120R and the mobile phone 120M may be affixed to the ambulance 91, allowing the first responder 140 to equip the radio communication device 120R and/or the mobile phone 120M upon reaching the initial location 158. Additionally, in such embodiments, step 112 may include a step 168 of transmitting a voice command VC (shown in FIG. 3) with the radio communication device 120R and/or the mobile phone 120M to communicate the refined location 164 to the navigation system 86. For example, the voice

command VC may include a description of the refined location 164 from the first responder 140. The radio communication device 120R and/or the mobile phone 120M may transmit the voice command VC to communicate the refined location 164 of the incident scene 136 to the navigation system 86.

[0052] In some embodiments, such as the embodiment of FIG. 3, the radio communication device 120R and/or the mobile phone 120M may transmit the voice command VC to the remote dispatch center 126 to communicate the refined location 164 (shown as “RL (164)” in FIG. 3) to the navigation system 86. In such embodiments, the remote dispatch center 126 may process the voice command VC to determine the refined location 164. The remote dispatch center 126 may then transmit the refined location 164 to the navigation system 86. For example, in the embodiment of FIG. 3, the remote dispatch center 126 transmits the refined location 164 to the navigation system 86 via the controller 93.

[0053] In embodiments where the method 100 includes the steps 166 and 168, the method 100 may not necessarily include the step 162 of establishing patient contact at the refined location 164. In some instances, the first responder 140 may transmit the voice command VC during step 168 without establishing patient contact at the refined location 164. In one such instance, the refined location 164 may be a location that the autonomous patient support apparatus 20 could reach, but the first responder 140 is unable to reach. As such, the first responder 140 may transmit a voice command VC describing the refined location 164 to communicate the refined location 164 to the navigation system 86. In this way, the autonomous patient support apparatus 20 may reach the patient 160 even if the first responder 140 is not able to.

[0054] The method 100 may include a step 173 of equipping the first responder 140 with a tracker 172, which is shown in FIGS. 6E and 6F. In such embodiments, the method may include the above-described step 162 of establishing patient contact at the refined location 164 with the first responder 140. As such, the tracker 172 may be configured to determine the refined location 164 of the incident scene 136 based on the first responder 140 traveling from the initial location 158 and establishing patient contact at the refined location 164. In some embodiments, the tracker 172 includes at least one of a GPS tracker, a cellular tracker, and a WiFi tracker. In such embodiments, the step 110 of determining the refined location 164 includes a step 174 in which the tracker 172 determines its location based on at least one of a GPS signal, a cellular signal, and a WiFi signal. As such, to determine the refined location 164 during step 110, the first responder 140 may establish patient contact at the refined location 164 with the tracker 172 during step 162, and the tracker 172 may determine its location using a GPS signal, a cellular signal, and/or a WiFi signal during step 174.

[0055] In some embodiments, the first communication system 120 includes a mobile computing device such as the mobile phone 120M, a laptop computer, a tablet, or any other computing system suitable for communicating the refined location 164. In such embodiments, the tracker 172 may be coupled to the mobile computing device and the step 112 of communicating the refined location 164 of the incident scene 136 includes a step 176 of transmitting data D1 (shown in FIG. 3) associated with a location of the tracker 172 to the navigation system 86 of the autonomous

patient support apparatus 20. In embodiments where the tracker 172 is coupled to the mobile computing device, the mobile computing device may execute the step 176. Furthermore, in such embodiments, the mobile computing device may transmit the data D1 associated with the location of the tracker 172 to the navigation system 86 via the remote dispatch center 126. As such, the remote dispatch center 126 may process the data D1 associated with the location of the tracker 172 prior to transmitting the data to the navigation system 86.

[0056] In other embodiments, the first communication system 120 may include the tracker 172 and the tracker 172 may include a tracker user interface, such as a touchscreen, a button, a switch, or any other user interface suitable for receiving an input from a user of the tracker 172. For example, the tracker user interface may be a handheld device comprising a button, such as the tracker user interface 120T shown in FIG. 4B. In such embodiments, the step 112 of communicating the refined location 164 of the incident scene 136 includes the step 176 of transmitting data D1 associated with the location of the tracker 172 to the navigation system 86 of the autonomous patient support apparatus 20. In embodiments where the tracker 172 includes the tracker user interface 120T, the tracker 172 may execute the step 176 after the tracker user interface 120T is actuated. For example, in an instance where the tracker user interface 120T is realized as a touchscreen, the tracker 172 may transmit data D1 associated with the location of the tracker 172 after a “TRANSMIT” button is actuated on the touchscreen. Additionally, the tracker 172 may transmit the data D1 associated with the location of the tracker 172 to the navigation system 86 via the remote dispatch center 126.

