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Murphy et al.

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(45) **Date of Patent: Sep. 11, 2012**

(54) **UNMANNED SURVEILLANCE VEHICLE**

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(73) Assignee: **Raytheon Company**, Waltham, MA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 941 days.

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(22) Filed: **Nov. 26, 2008**

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Related U.S. Application Data

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(51) **Int. Cl.**
B64D 17/80 (2006.01)

(52) **U.S. Cl.** **244/3.1**; 244/63; 244/147; 244/152

(58) **Field of Classification Search** 244/3.1, 244/3.24–3.29, 63, 139, 147, 152; 348/144–147
See application file for complete search history.

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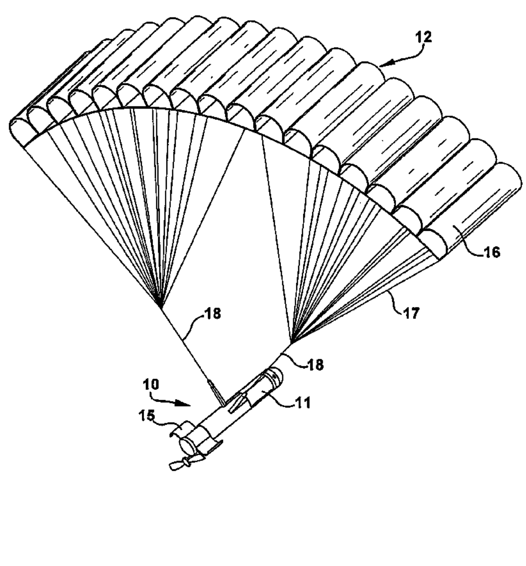
(74) *Attorney, Agent, or Firm* — Renner, Otto, Boisselle & Sklar, LLP

(57) **ABSTRACT**

A surveillance vehicle (**10**) comprising a vessel (**11**) and a parasail (**12**). The vehicle (**10**) is loaded, in a pre-launch condition, into a mortar tube for projection therefrom towards an area of interest. In this pre-launch condition, the vessel (**11**) resembles a conventional mortar round and the parasail (**12**) is stowed within the vessel (**11**). Upon arrival at the area of interest, the parasail (**12**) is deployed from the vessel (**11**) and instrumentation collects survey data.

20 Claims, 42 Drawing Sheets



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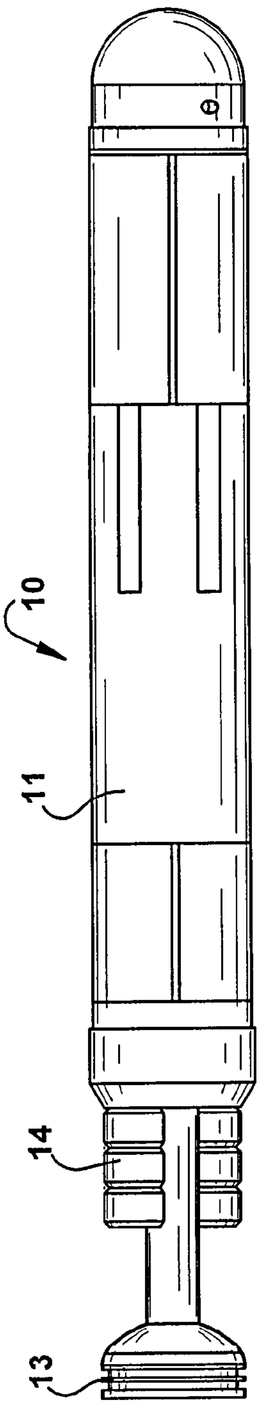


Figure 1A

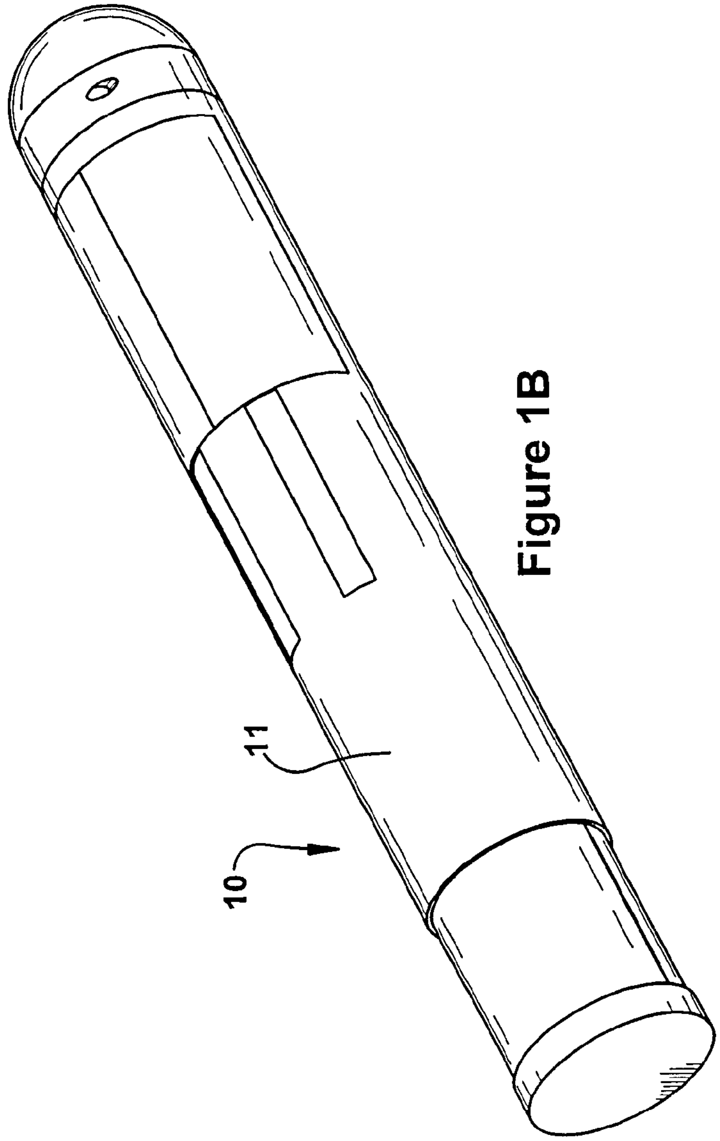


Figure 1B

techniques, including, by non-limiting example, an oral exchange, a data exchange, an oral and data exchange, a signal strength test, or any other method or process of verifying the existence and/or reliability of a communication channel.

In places where the description above refers to particular implementations of UAS position reporting systems, it should be readily apparent that a number of modifications may be made without departing from the spirit thereof and that these implementations may be applied to other UAS position reporting systems.

The invention claimed is:

1. A method of communicating the location of an unmanned aerial system (UAS) the method comprising:

defining a radio frequency line of sight (RFLOS) region surrounding an air traffic control reporting system (ATC-RS) using the ATC-RS;

defining a beacon line of sight region surrounding the ATC-RS using the ATC-RS, the ATC-RS including an automatic dependent surveillance broadcast (ADS-B) and traffic information services broadcast (TIS-B) transceiver;

transmitting position information of the UAS located within the RFLOS region to an air traffic control center (ATC) using one or more telecommunication modems included in the ATC-RS the position information generated using position data received from a ground control station (GCS) coupled to the ATC RS and in operational communication with the UAS for guidance during flight; and

transmitting position information of the UAS using the ADS B and TIS B transceiver of the ATC RS to one or more aircraft located within the beacon line of sight region the one or more aircraft including an ADS B and TIS B transceiver.

2. The method of claim **1**, wherein defining the RFLOS region further comprises using one or more characteristics of a radio frequency connection between the GCS and the UAS in defining the RFLOS region and wherein defining the beacon line of sight region further comprises using one or more characteristics of the ADS-B and TIS-B transceiver in defining the beacon line of sight region.

3. The method of claim **1**, wherein defining the RFLOS region and defining the beacon line of sight region further include defining a beacon line of sight region larger than the RFLOS region.

4. The method of claim **1**, further comprising transmitting a voice signal from an operator of the UAS received by the ATC-RS using the one or more telecommunication modems.

5. The method of claim **1**, further comprising defining one or more terrain shadowed regions within the RFLOS region by locating a contour of one or more terrain based obstructions and specifying that the one or more terrain shadowed regions exist within a predetermined distance from the contour.

6. The method of claim **5**, further comprising automatically rerouting the UAS as it enters the one or more terrain shadowed regions.

7. A method of enabling tracking of the position of an unmanned aerial system (UAS) using a first air traffic control (ATC) and at least a second ATC, the method comprising:

establishing a first data connection and a first voice connection with the first ATC using one or more telecommunications modems included in an air traffic control reporting system (ATC-RS) coupled with a ground control station GCS in operational communication with the UAS for guidance during flight, the ATC-RS and the GCS located on the ground;

transmitting position information and a voice signal to the first ATC using the first data connection and the first voice connection, the position information generated using the ATC-RS from position data received by the ATC-RS from the GCS;

defining at least a first ATC sector and a second ATC sector, the first ATC located in the first ATC sector and the second ATC located in the second ATC sector;

defining an ATC transition zone in one of the first ATC sector, the second ATC sector, or in both the first ATC sector and the second ATC sector;

establishing a second data connection and a second voice connection with the second ATC using the one or more telecommunications modems in response to the UAS entering the ATC transition zone; and

closing the first data connection and the first voice connection with the first ATC after confirming the existence of the second data connection and the second voice connection with the second ATC.

8. The method of claim **7**, wherein defining an ATC transition zone further includes defining size of the ATC transition zone using the speed of the UAS and the average time required to make a data connection and a voice connection with an ATC.

* * * * *

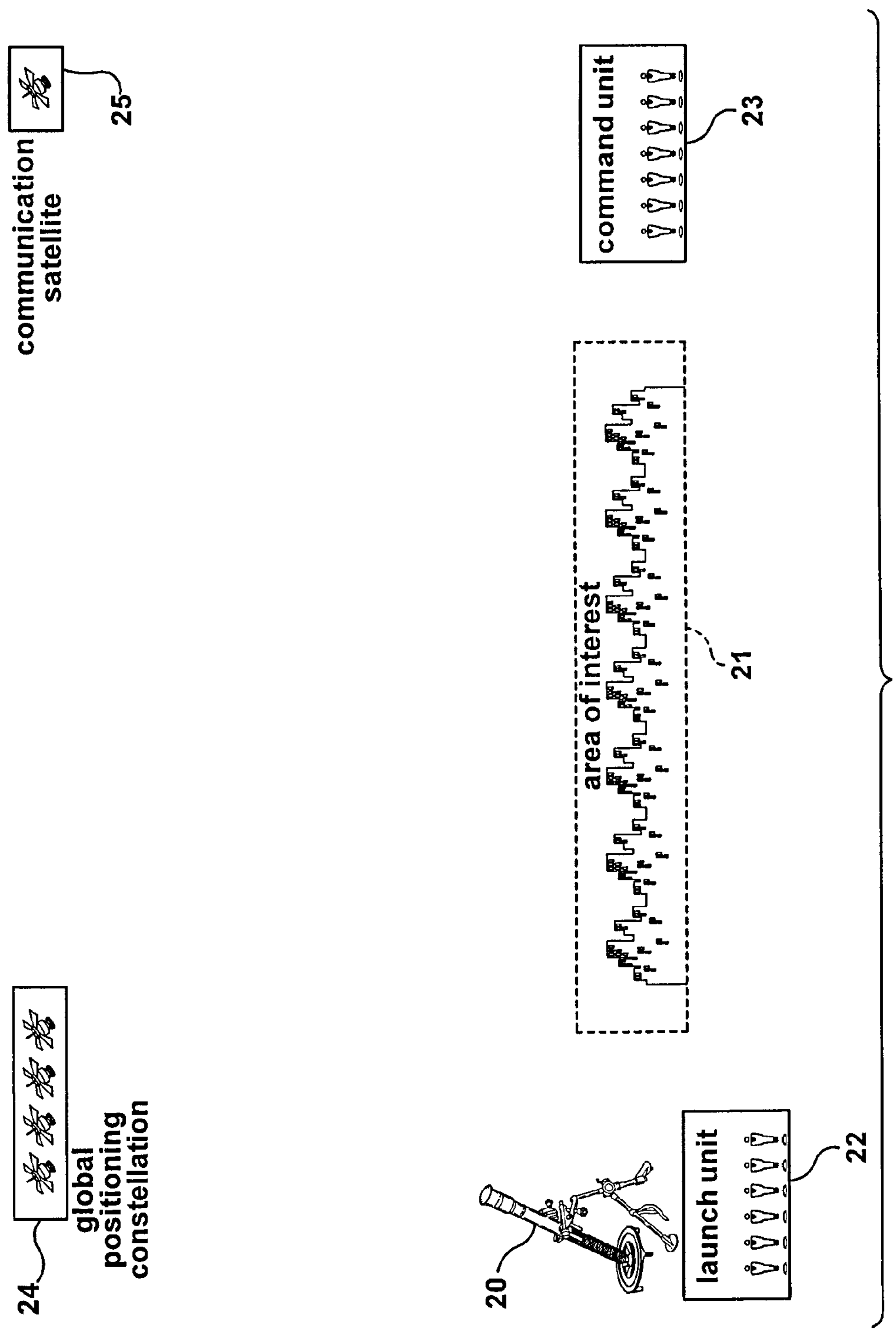

communication satellite
25
global positioning constellation
24
area of interest
21
command unit
23
launch unit
22
20

Figure 2A

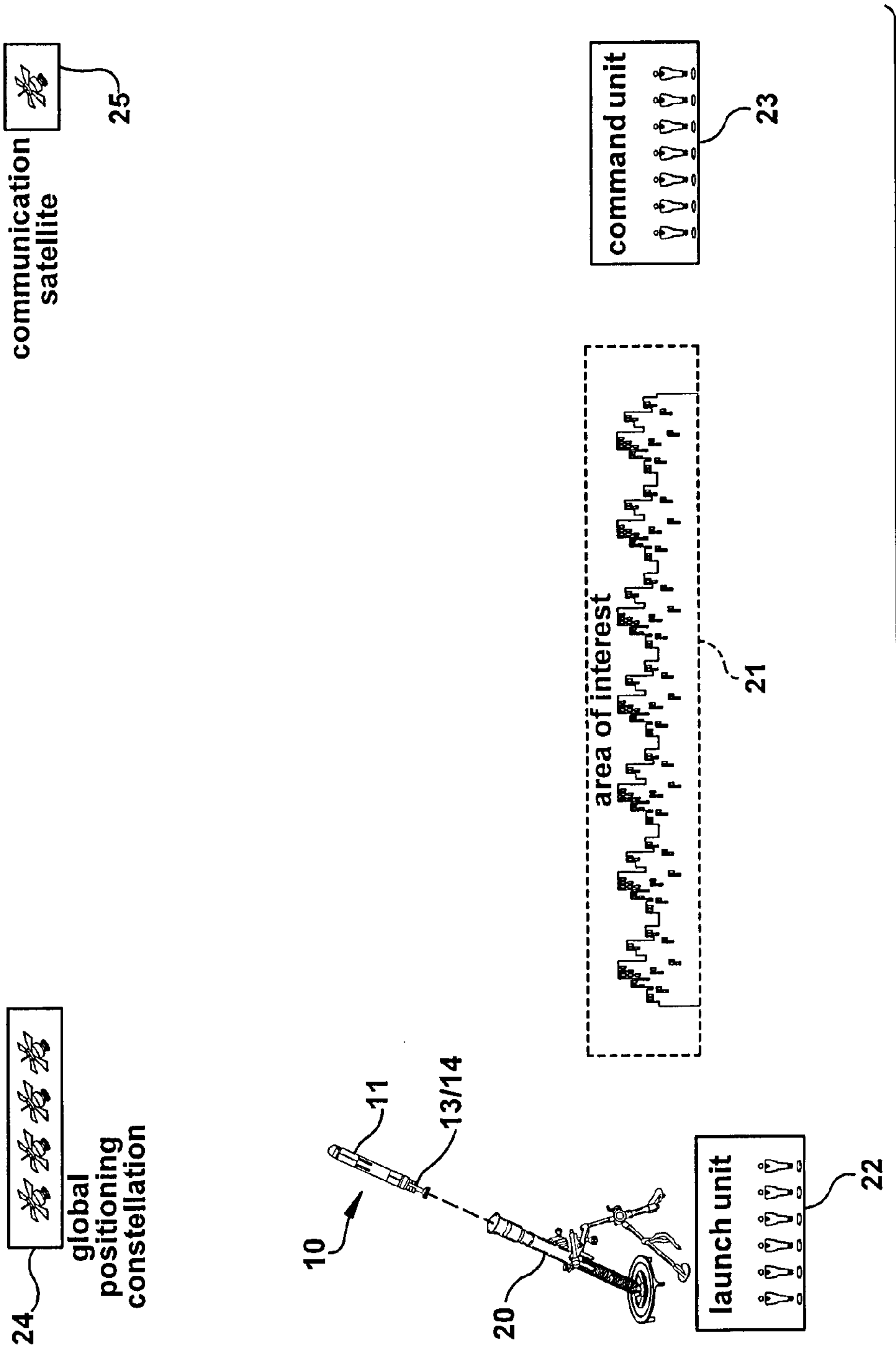

communication satellite
25
global positioning constellation
24
area of interest
21
command unit
23
10
11
13/14
20
launch unit
22

Figure 2B

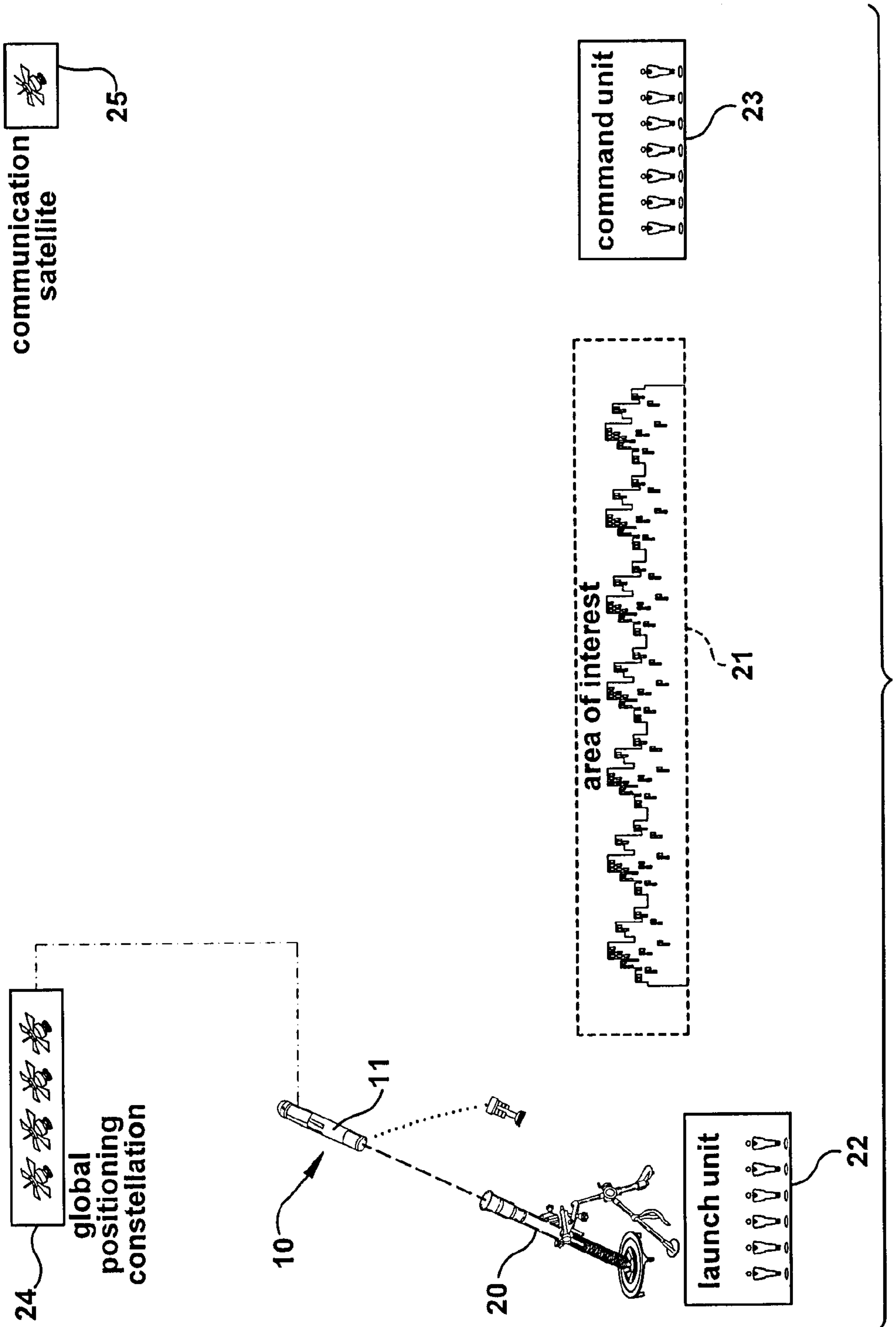

communication satellite
25
command unit
23
area of interest
21
global positioning constellation
24
11
10
20
launch unit
22

Figure 2C

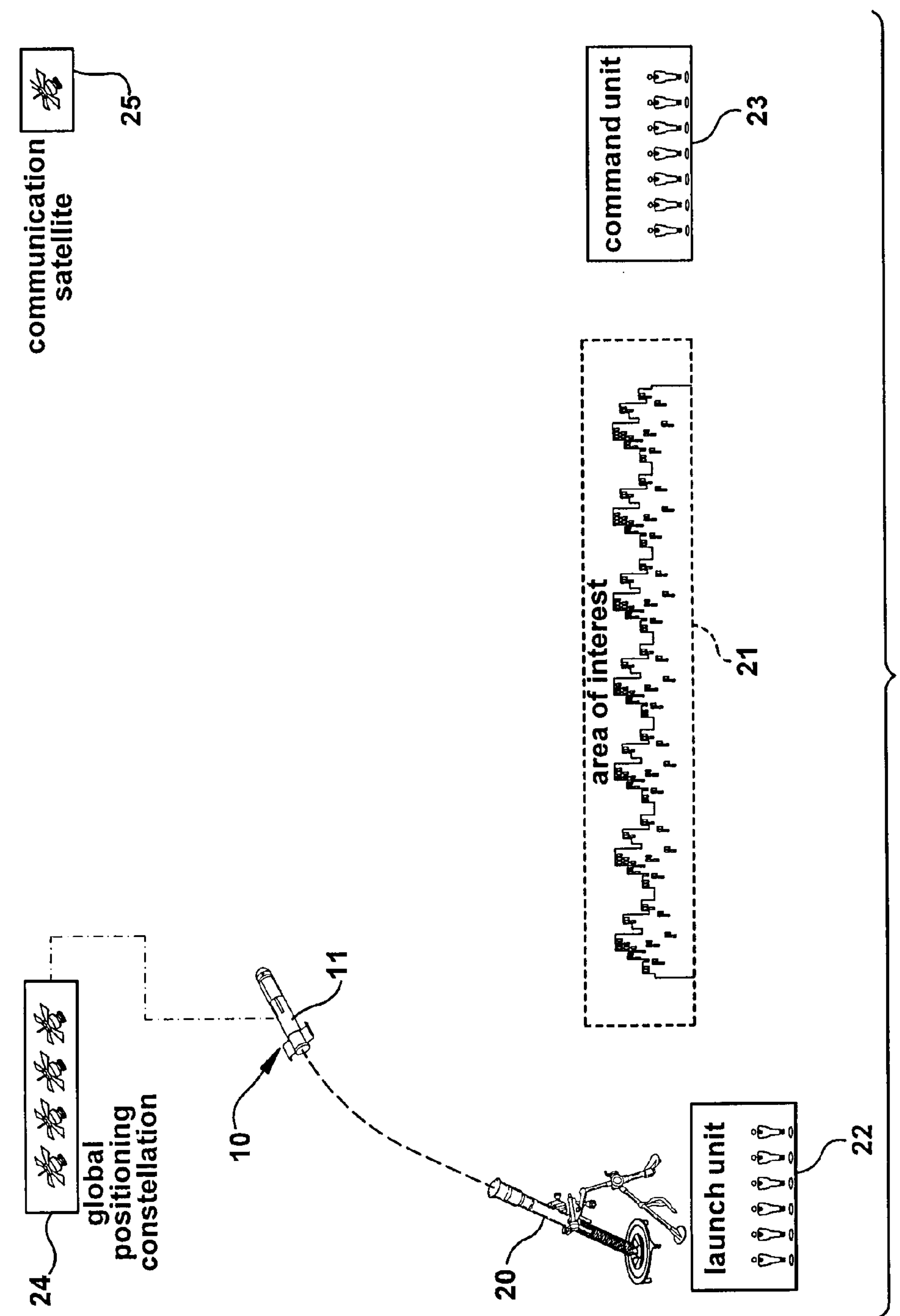

communication satellite
25
command unit
23
area of interest
21
global positioning constellation
24
11
10
20
launch unit
22