[0057] As shown in FIG. 6D, the method 100 includes the step 116 of generating the drive path 186 with the navigation system 86. In an embodiment including the step 166 of equipping the first responder 140 with at least one of a radio communication device 120R and a mobile phone 120M, the navigation system 86 may determine the drive path 186 during step 116 based on a voice command VC received from the first responder 140 via the radio communication device 120R and/or the mobile phone 120M. The controller 93 may then control the drive system 84 based on the drive path 186 such that the autonomous patient support apparatus 20 travels from the initial location 158 to the refined location 164.

[0058] In embodiments including the tracker 172, the step 116 of generating the drive path 186 may include a step 180 of generating a tracker path 184 based on movement of the first responder 140 away from the initial location 158. In such embodiments, step 180 may be executed by the tracker 172 and the tracker path 184 includes a plurality of locations associated with the tracker 172. Additionally, in embodiments including step 180, the step 116 of generating the drive path 186 may also include a step 182 of generating the drive path 186 with the navigation system 86 based on the tracker path 184. The controller 93 may then control the drive system 84 based on the drive path 186.

[0059] FIG. 6E illustrates one embodiment of steps 180 and 182. As shown, the first responder 140 is equipped with the tracker 172 and is moving towards the refined location 164 of the incident scene 136. Accordingly, during step 180, the tracker 172 generates the tracker path 184 based on the movement of the first responder 140 and during step 182, the navigation system 86 generates the drive path 186. In FIG.

6E, the drive path **186** is generated in accordance with a “follow me” mode as disclosed in U.S. Patent Application Publication No. 2014/0076644A1, which claims priority to U.S. Provisional Patent App. No. 61/702,316, filed on Sep. 18, 2012, entitled “Powered Patient Support Apparatus,” the disclosures of which are hereby incorporated by reference in their entirety. As shown, the controller **93** controls the drive system **84** based on the drive path **186** such that the autonomous patient support apparatus **20** follows the first responder **140**.

[0060] FIG. 6F illustrates another embodiment of steps **180** and **182**. As shown, the first responder **140** is equipped with the tracker **172** and has established patient contact at the incident scene **136**. Accordingly, during step **180**, the tracker **172** generates the tracker path **184** based on the movement of the first responder **140** and during step **182**, the navigation system **86** generates the drive path **186**. However, in the embodiment of FIG. 6F, the drive path **186** is generated such that a distance between the initial location **158** and the refined location **164** is minimized.

[0061] Referring to FIG. 6A, steps **166** and **168** are illustrated using dotted lines (“- - -”). Embodiments of any method herein including a step that is illustrated using the dotted lines also include step **166**. For example, embodiments of the method **100** that include the step **168** of transmitting the voice command VC with the radio communication device **120R** and/or the mobile phone **120M** also include the step **166** of equipping the first responder **140** with the radio communication device **120R** and/or the mobile phone **120M**.

[0062] Referring to FIGS. 6A and 6D, steps **173**, **174**, **176**, **180**, and **182** are illustrated using dot-dash lines (“-.-”). Embodiments of any method herein including a step that is illustrated using the dot-dash lines also include step **173**. For example, embodiments of the method **100** that include the step **176** of transmitting data **D1** associated with the location of the tracker **172** to the navigation system **86** also include the step **173** of equipping the first responder **140** with the tracker **172**. As another example, embodiments of the method **100** that include the step **180** of generating the tracker path **184** also include the step **173** of equipping the first responder **140** with the tracker **172**.

[0063] In FIG. 6G, an instance where the autonomous patient support apparatus **20** has encountered an obstruction **188** is shown. As shown in FIG. 6G, the obstruction **188** prevents the drive system **84** from driving the autonomous patient support apparatus **20** to the refined location **20**. In such instances, the autonomous patient support apparatus **20** may include the above-described obstruction detection system **88**. Referring back to FIG. 6A, the method **100** may further include a step **190** of detecting a presence of the obstruction **188** at an obstruction location **192** and a step **194** of interrupting operation of the drive system **84** in response to detecting the obstruction **188** at the obstruction location **192**. The obstruction detection system **88** may be configured to detect the presence of the obstruction **188** during step **190** and may be configured to communicate with the controller **93** to interrupt operation of the drive system **84** during step **194**.

[0064] After detecting the presence of the obstruction **188**, the method **100** may proceed in a variety of ways. For example, as shown in FIG. 6H, the method may proceed to a step **196** of generating, with the navigation system **86**, an alternate drive path for the autonomous patient support

apparatus **20** between a location of the obstruction location **192** and the refined location **164**. In such an embodiment, the obstruction detection system **88** may communicate with the navigation system **86** via the controller **93**. The method may then proceed to a step **198** of driving the autonomous patient support apparatus **20** with the drive system **84** from the obstruction location **192** along the alternate drive path. For example, in FIG. 6G, the obstruction **188** is illustrated as a pile of rocks, which are preventing the drive system **84** from driving the patient support apparatus **20** along the drive path **186**. During step **196**, the navigation system **86** may generate an alternate drive path, which bypasses the obstruction **188**. Accordingly, the autonomous patient support apparatus **20** may bypass the obstruction **188** by driving from the obstruction location **192** along the alternate drive path.

[0065] In another example, shown in FIG. 6I, the method **100** may proceed to a step **200** of determining that the autonomous patient support apparatus **20** cannot reach the refined location **164** with the drive system **84**. The method **100** may then proceed to a step **202** of generating an alarm A (shown in FIG. 3) with the patient support apparatus **20** to indicate that the obstruction **188** cannot be traversed without intervention. As shown in FIG. 3, the alarm A may include an alarm A transmitted to the remote dispatch center **126** and/or to the first responder **140** via the first communication system **120**. The alarm A may also include an audible alarm, a visual alarm, a tactile alarm, or any other alarm suitable for indicating that the obstruction **188** cannot be traversed without intervention. Steps **200** and **202** may be executed by the obstruction detection system **88**.

[0066] In yet another example, shown in FIG. 6J, the method **100** may proceed to a step **204** of communicating, with the obstruction detection system **88**, an intervention request IR (shown in FIG. 3) related to the presence of the obstruction **188** to the remote dispatch center **126** and/or to the first responder **140** via the first communication system **120**. Accordingly, the method **100** may then proceed to a step **206** of rectifying the obstruction **188** communicated via the intervention request IR and a step **208** of driving, with the drive system **84**, the autonomous patient support apparatus **20** from the obstruction location **192** to the refined location **164** along the drive path **186**. For example, referring to FIG. 6G, the obstruction **188** is illustrated as a pile of rocks, which are preventing the drive system **84** from driving the patient support apparatus **20** along the drive path **186**. During step **206**, the first responder **140** may move the pile of rocks to rectify the obstruction **188**. Accordingly, the drive system **84** may then continue driving the autonomous patient support apparatus **20** along the drive path **186**.

[0067] FIG. 7A illustrates a method **210** of transporting an autonomous patient support apparatus, such as the above-described autonomous patient support apparatus **20**, to an incident scene **136** via an optimized drive path. As shown, the method **210** includes the above-described step **102** of determining the initial location **158** of the incident scene **136**; the above-described step **104** of dispatching the ambulance **91** loaded with the autonomous patient support apparatus **20** to the initial location **158**; the above-described step **108** of unloading the autonomous patient support apparatus **20** from the ambulance **91** at the initial location **158**; and the above-described step **114** of driving, with the drive system **84**, the autonomous patient support apparatus **20** from the initial location **158** to the refined location **164**.

[0068] The method 210 also includes a second embodiment 110' of the step 110 of determining the refined location 164 of the incident scene 136 and a second embodiment 112' of the step 112 of communicating the refined location 164 of the incident scene 136 to the navigation system 86 of the autonomous patient support apparatus 20. Additionally, the method 210 includes a step 212 of determining, with the navigation system 86, an optimized path between the initial location 158 and the refined location 164; and a step 214 of generating, with the navigation system 86, the drive path (also shown as “DP (186)” in FIG. 7B) for the autonomous patient support apparatus 20 based on the optimized path.

[0069] Referring to FIG. 7H, one instance of the method 210 is shown. As shown, the first responder 140 establishes patient contact to determine the refined location 164 of the incident scene 136. The navigation system 86 then determines an optimized path (not shown in FIG. 7H) between the initial location 158 and the refined location 164 during step 212. In some embodiments, the optimized path may be based on at least one of topographical data, street mapping data, traffic data, and building infrastructure data. In such embodiments, the navigation system 86 may receive this information from the first responder 140 in the form of data D2 (shown in FIG. 7B) associated with the first responder 140 traveling from the initial location 158 to the refined location 164. The navigation system 86 may also receive this information from an internet connection. Accordingly, the navigation system 86 generates the drive path 186 for the autonomous patient support apparatus 20 based on the optimized path during step 214. The controller 93 then controls the drive system 84 to drive the autonomous patient support apparatus 20 from the initial location 158 to the refined location 164 along the drive path 186.

[0070] As shown in FIG. 7B, the steps 102, 104, 108, 110', 112', 212, and 214 may be executed by components of a system 216 for transporting the autonomous patient support apparatus 20 to the incident scene 136 via the optimized path. As shown, the system 216 includes the components of system 118 and a deployment system 218 of the ambulance 91. In one instance, the deployment system 218 may deploy an unmanned aerial vehicle, such as the above-described unmanned aerial vehicle 94 from the ambulance 91. In another instance, the deployment system 218 may include the unloading system 90 and may unload the autonomous patient support apparatus 20 from the ambulance 91. In some embodiments, some of the components of system 216 may be omitted.