Figure 2D

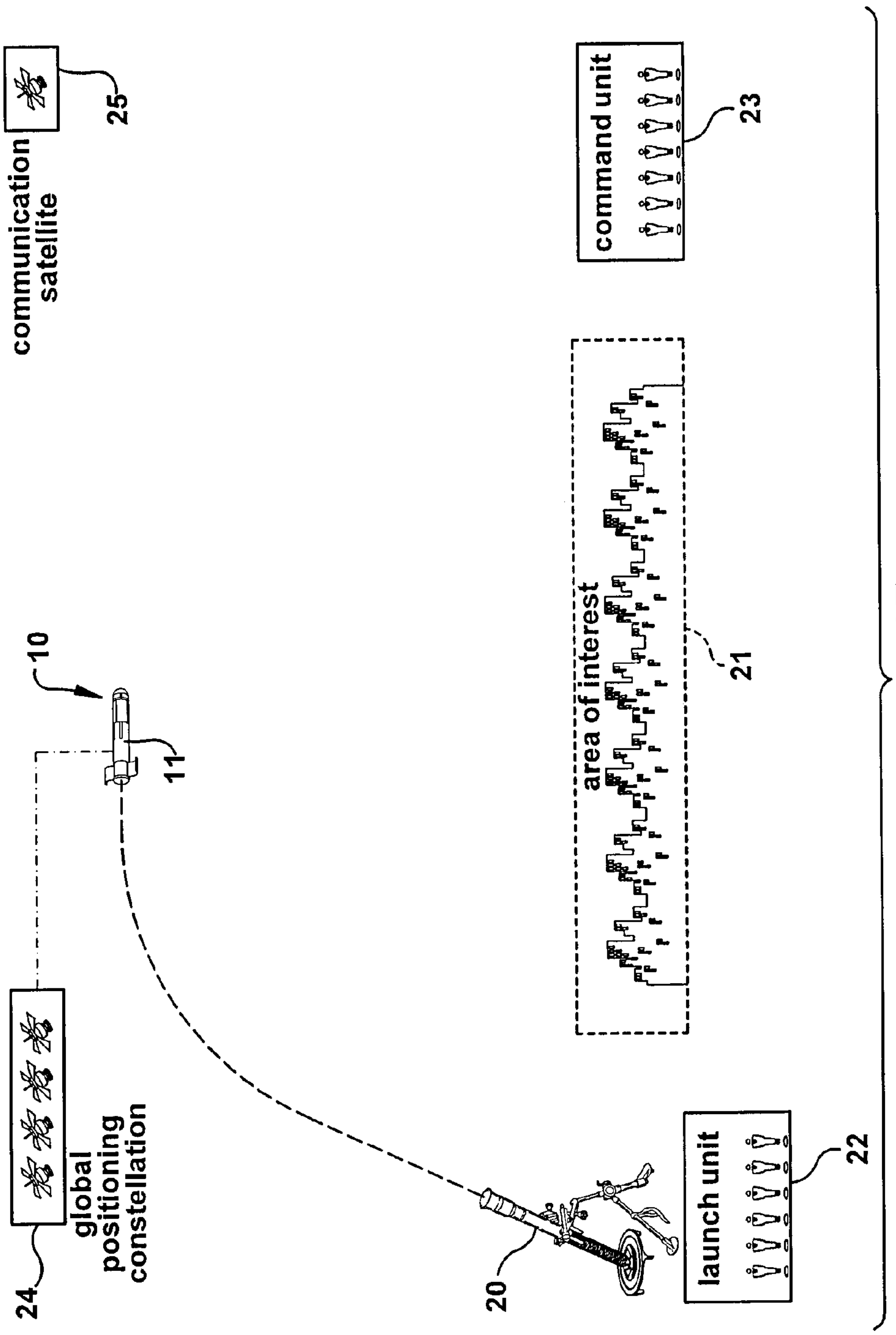

communication satellite
25
10
11
global positioning constellation
24
area of interest
21
command unit
23
launch unit
22
20

Figure 2E

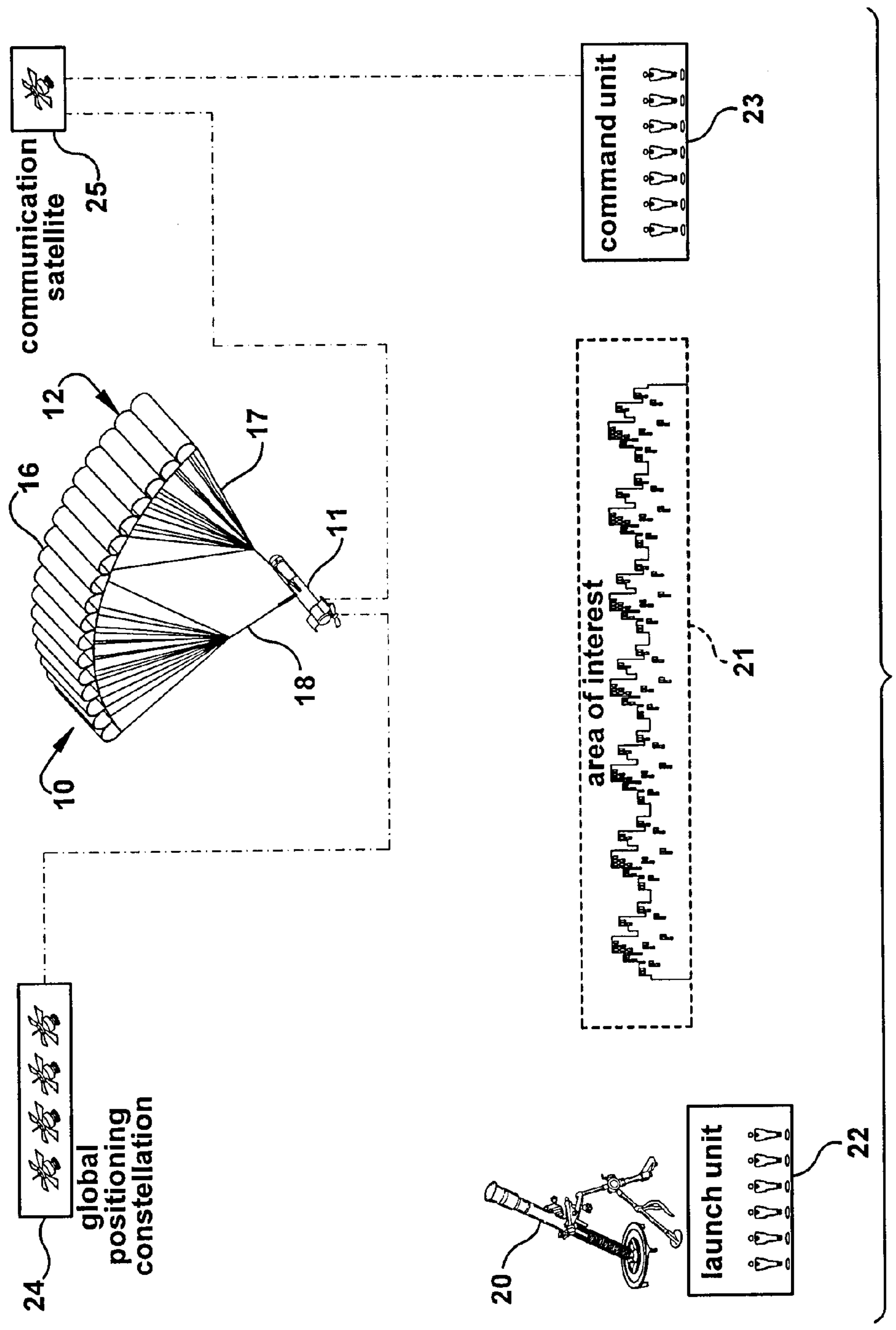

communication
satellite
25
command unit
23
12
16
17
11
10
18
area of interest
21
global
positioning
constellation
24
launch unit
22
20