[0071] In some embodiments, the ambulance 91 may be loaded with an unmanned aerial vehicle, such as the above-described unmanned aerial vehicle 94. In such embodiments, the step 110' may include a step 218 of dispatching the unmanned aerial vehicle 94 from the ambulance 91 to the initial location 158 as shown in FIG. 7C. The step 110' also includes a step 220 of determining a location of the patient 160 with the unmanned aerial vehicle 94 to define the refined location 164 of the incident scene. The steps 218 and 220 are further illustrated in FIG. 7D. As shown, the unmanned aerial vehicle 94 is dispatched to the initial location 158 and then determines the location of the patient 160 by travelling toward the incident scene 136 in order to define the refined location 164. For example, as previously stated, the unmanned aerial vehicle 94 may include a variety of sensors, such as an imaging sensor realized as the camera 95 (shown in FIG. 5) and a location sensor. As such, the camera 95 may

capture imaging data while the unmanned aerial vehicle 94 travels towards the incident scene 136. The imaging data may then be analyzed to determine the refined location 164 relative to the location of the unmanned aerial vehicle 94.

[0072] In another embodiment where the ambulance 91 is loaded with the unmanned aerial vehicle 94, the step 110' includes a step 222 of deploying the unmanned aerial vehicle 94 from the ambulance 91 at the initial location 158, as shown in FIG. 7E. The step 110' also includes the above-described step 220. The steps 222 and 220 are further illustrated in FIG. 7F. As shown, the unmanned aerial vehicle 94 is deployed from the ambulance 91 at the initial location 158 and then determines the location of the patient 160 by travelling toward the incident scene 136 in order to define the refined location 164. The unmanned aerial vehicle 94 may be deployed from the ambulance 91 by the deployment system 218.

[0073] In embodiments where the ambulance 91 is loaded with the unmanned aerial vehicle 94, the step 112', as shown in FIGS. 7C and 7E, may include a step 224 of transmitting data D3 (shown in FIG. 7B) associated with the refined location 164 with the unmanned aerial vehicle 94. As shown in FIG. 7B, the data D3 associated with the refined location 164 may be transmitted from the unmanned aerial vehicle 94 to the navigation system 86 via the controller 93 and via the remote dispatch center 126. The data D3 associated with the refined location 164 may include imaging data, obstruction data, topographical data, location data, weather data, and movement data. As such, the step 212 of determining, with the navigation system 86, an optimized path between the initial location 158 and the refined location 164 may include a step 226 of determining the optimized path based on at least one of imaging data, obstruction data, topographical data, location data, weather data, and movement data communicated from the unmanned aerial vehicle 94. For example, during step 226, the navigation system 86 may determine the optimized path based on imaging data of topographical features communicated from the unmanned aerial vehicle 94.

[0074] Referring to FIGS. 7C and 7E, steps 218, 220, 222, 224, and 226 are illustrated using dot-dot-dash lines (“...”). Embodiments of any method herein including a step that is illustrated using the dot-dot-dash lines also include either step 218 or 222. For example, embodiments of the method 210 that include the step 226 of determining the optimized path based on imaging data, obstruction data, topographical data, location data, weather data, and/or movement data communicated from the unmanned aerial vehicle 94 include either the step 218 of dispatching the unmanned aerial vehicle 94 to the initial location 158 or the step 222 of deploying the unmanned aerial vehicle 94 from the ambulance 91 at the initial location 158.

[0075] FIG. 7G illustrates an embodiment where the method 210 includes the step 112' of communicating the refined location 164 to the navigation system 86. In embodiments where the first responder 140 is equipped with the radio communication device 120R and/or the mobile phone 120M, the step 112' may include the above-described step 168 of transmitting the voice command VC (also shown in FIG. 7B) with the radio communication device 120R and/or the mobile phone 120M. In such an embodiment, the voice command VC may include a description of the refined location 164 from the first responder 140. During step 212, the navigation system 86 may then determine the optimized

path between the initial location 158 and the refined location 164 based on the voice command VC. In embodiments where the tracker 172 is coupled to the above-described mobile computing device or where the tracker 172 includes the above-described tracker user interface 120T, the step 112' may also include the above-described step 176 of transmitting data D1 (also shown in FIG. 7B) associated with the location of the tracker 172 to the navigation system 86. During step 212, the navigation system 86 may then determine the optimized path between the initial location 158 and the refined location 164 based on the data D1 associated with the location of the tracker 172.

[0076] FIG. 7H illustrates the embodiment where the method includes the step 112' and where the tracker is coupled to the mobile computing device. In such an embodiment, the method 210 includes the steps 106, 173, 110', 162, 174, 112', 176, and 212. As shown, the first responder 140 is equipped with the tracker 172, the first responder 140 establishes patient contact at the refined location 164, the tracker 172 determines its location at the refined location 164 during step 174, and the mobile computing device transmits data D1 associated with the location of the tracker 172 to the navigation system 86. The navigation system 86 then determines the optimized path based on the data D1 associated with the location of the tracker 172 and generates the drive path 186 accordingly. The controller 93 then controls the drive system 84 to drive the autonomous patient support apparatus 20 from the initial location 158 to the refined location 164 along the drive path 186.