Figure 2F

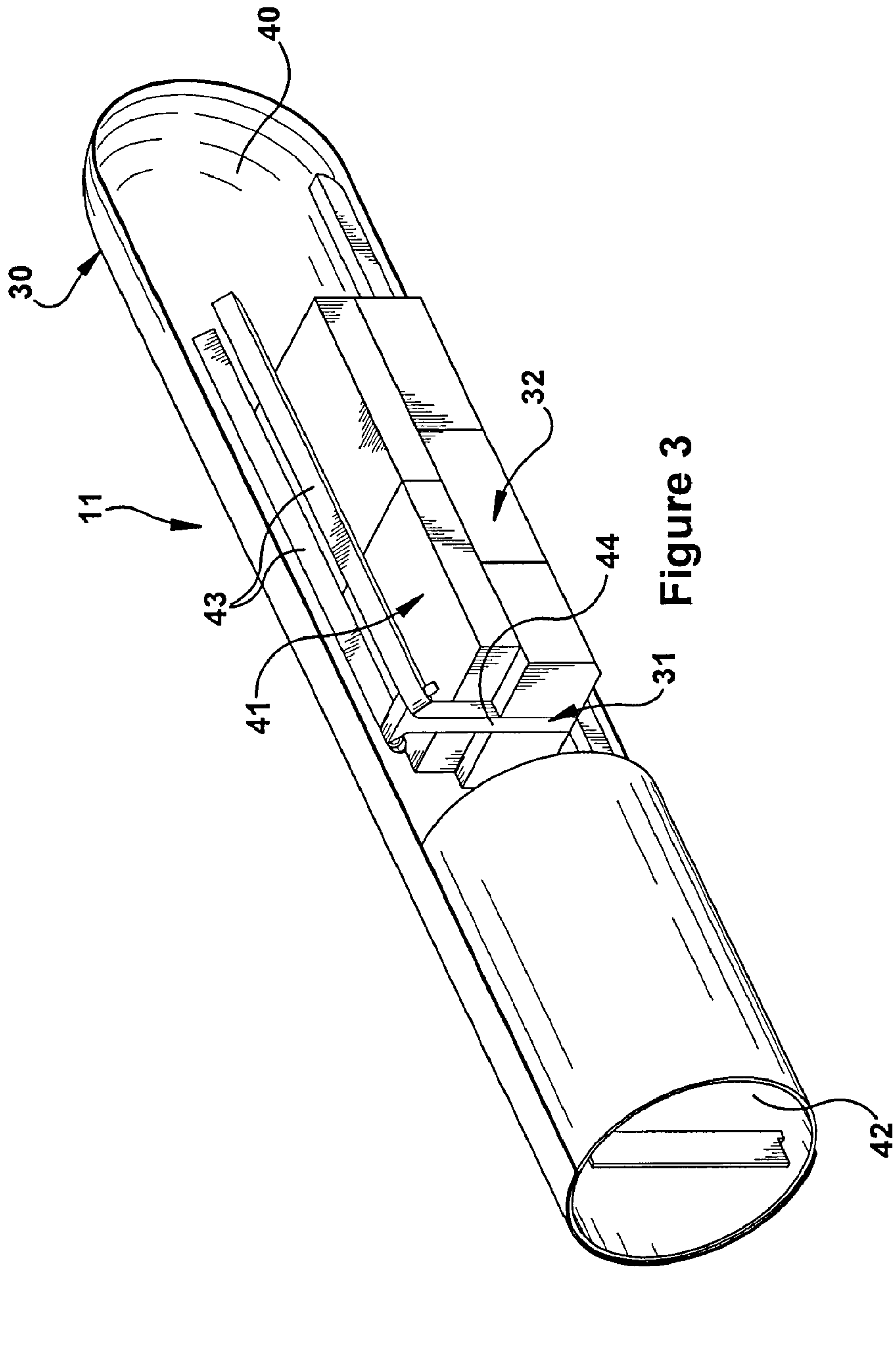


Figure 3

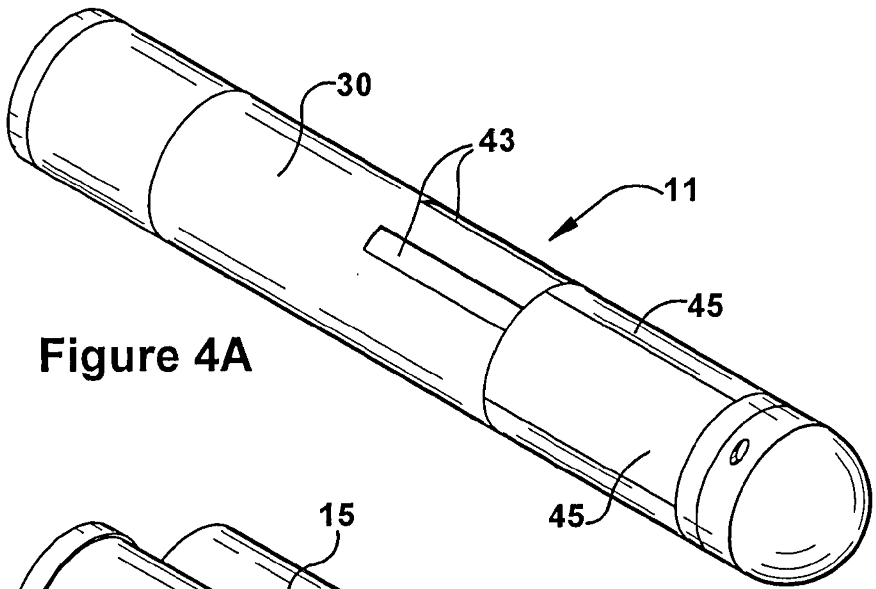


Figure 4A

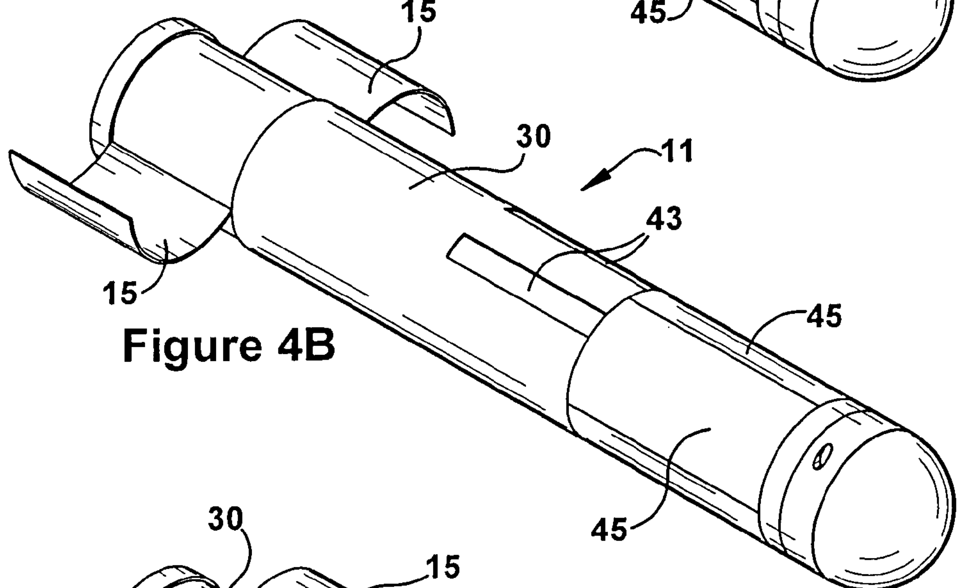


Figure 4B

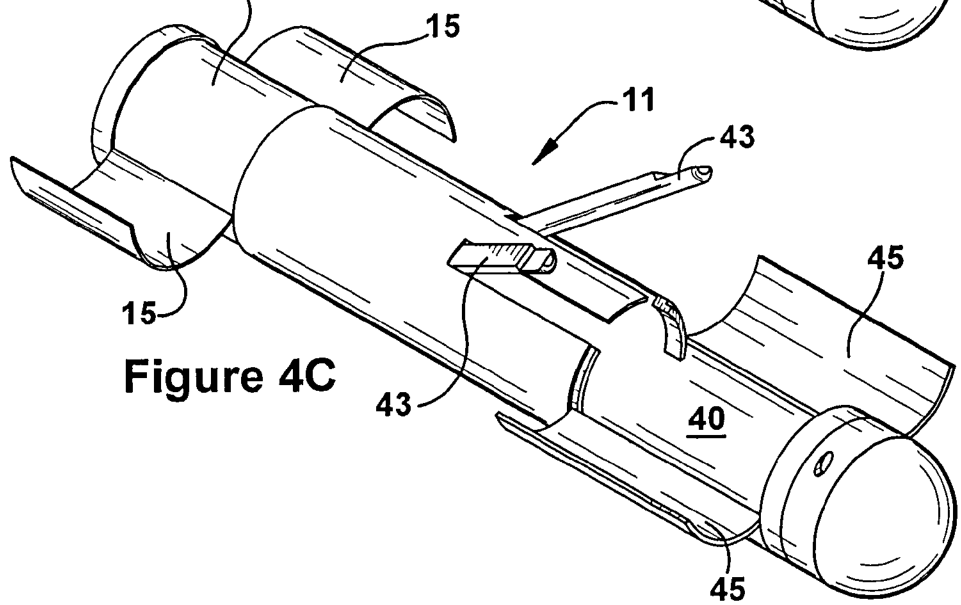


Figure 4C

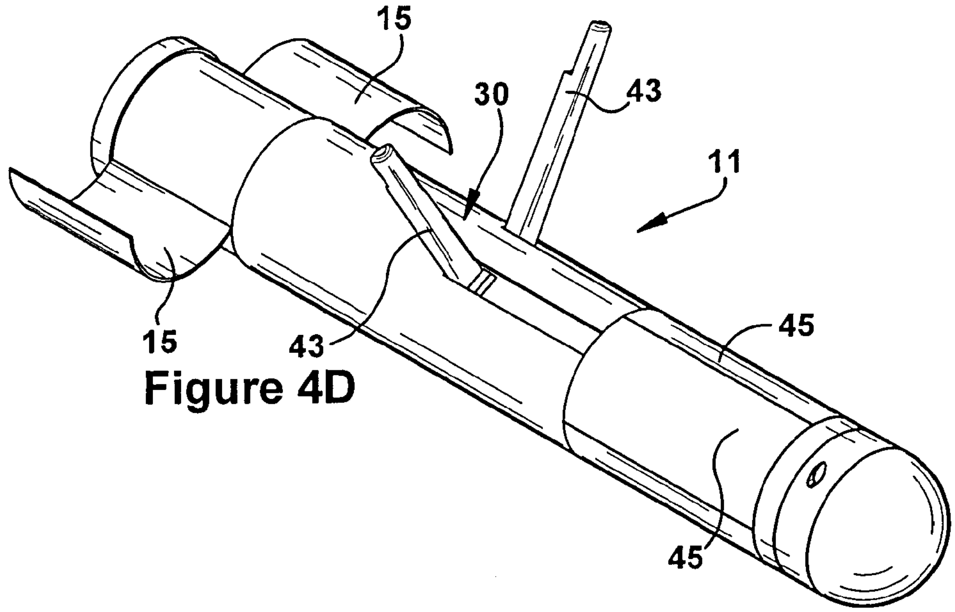


Figure 4D

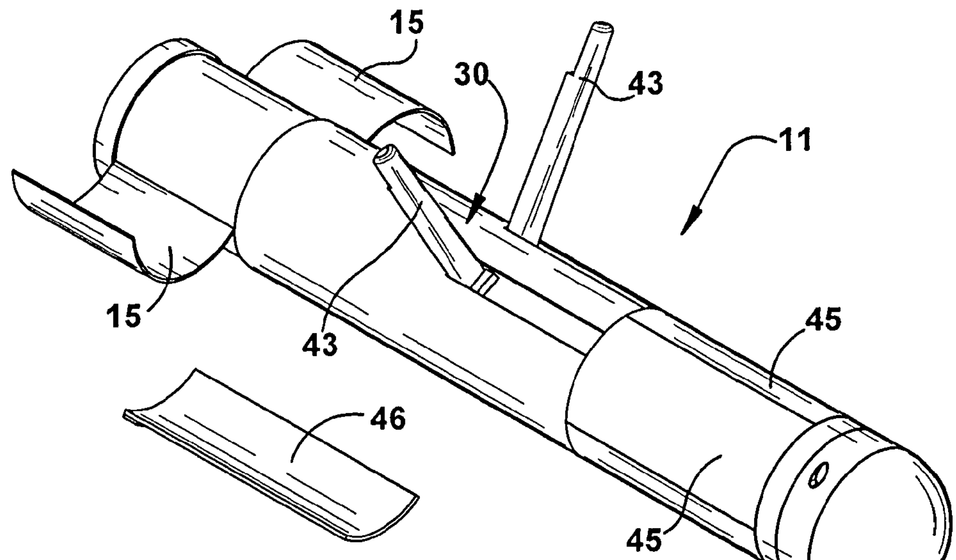


Figure 4E

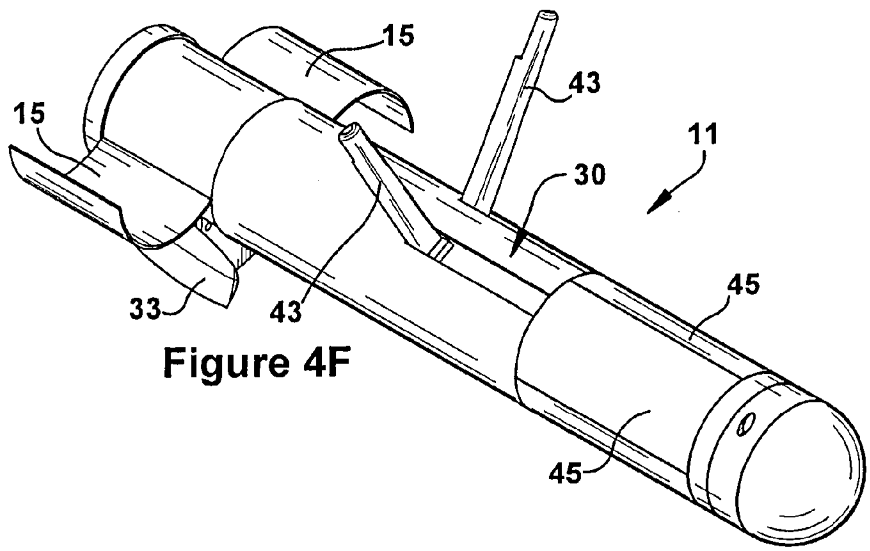


Figure 4F

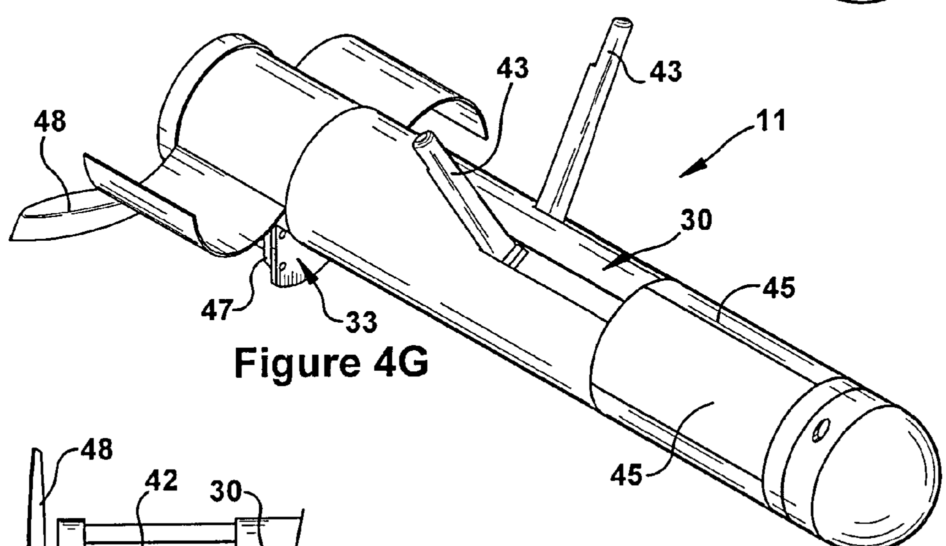


Figure 4G

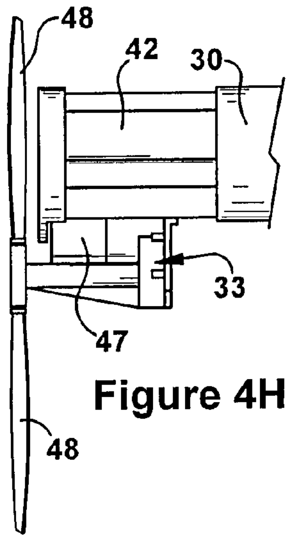


Figure 4H

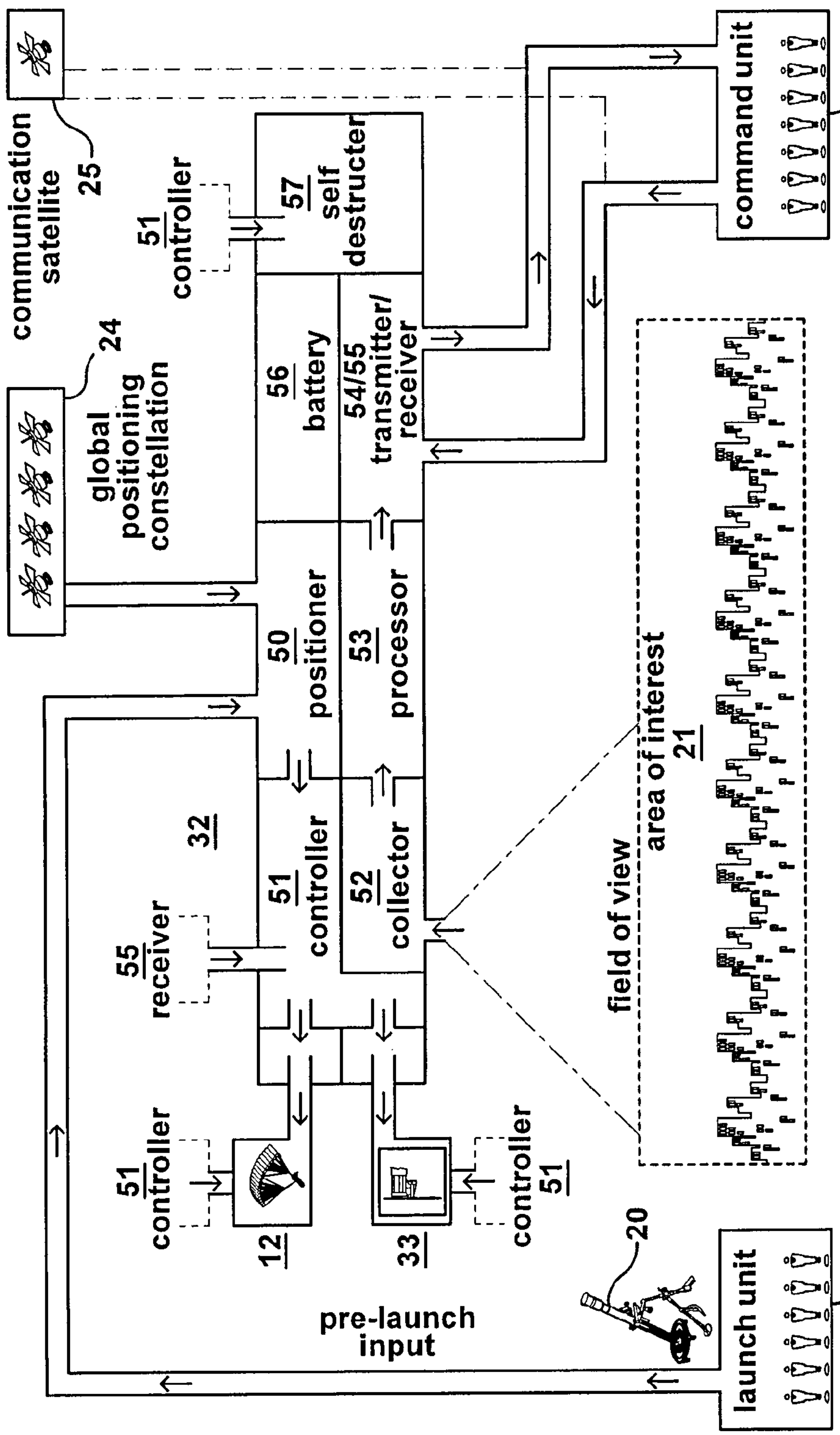

communication satellite
25
global positioning constellation
24
51 controller
57 self destructer
56 battery
54/55 transmitter/ receiver
command unit
23
50 positioner
53 processor
32
51 controller
52 collector
55 receiver
field of view
area of interest
21
51 controller
12
33
controller 51
20
pre-launch input
launch unit
22

Figure 5

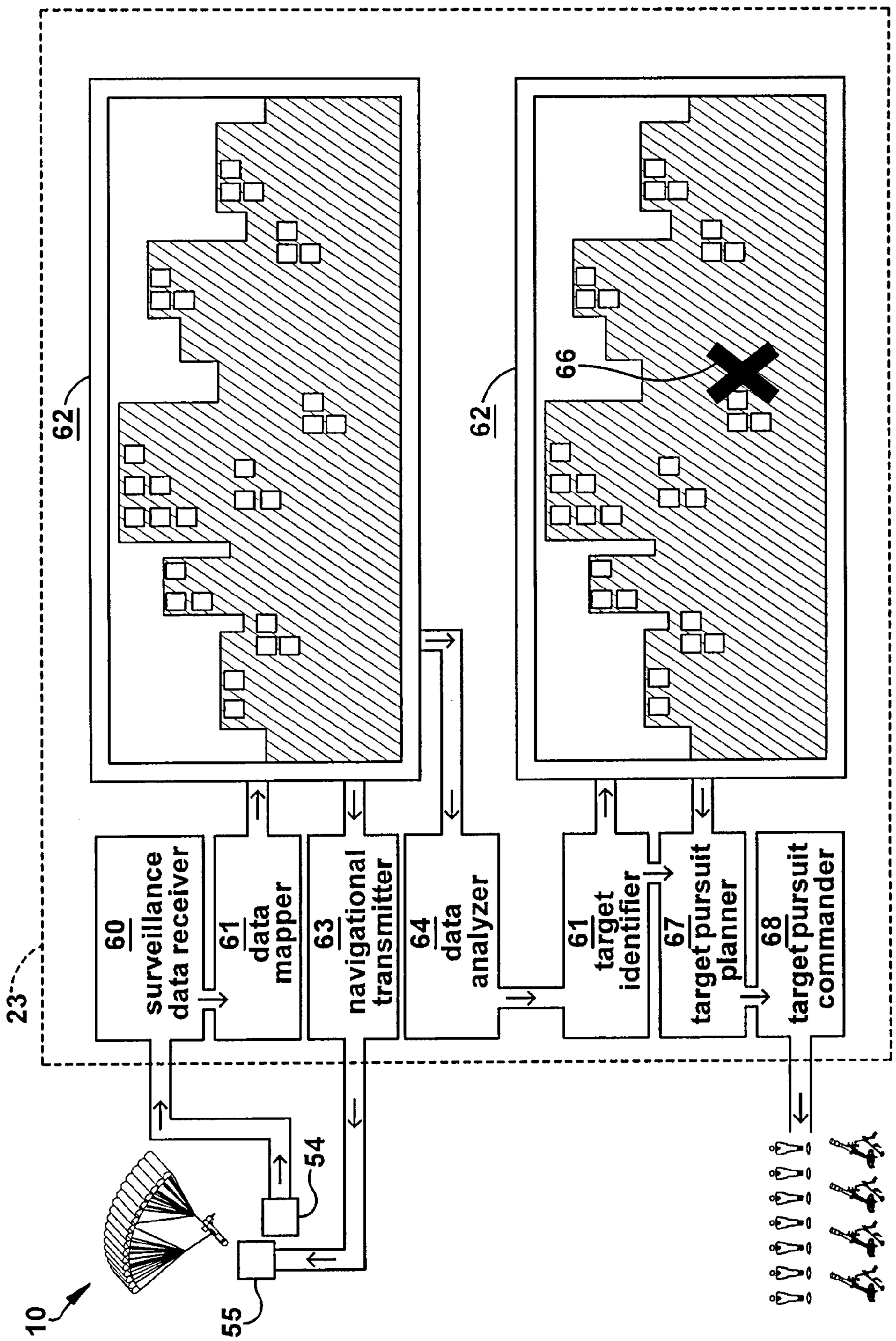

10
55
54
23
60
surveillance data receiver
61
data mapper
63
navigational transmitter
64
data analyzer
61
target identifier
67
target pursuit planner
68
target pursuit commander
62
62
66

Figure 6

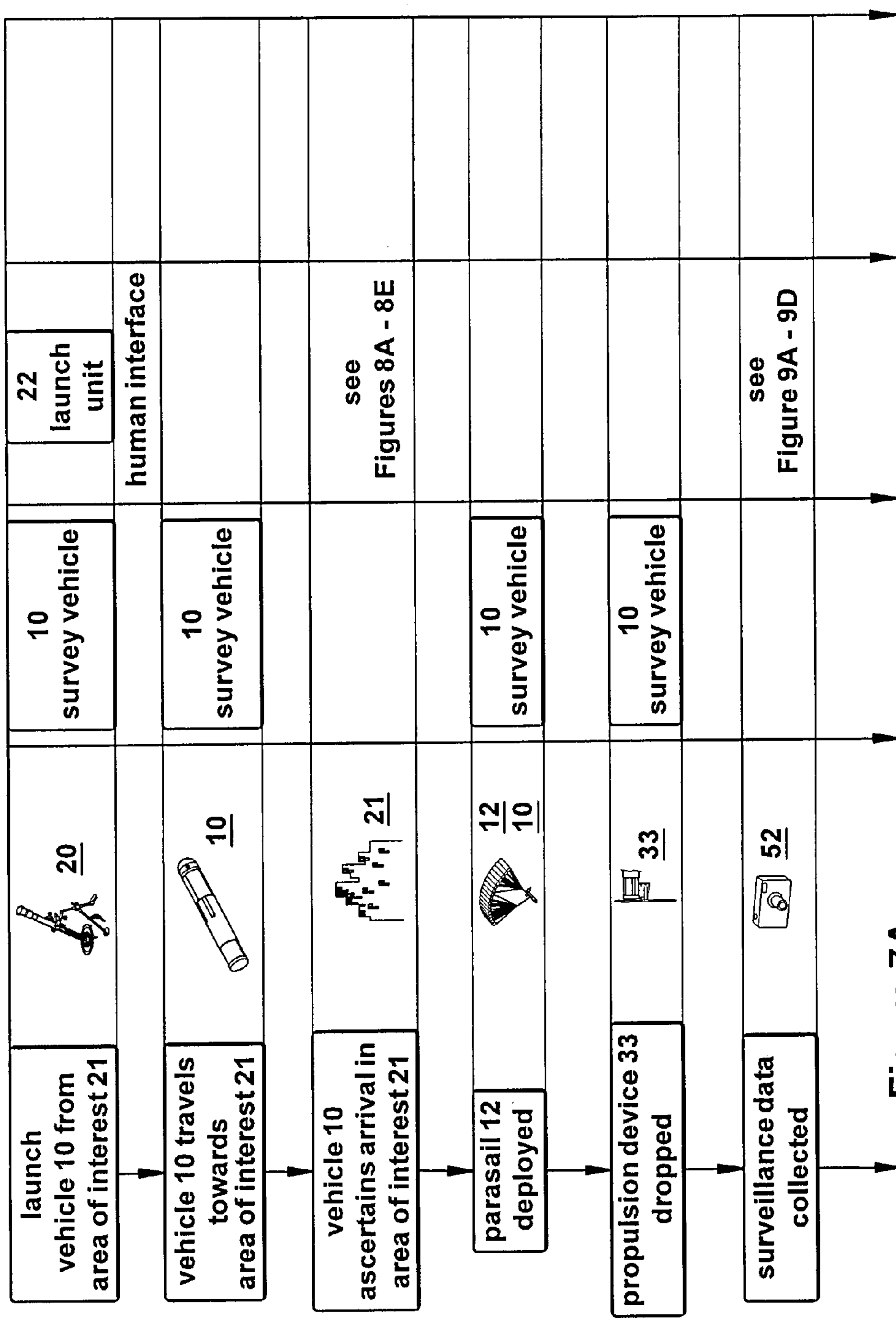

launch vehicle 10 from area of interest 21
vehicle 10 travels towards area of interest 21
vehicle 10 ascertains arrival in area of interest 21
parasail 12 deployed
propulsion device 33 dropped
surveillance data collected
20
10
21
12
10
33
52
10 survey vehicle
10 survey vehicle
10 survey vehicle
10 survey vehicle
22 launch unit
human interface
see Figures 8A - 8E
see Figure 9A - 9D

Figure 7A

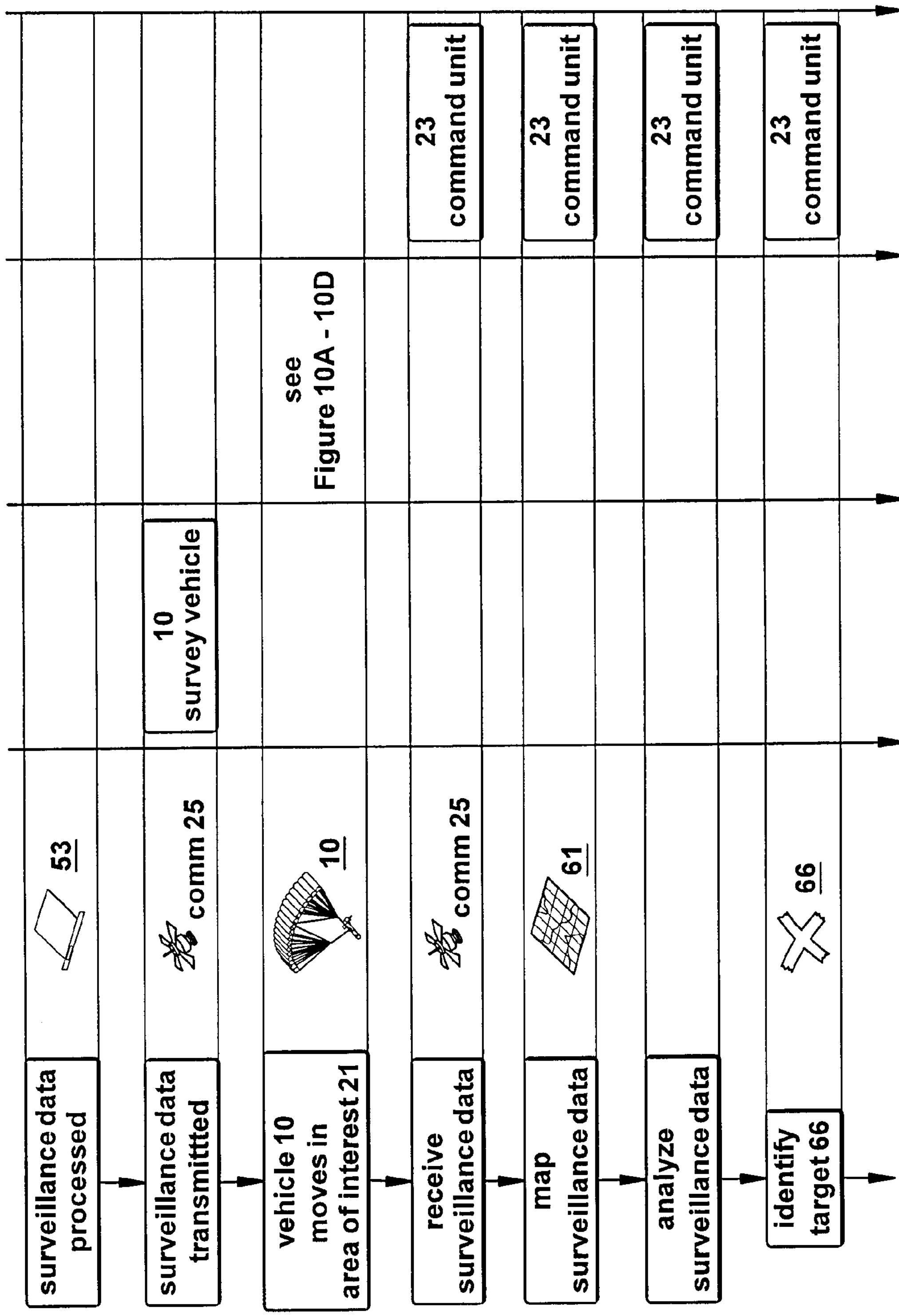

surveillance data processed
53
surveillance data transmitted
comm 25
vehicle 10 moves in area of interest 21
10
receive surveillance data
comm 25
map surveillance data
61
analyze surveillance data
identify target 66
66
10 survey vehicle
see Figure 10A - 10D
23 command unit
23 command unit
23 command unit
23 command unit