[0077] FIG. 7I illustrates an embodiment where the method 210 includes a step 112' of communicating data D2 (shown in FIG. 7B) associated with the first responder 140 traveling from the initial location 158 to the refined location 164 to the navigation system 86 of the autonomous patient support apparatus 20. As shown, the data D2 associated with the first responder 140 traveling from the initial location 158 to the refined location 164 may be transmitted to the navigation system 86 via the controller 93 and via the remote dispatch center 126. Additionally, the step 212 of determining the optimized path with the navigation system 86 may include a step 228 of determining the optimized path based on the data D2 associated with the first responder 140 traveling from the initial location 158 to the refined location 164.

[0078] In embodiments where the first responder 140 is equipped with at least one of the radio communication device 120R and the mobile phone 120M, the step 112' may include the step 168 of transmitting the voice command VC with the radio communication device 120R and/or the mobile phone 120M. In such an embodiment, the voice command VC may include a description of any suitable information associated with the first responder 140 traveling from the initial location 158 to the refined location 164. For example, the voice command VC may include a description of topographical features, a warning of a potential obstruction, and/or a suggested optimized path.

[0079] Similarly, in embodiments where the first responder 140 is equipped with the tracker 172, the step 112' includes the step 176 of transmitting the data D2 associated with the first responder 140 traveling from the initial location 158 to the refined location 164 to the navigation system 86. For example, the data D2 may include a notification of topographical features, a warning of a potential obstruction, and/or a suggested optimized path. In an embodiment where

the tracker 172 is coupled to the mobile computing device, the mobile computing device may transmit the data D2 associated with the first responder 140 traveling from the initial location 158 to the refined location 164 to the navigation system 86. For example, the mobile computing device may transmit data D2 indicating a location and an approximate size of a pond that the first responder 140 encountered. In an embodiment where the tracker 172 includes the tracker user interface 120T, the tracker 172 may transmit the data D2 associated with the first responder 140 after the first responder 140 actuates the tracker user interface 120T. For example, the tracker 172 may transmit data D2 indicating a location of a steep cliff after the first responder 140 depresses a button on the tracker user interface 120T.

[0080] FIG. 7J illustrates an embodiment where the first responder 140 is equipped with the tracker 172, and the method 210 includes the step 112' of transmitting the data D2 associated with the first responder 140 traveling from the initial location 158. In such an embodiment, the method 210 includes the steps 106, 173, 162, 176, 174, 112', 176, 212, and 228. As shown, the tracker 172 is carried by the first responder 140 and the first responder 140 observes a pond 230 while traveling from the initial location 158 to the refined location 164. In FIG. 7J, the tracker 172 may be coupled to the mobile computing device. Accordingly, the mobile computing device transmits data D2 indicating a location of the pond 230 to the navigation system 86 in the form of data D2 associated with the first responder 140 traveling from the initial location 158 to the refined location 164. For example, the first responder 140 may transmit the location of the pond 230 to the navigation system 86 by pressing an "OBSTRUCTION DETECTED" button on a touchscreen of the mobile computing device. The navigation system 86 then determines the optimized path such that the autonomous patient support apparatus 20 avoids the pond 230 when traveling to the refined location 164 and generates the drive path 186 around the pond 230. The controller 93 then controls the drive system 84 to drive the autonomous patient support apparatus 20 from the initial location 158 to the refined location 164 along the drive path 186.

[0081] FIG. 7K illustrates an embodiment where the method 210 includes a step 232 of determining a redirect location of the incident scene 136 based on the refined location 164 of the incident scene 136. For example, the first responder 140 may determine that the autonomous patient support apparatus 20 may not reach or will encounter great difficulty when attempting to reach the refined location 164. In such embodiments, the navigation system 86 determines the redirect location of the incident scene 136 after the refined location 164 is determined and communicated to the navigation system 86 during steps 110' and 112', respectively. For instance, during step 112', data D1 associated with the location of the tracker 172 and/or data D2 associated with the first responder 140 traveling from the initial location 158 to the refined location 164 may be transmitted to the navigation system 86. For example, the first responder 140 may encounter a river or hazardous terrain, and may notify the navigation system 86 via data D2 associated with the first responder 140 traveling from the initial location 158 to the refined location 164. The navigation system 86 may then determine a redirect location.

[0082] During step 232, the navigation system 86 may determine the redirect location of the incident scene based

on the refined location 164. As shown in FIG. 7M, step 232 may include the step 234 of evaluating each of the initial location 158 and the redirect location relative to the refined location 164 based on one or more of an obstacle presence, topographical data, street mapping data, street traffic data, and building infrastructure data. The navigation system 86 may also evaluate a distance between the initial location 158 and the refined location compared to a distance between the redirect location and the refined location 164.