Figure 7B

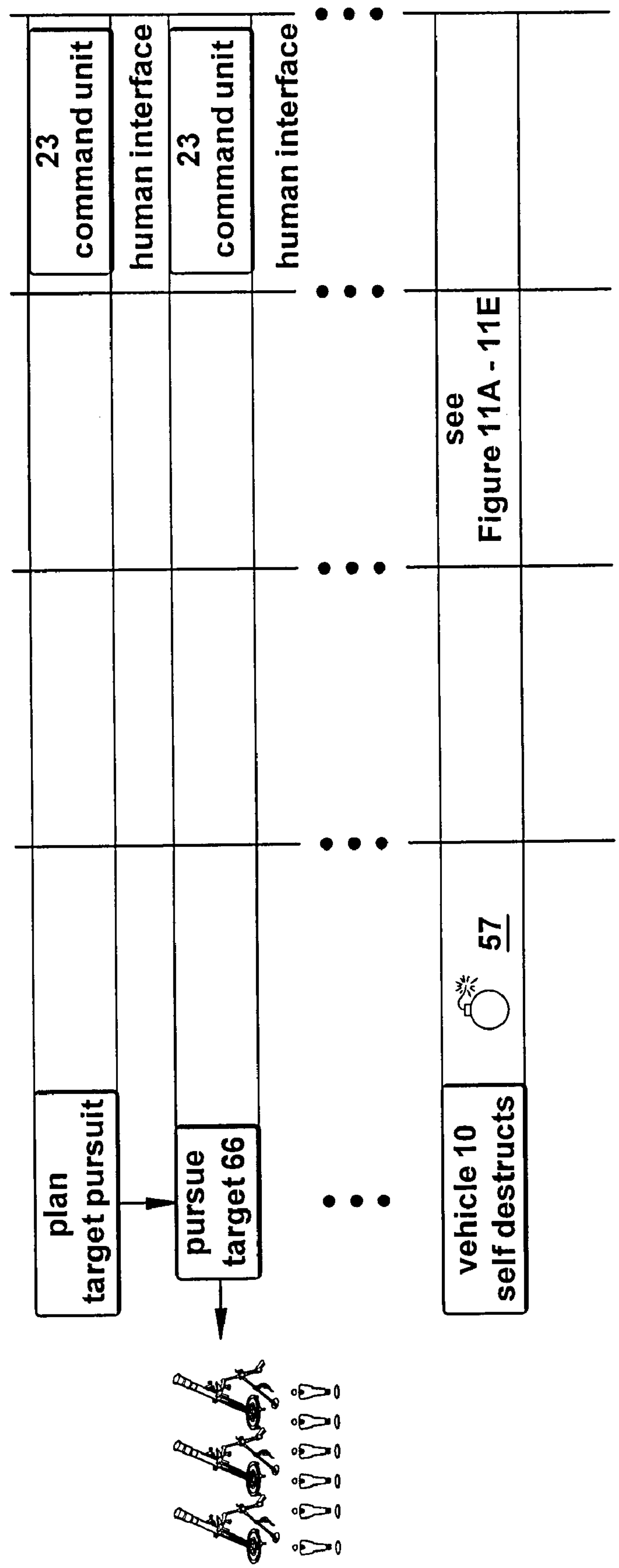

23
command unit
human interface
23
command unit
human interface
see
Figure 11A - 11E
57
plan
target pursuit
pursue
target 66
vehicle 10
self destructs

Figure 7C

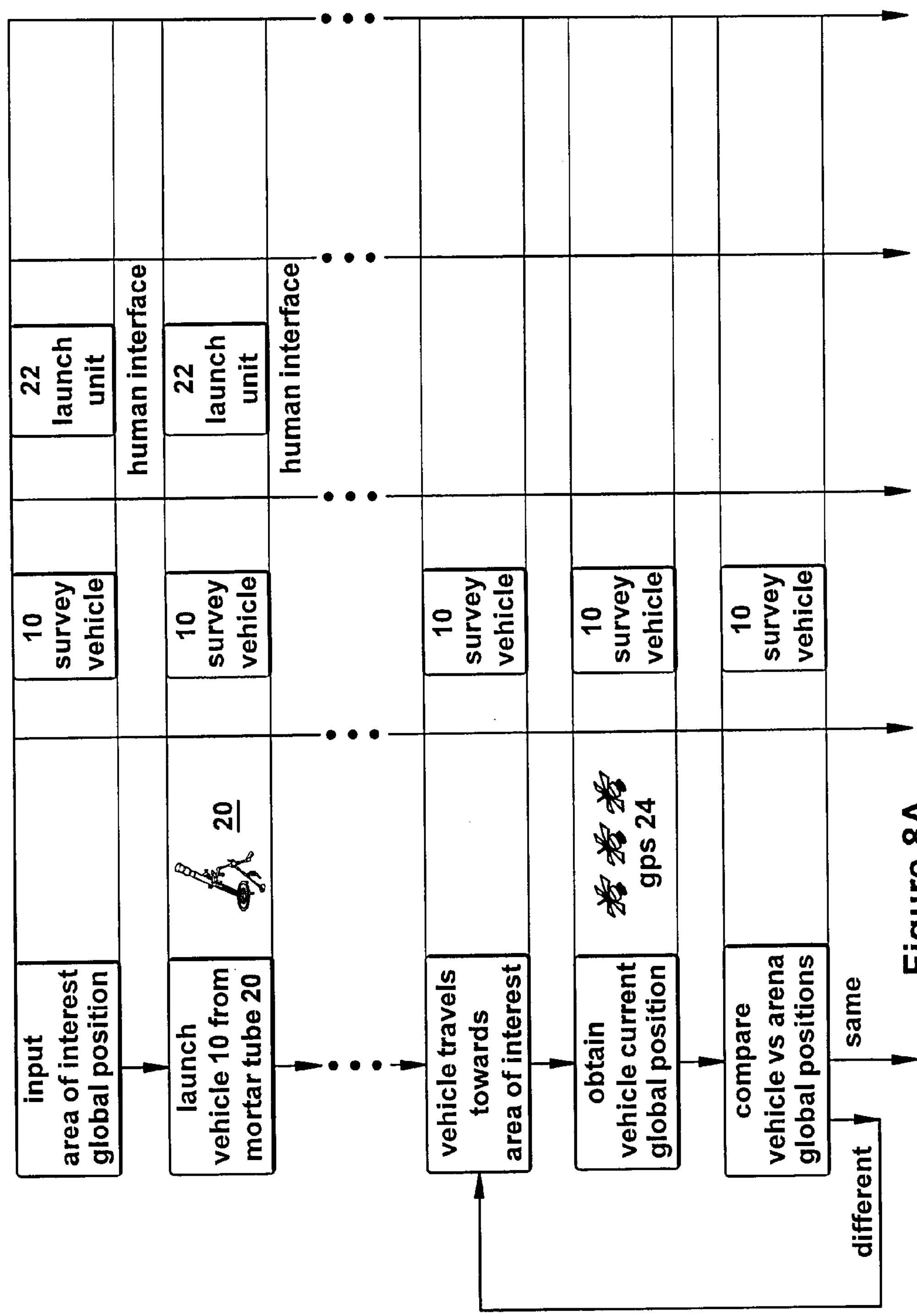
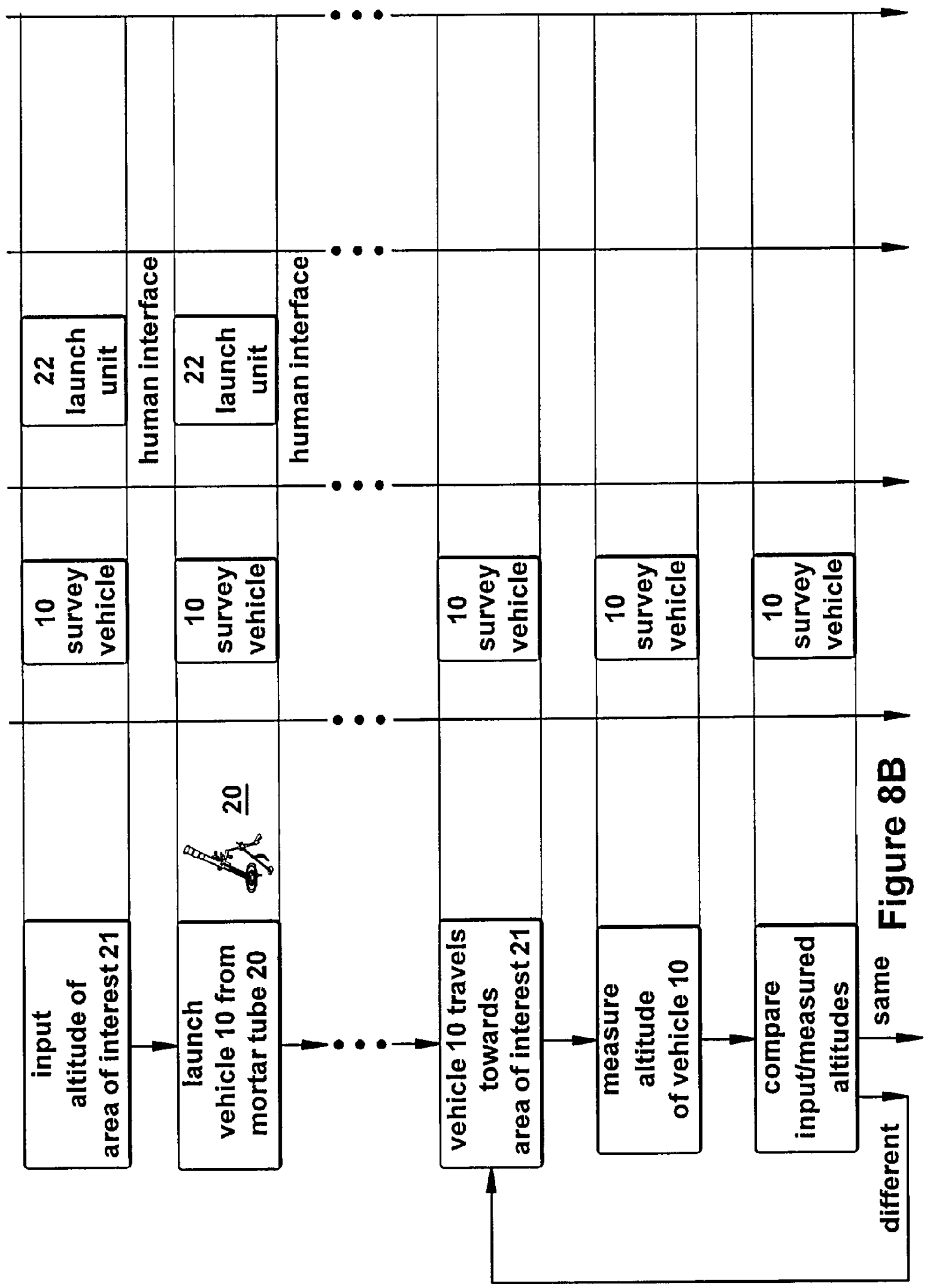
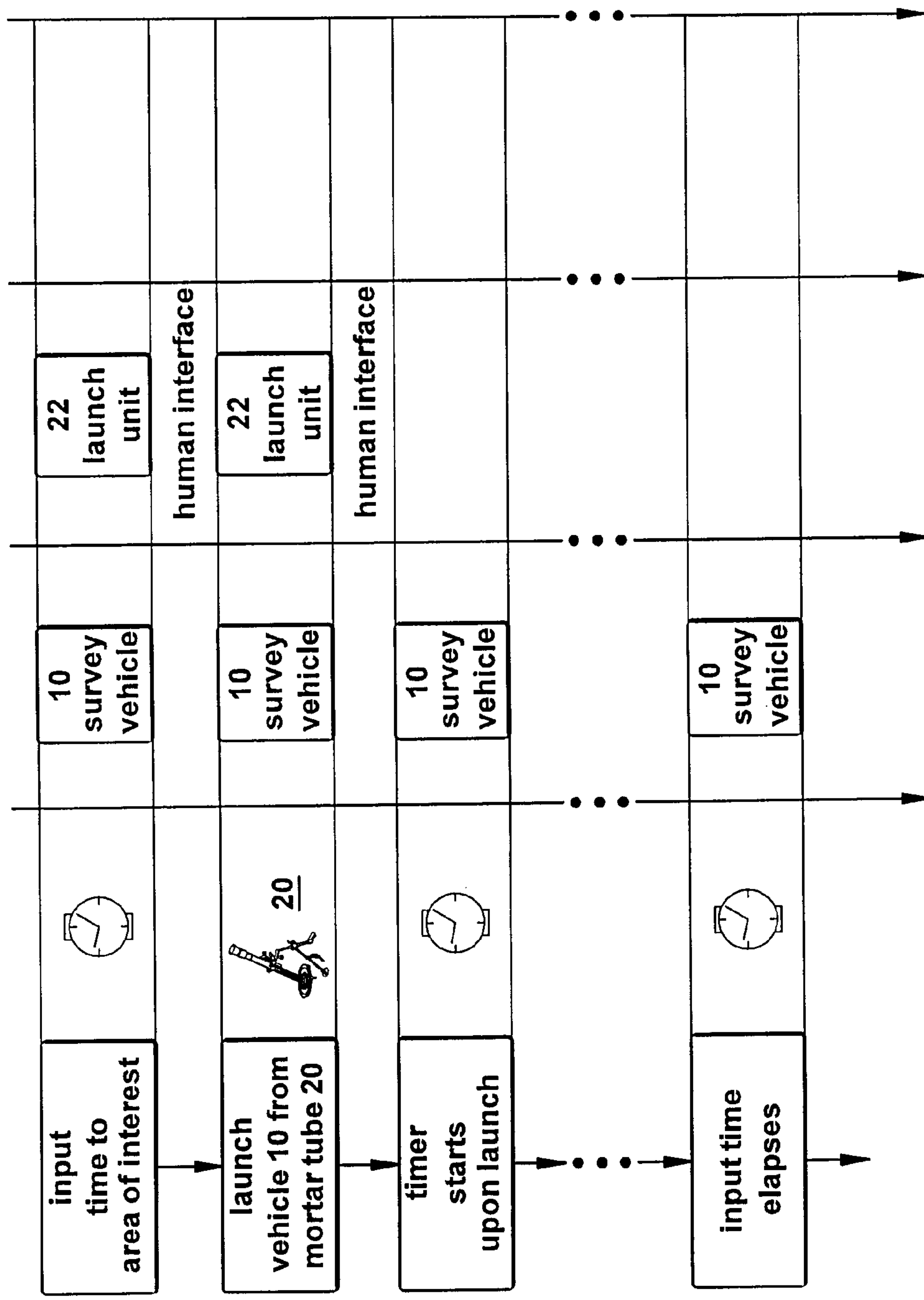