[0083] After the navigation system 86 determines the redirect location, the unloading system 90 unloads the autonomous patient support apparatus 20 during step 108 at the redirect location. The method 210 then proceeds to the above-described step 212 of determining, with the navigation system 86, the optimized path. However, in this instance of step 212, the navigation system 86 determines the optimized path between the redirect location and the refined location 164. The method 210 then proceeds to generate the drive path 186 during step 214 and drives the autonomous patient support apparatus along the drive path 186 during step 114.

[0084] To illustrate the embodiment where the method 210 includes the step 232 of determining the redirect location of the incident scene 136, FIG. 7L illustrates an embodiment where the incident scene occurs in a backyard of a home with a river 236. As shown in FIG. 7L, the ambulance 91 is dispatched to the home with the address 1236 Main St. by the remote dispatch center 126.

[0085] In an embodiment shown in FIG. 7M and FIG. 7N, the method 210 may include an instance of the step 218 where the unmanned aerial vehicle 94 is dispatched to the refined location 164, and the step 220 where the unmanned aerial vehicle 94 determines the patient location to define the refined location 164. The unmanned aerial vehicle 94 may then communicate the refined location 164 to the navigation system 86 during step 112'. The navigation system 86 may then determine, during a step 232 and step 234, the redirect location based on the refined location 164. In the embodiment of FIG. 7M, the step 234 may include a step 238 of evaluating each of the initial location 158 and the redirect location relative to the refined location 164 based on at least one of imaging data, location data, weather data, and movement data communicated from the unmanned aerial vehicle 94. For example, the unmanned aerial vehicle 94 of FIG. 7N may communicate imaging data of the river 236. Accordingly, during step 232, the navigation system 86 may determine the redirect location based on the imaging data of the river 236.

[0086] In an embodiment of FIGS. 70 and 7P, the method 210 may include a step 240 of dispatching, to the initial location 158, the first responder 140 equipped with at least one of the tracker 172, the mobile phone 120M, the radio communication device 120R, and the mobile computing device. The method 210 also includes the step 162 of establishing patient contact at the refined location 164 with the first responder 140. The navigation system 86 may then determine, during step 232 and step 234, the redirect location based on the refined location 164. In the embodiment of FIG. 70, the step 234 may include a step 242 of evaluating each of the initial location 158 and the redirect location relative to the refined location 164 based on at least one of a voice command VC, data associated with a location of the tracker 172, and data associated with traveling from the initial location 158 to the refined location 164 communi-

cated with at least one of the tracker 172, the mobile phone 120M, the radio communication device 120R, and the mobile computing device.

[0087] For example, in the embodiment of FIG. 7P, the first responder 140 equipped with the tracker 172 travels to the refined location 164. Accordingly, the navigation system 86 may determine the redirect location after evaluating each of the initial location 158 and the redirect location relative to the refined location 164 based on data D1 associated with the location of the tracker 172 and/or data associated with traveling from the initial location 158 to the refined location 164. In one instance, the first responder 140 may cross the river 236 and notify the navigation system 86 of the location of the river 236 and that the navigation system 86 should determine a redirect location because, for example, the first responder 140 recognizes that the autonomous patient support apparatus 20 will be unable to traverse the river 236.

[0088] In the embodiment of FIGS. 7K and 7Q, after the method 210 determines the redirect location during step 232, the method 210 proceeds to an instance of the step 108 of unloading the autonomous patient support apparatus 20. However, in this instance, the autonomous patient support apparatus 20 is unloaded at the redirect location 244 instead of the initial location 158. As shown in FIG. 7Q, the ambulance 91 travels to the redirect location 244, a home associated with an address 789 State St., and unloads the autonomous patient support apparatus 20 there. The controller 93 then controls the drive system 84 to drive the autonomous patient support apparatus 20 to the refined location 164 from the redirect location 244.

[0089] In the embodiment of FIGS. 7R and 7S, the method 210 includes a step 246 of dispatching a second ambulance 91' loaded with a second autonomous patient support apparatus 20' to the redirect location 244. To drive the second ambulance 91' to the refined location 164, the method 210 also includes an instance of the step 108 of unloading the second autonomous patient support apparatus 20' from the second ambulance 91' at the redirect location 244; an instance of the step 112' where the refined location 164 is communicated to the navigation system 86 of the second autonomous patient support apparatus 20'; an instance of the steps 212 and 214 where the navigation system 86 determines the optimized path and generates a drive path for the second autonomous patient support apparatus 20'; and an instance of the step 114 where the drive system 84 drives the second autonomous patient support apparatus 20' from the redirect location 244 to the refined location 164. As shown in FIG. 7S, the second ambulance 91' is dispatched by the remote dispatch center 126 to the redirect location 244. The second autonomous patient support apparatus 20' is then unloaded from the second ambulance 91' and drives to the refined location 164.