input
area of interest
global position
launch
vehicle 10 from
mortar tube 20
20
vehicle travels
towards
area of interest
obtain
vehicle current
global position
gps 24
compare
vehicle vs arena
global positions
same
different
10
survey
vehicle
10
survey
vehicle
10
survey
vehicle
10
survey
vehicle
10
survey
vehicle
22
launch
unit
human interface
22
launch
unit
human interface

Figure 8A



22 launch unit
human interface
22 launch unit
human interface
10 survey vehicle
10 survey vehicle
10 survey vehicle
10 survey vehicle
10 survey vehicle
20
input altitude of area of interest 21
launch vehicle 10 from mortar tube 20
vehicle 10 travels towards area of interest 21
measure altitude of vehicle 10
compare input/measured altitudes
same
different

Figure 8B



input time to area of interest
launch vehicle 10 from mortar tube 20
timer starts upon launch
input time elapses
20
10 survey vehicle
22 launch unit
human interface

Figure 8C

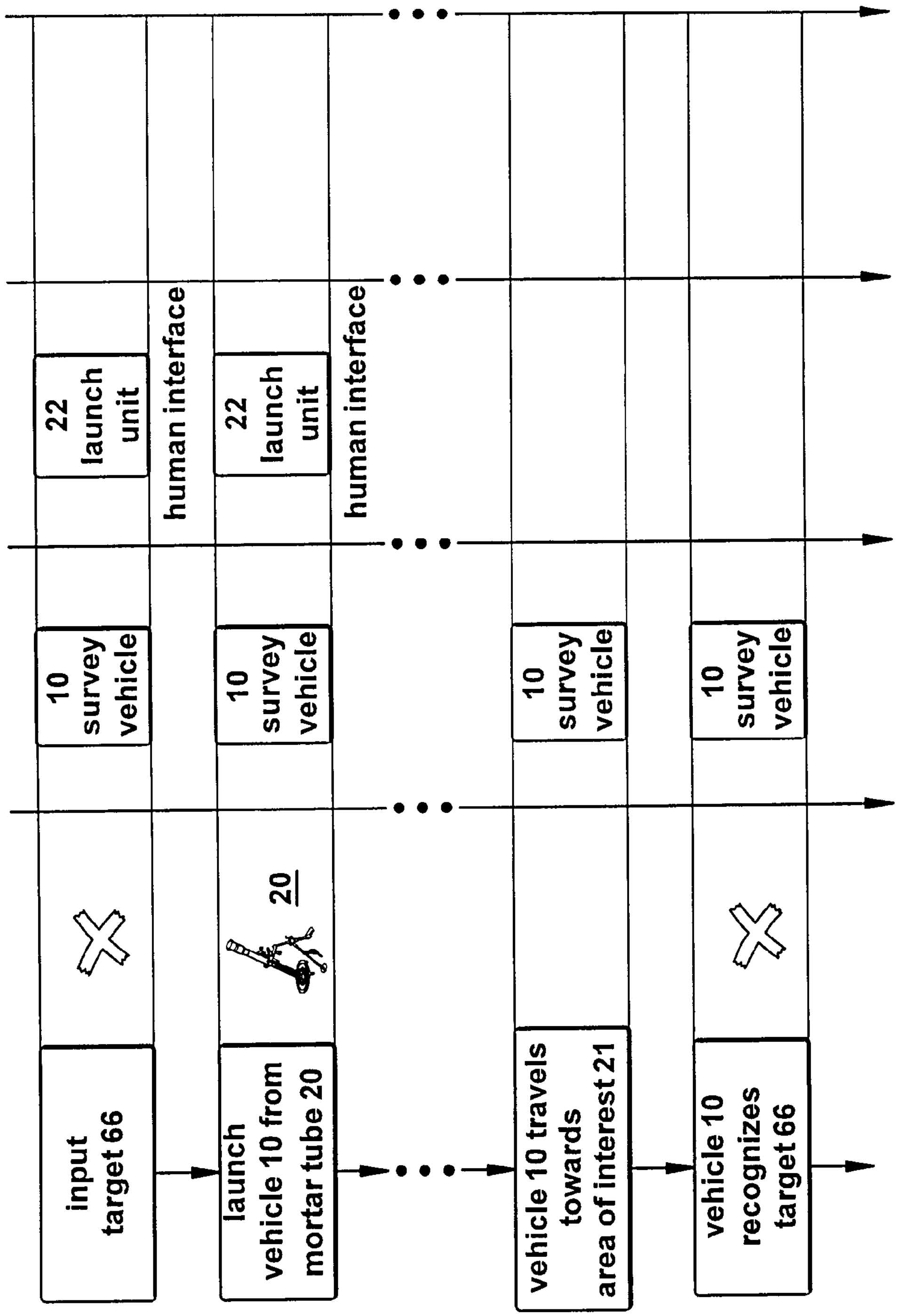

input
target 66
launch
vehicle 10 from
mortar tube 20
vehicle 10 travels
towards
area of interest 21
vehicle 10
recognizes
target 66
20
10
survey
vehicle
10
survey
vehicle
10
survey
vehicle
10
survey
vehicle
22
launch
unit
human interface
22
launch
unit
human interface

Figure 8D

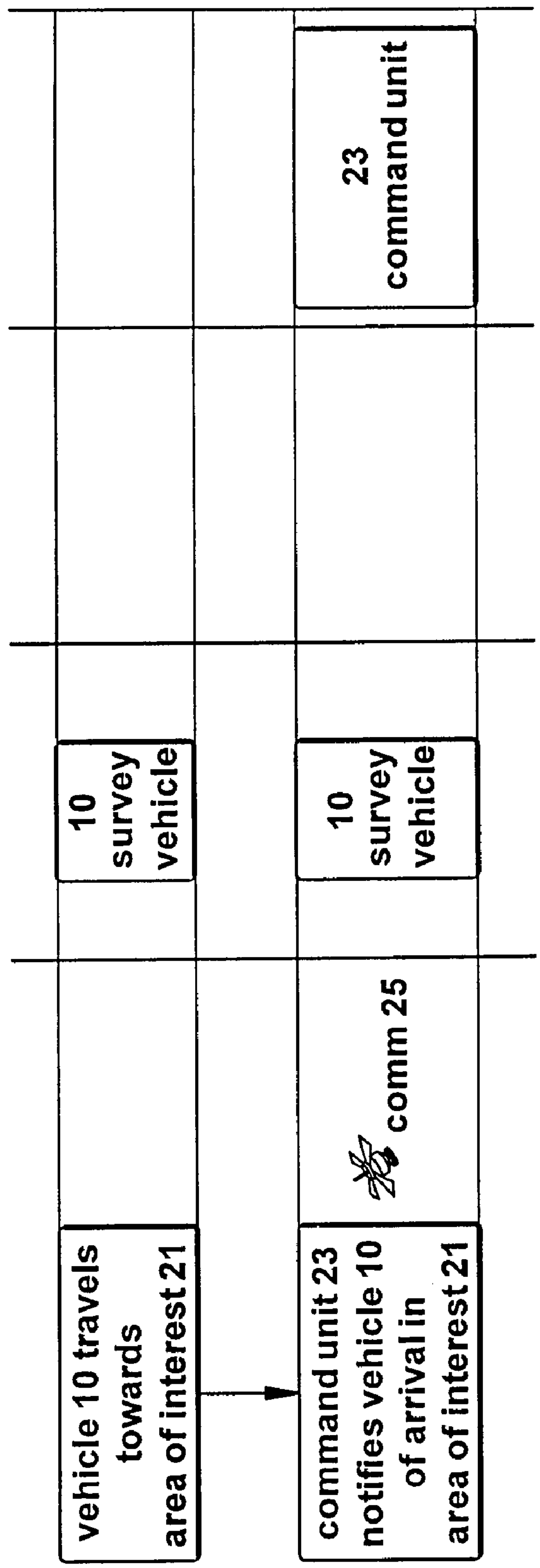

vehicle 10 travels towards area of interest 21
command unit 23 notifies vehicle 10 of arrival in area of interest 21
comm 25
10 survey vehicle
10 survey vehicle
23 command unit