[0090] FIG. 8A illustrates a method 248 of transporting medical equipment modules 96, such as a trauma kit, a drug box, an O₂ bottle, a defibrillator, and/or a heart monitor, to an incident scene. As shown, the method 210 includes the above-described step 102 of determining the initial location 158 of the incident scene 136 and the above-described step 110 of determining the refined location 164 of the incident scene 136.

[0091] The method 248 also includes a step 250 of dispatching an ambulance 91 loaded with the autonomous mobile response unit and a plurality of medical equipment modules 96 to the initial location 158; a step 252 of selecting

a first medical equipment module, such as one of the medical equipment modules 96 shown in FIG. 1 or the medical equipment module 96 shown in FIG. 5; a step 254 of dispensing the first medical equipment module 96 from the ambulance 91 onto the autonomous mobile response unit; a step 256 of deploying the autonomous mobile response unit from the ambulance 91 at the initial location 158; a step 258 of communicating the refined location 164 of the incident scene 136 to the autonomous mobile response unit; a step 260 of generating, with the navigation system 86, a drive path 186 from the initial location 158 to the refined location 164; and a step 262 of driving, with the drive system 84, the autonomous mobile response unit loaded with the first medical equipment module 96 based on the drive path 186.

[0092] As shown in FIG. 8B, the steps 102, 110, and 250-262 may be executed by components of a system 264 for transporting medical equipment modules 96 to an incident scene 136. As previously stated, the autonomous mobile response unit may include the autonomous patient support apparatus 20 and/or the unmanned aerial vehicle 94. As shown in FIG. 8B, the autonomous patient support apparatus 20 and the unmanned aerial vehicle 94 may include the navigation system 86, the drive system 84, the controller 93, and the obstruction detection system 88.

[0093] The system 264 may also include a dispensing system 270 configured to dispense medical equipment modules 96 from the ambulance 91 onto the autonomous mobile response unit. For example, in an embodiment where the autonomous mobile response unit is the unmanned aerial vehicle 94, the dispensing system 270 may dispense a medical equipment module 96 into the retaining system 98 (see FIG. 5) of the unmanned aerial vehicle 94. In an embodiment where the autonomous mobile response unit is the autonomous patient support apparatus 20, a medical equipment module 96 may be dispensed onto and affixed to the patient support surface 50 (see FIG. 5) of the autonomous patient support apparatus 20. The dispensing system 270 may be operated manually or autonomously. For example, a first responder 140 may activate the dispensing system 270 by physically depressing a button. In another example, the dispensing system 270 may dispense a medical equipment module 96 after receiving an input from a remote computing device.

[0094] As shown, the system 264 may also include components of the above-described system 216. However, the system 264 may omit the second communication system 122, which is included in systems 118, 216. In some embodiments, components of the system 264 may be omitted.

[0095] FIG. 8C further illustrates the step 252 of selecting a first medical equipment module 96. As shown, the step 252 may include a step 264 of transmitting from the refined location 164, with the communication system 120, data D4 associated with the selection of the first medical equipment module 96. In such embodiments, the first responder 140 travels to the refined location 164 during step 162 and, after evaluating the patient's 160 condition, determines types of equipment that are needed. The first responder 140 then selects the first medical equipment module 96 accordingly using the communication system 120.

[0096] FIG. 8D illustrates an embodiment where the autonomous mobile response unit is the unmanned aerial vehicle 94 and the method 248 includes the step 252 of selecting the first medical equipment module 96. As shown,

the first responder 140 travels to the refined location 164 during step 110. The first responder 140 then selects the first medical equipment module 96 during step 252 by transmitting, from the refined location 164, data D4 associated with the selection of the first medical equipment module 96. After the first medical equipment module 96 is dispensed onto the unmanned aerial vehicle 94 by the dispensing system 270 during step 254, the unmanned aerial vehicle 94 is deployed from the ambulance 91 during step 256, receives the refined location 164 during step 258, generates a drive path 186 during step 260, and drives to the refined location 164 during step 262. As such, the first medical equipment module 96 is transported to the incident scene 136.

[0097] FIG. 8E illustrates an embodiment where the method 248 includes a step 266 of dispatching a second first responder 140' (shown in FIG. 8F) to the initial location 158 and a step 268 of manually dispensing the first medical equipment module 96 from the ambulance 91 onto the autonomous mobile response unit with the second first responder 140' in response to receiving the data D4 associated with the selection of the first medical equipment module 96 transmitted by the first responder 140 from the refined location 164. FIG. 8F further illustrates this embodiment. In FIG. 8F, the first responder 140 has traveled to the refined location 164 and has selected the first medical equipment module 96 during step 252. As shown, the second first responder 140' is then dispatched to the initial location 158 during step 266 and manually dispenses the first medical equipment module 96 from the ambulance 91 onto the unmanned aerial vehicle 94 using the dispensing system 270. The unmanned aerial vehicle 94 then drives to the refined location 164, providing the first responder 140 with the first medical equipment module 96.

[0098] It will be further appreciated that the terms "include," "includes," and "including" have the same meaning as the terms "comprise," "comprises," and "comprising." Moreover, it will be appreciated that terms such as "first," "second," "third," and the like are used herein to differentiate certain structural features and components for the non-limiting, illustrative purposes of clarity and consistency.

[0099] Several configurations have been discussed in the foregoing description. However, the configurations discussed herein are not intended to be exhaustive or limit the invention to any particular form. The terminology which has been used is intended to be in the nature of words of description rather than of limitation. Many modifications and variations are possible in light of the above teachings and the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A system for use with a remote dispatch center configured to dispatch a vehicle to an initial location of an incident scene, the system comprising:

- a patient support apparatus including:
 - a base supporting a plurality of caster wheels,
 - a support frame disposed above the base,
 - a patient support surface coupled to the support frame for supporting a patient,
 - a lift mechanism to move the support frame relative to the base between a plurality of vertical configurations, and
 - a navigation system configured to generate a path from the initial location to a refined location; and

an unloading system configured to unload the patient support apparatus from the vehicle at the initial location, the unloading system including a trolley and a track, wherein the patient support apparatus is configured to couple to the trolley and the trolley is configured to move along the track.

2. The system of claim 1, further comprising a portable electronic device configured to communicate the refined location of the incident scene.

3. The system of claim 2, wherein the remote dispatch center is further configured to dispatch a first responder to the initial location such that the first responder travels from the initial location and establishes patient contact at the refined location; and

wherein the first responder is equipped with the portable electronic device.

4. The system of claim 3, wherein the portable electronic device is further defined as at least one of a tracker, a mobile phone, a radio communication device, and a mobile computing device.

5. The system as set forth in claim 4, wherein the portable electronic device includes at least one of a GPS tracker configured to determine the location of the tracker based on a GPS signal, a cellular tracker configured to determine the location of the tracker based on a cellular signal, and a WiFi tracker configured to determine the location of the tracker based on a WiFi signal.

6. The system of claim 2, wherein the portable electronic device is configured determine the refined location of the incident scene based on a first responder traveling from the initial location and establishing patient contact at the refined location.

7. The system of claim 2, wherein the portable electronic device is further configured to transmit, from the refined location, data associated with one or more medical equipment modules.

8. The system of claim 7, wherein the remote dispatch center is further configured to dispatch a second first responder to the initial location; and

wherein the second first responder manually dispenses the one or more medical equipment modules from the vehicle onto the patient support apparatus in response to receiving the data associated with the one or more medical equipment modules transmitted from the refined location.

9. The system of claim 1, wherein the unloading system is further configured to unload the patient support apparatus from the vehicle in response to remote activation.

10. The system of claim 9, wherein the remote activation is sent by the remote dispatch center.

11. The system of claim 1, wherein unloading system is further configured to autonomously unload the patient support apparatus from the vehicle in response to the vehicle reaching a predetermined location.

12. The system of claim 1, wherein the unloading system is further configured for manual operation by a first responder.

13. The system of claim 1, wherein the patient support apparatus includes a drive system and a controller configured to control the drive system based on the path such that the drive system drives the patient support apparatus from the vehicle to the refined location.

14. The system of claim 13, wherein the drive system of the patient support apparatus is fixed to the base and includes at least one auxiliary wheel arranged between the plurality of caster wheels to drive the patient support apparatus.

15. The system of claim 14, wherein the navigation system is configured to generate the path between the initial location and the refined location for the drive system to drive the patient support apparatus along from the initial location to the refined location with the at least one auxiliary wheel.

16. The system of claim 14, wherein the drive system is configured to move the auxiliary wheel to a deployed position.

17. The system of claim 13, wherein the patient support apparatus is configured to autonomously drive along the path between the initial location and the refined location with the drive system.

18. The system of claim 1, further comprising a communication system configured to receive an emergency call at a public safety answering point.

19. The system, of claim 18, wherein the communication system is further configured to relay the initial location from the public safety answering point to the remote dispatch center.

20. A system for use with a remote dispatch center configured to dispatch a vehicle to an initial location of an incident scene, the system comprising:

a patient support apparatus including:

a base supporting a plurality of caster wheels,

a support frame disposed above the base,

a patient support surface coupled to the support frame for supporting a patient, and

a lift mechanism to move the support frame relative to the base between a plurality of vertical configurations, and

a navigation system configured to generate a path from the initial location to the refined location;

an unloading system configured to unload the patient support apparatus from the vehicle at the initial location, the unloading system including a trolley and a track, wherein the patient support apparatus is configured to couple to the trolley and the trolley is configured to move along the track; and

a portable electronic device configured to communicate a refined location of the incident scene.

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