Figure 8E

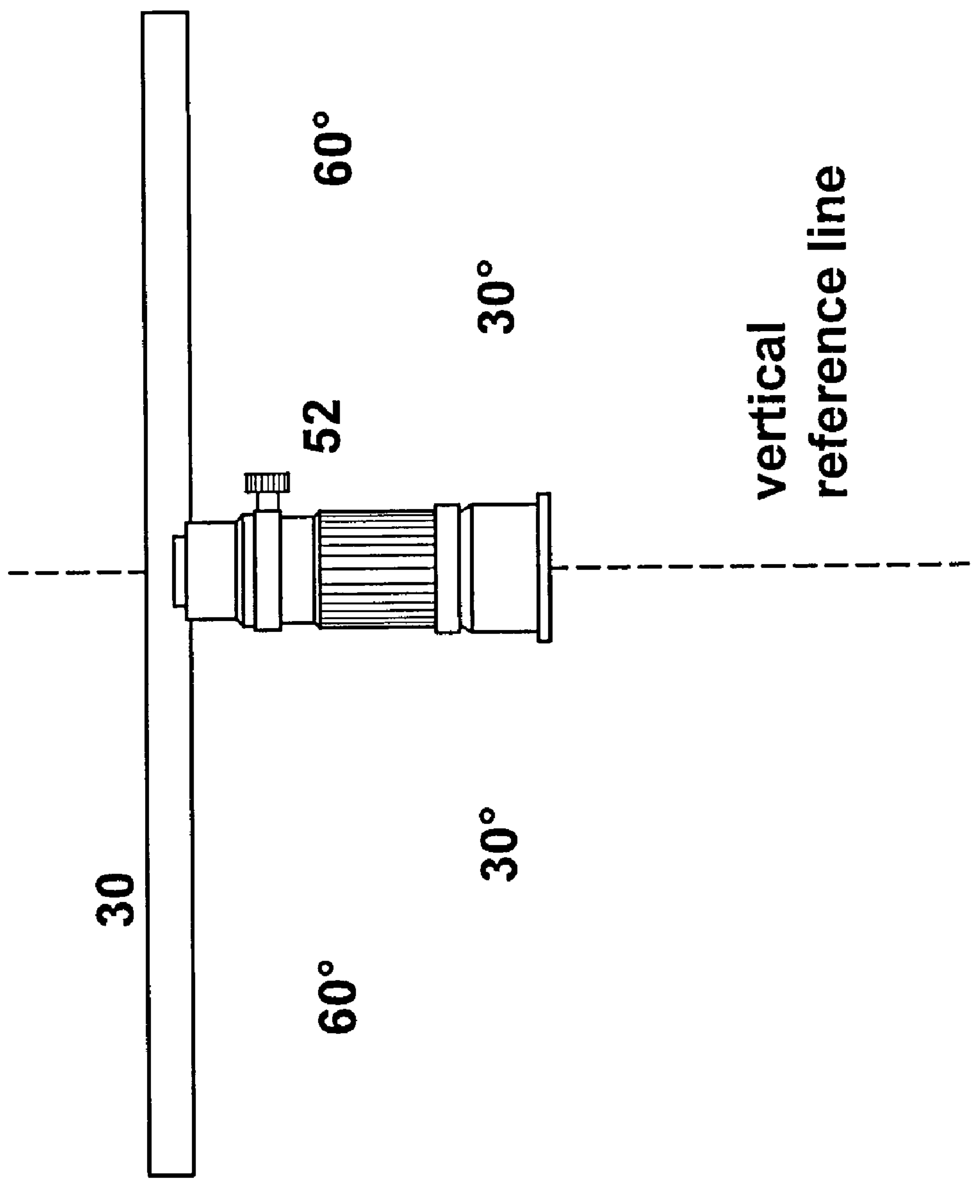


Figure 9A

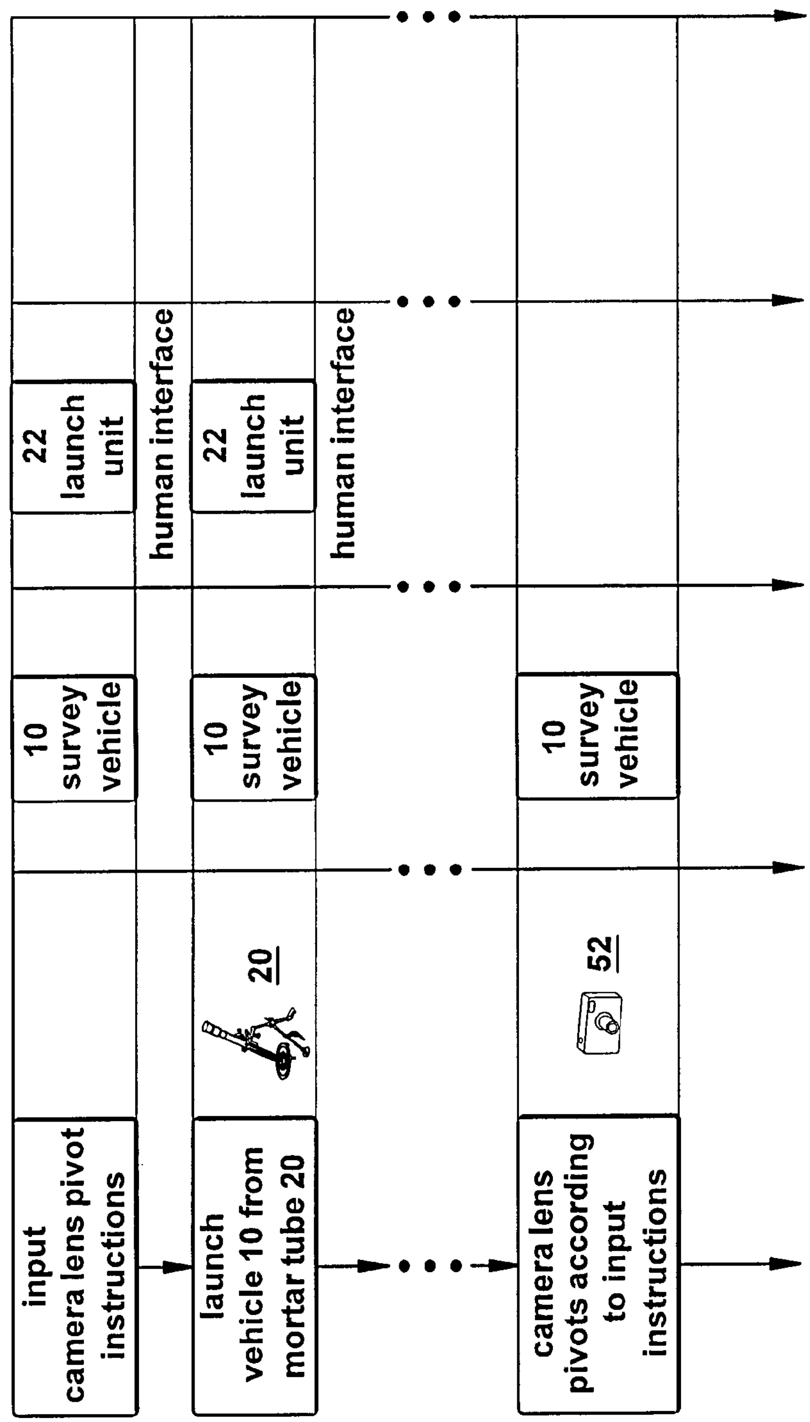
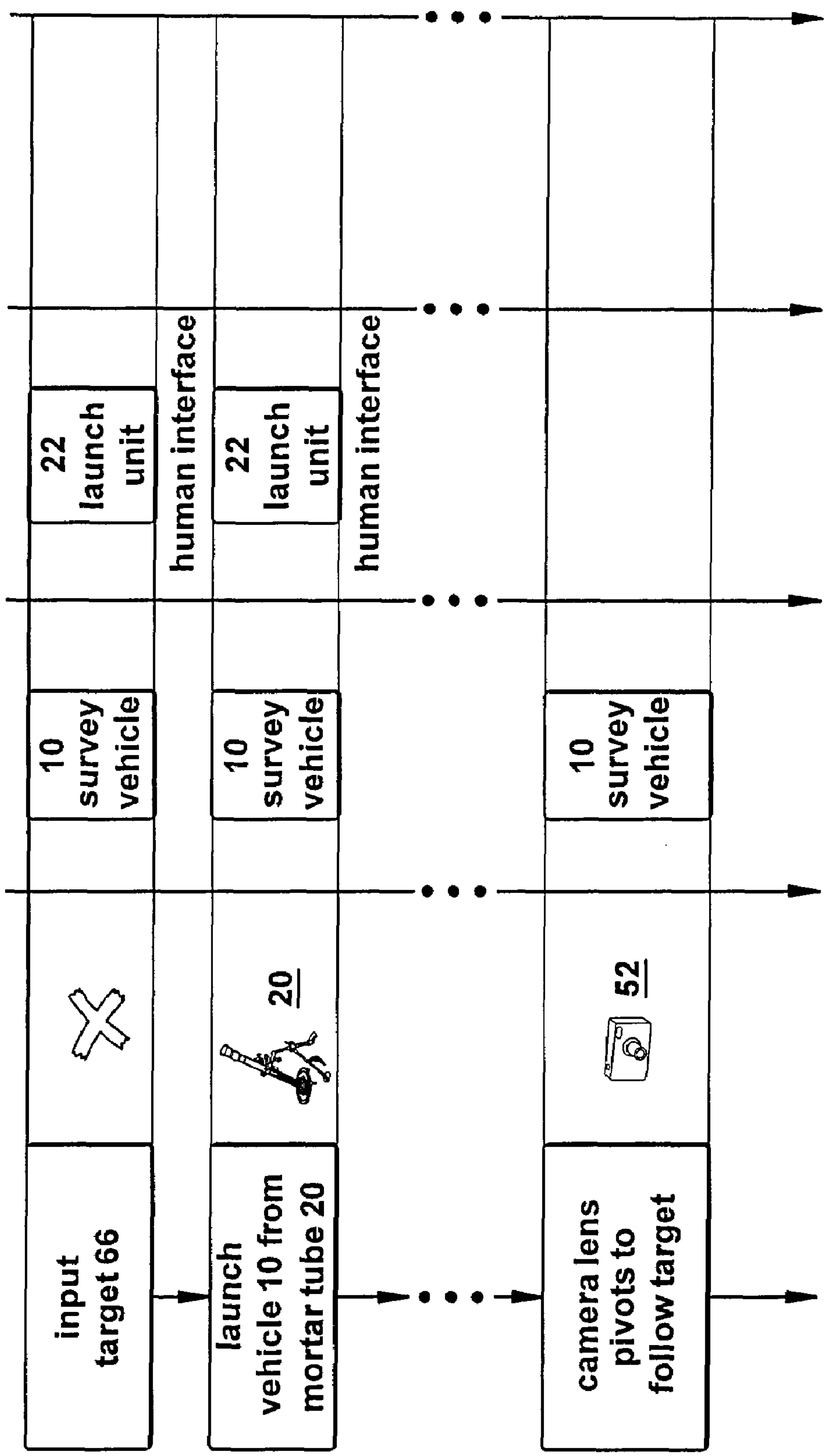

input
camera lens pivot
instructions
launch
vehicle 10 from
mortar tube 20
camera lens
pivots according
to input
instructions
20
52
10
survey
vehicle
10
survey
vehicle
10
survey
vehicle
22
launch
unit
human interface
22
launch
unit
human interface

Figure 9B



input target 66
launch vehicle 10 from mortar tube 20
20
camera lens pivots to follow target
52
10 survey vehicle
10 survey vehicle
10 survey vehicle
22 launch unit
human interface
22 launch unit
human interface

Figure 9C

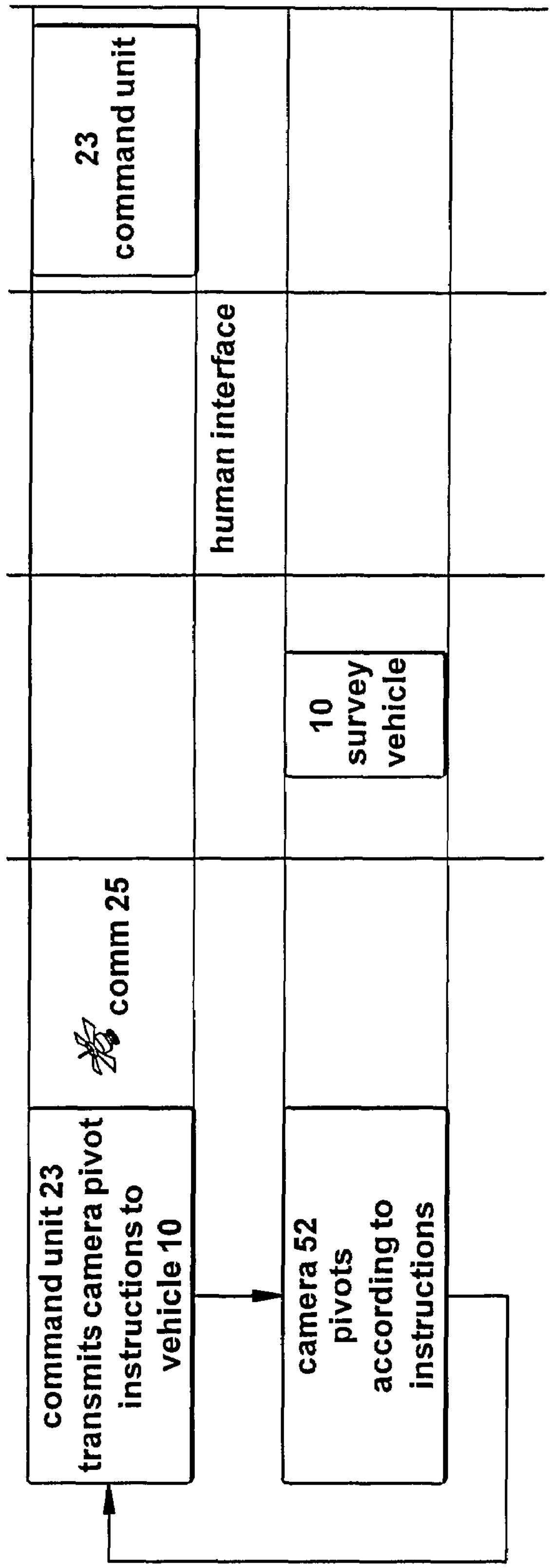

23
command unit
human interface
10
survey
vehicle
comm 25
command unit 23
transmits camera pivot
instructions to
vehicle 10
camera 52
pivots
according to
instructions

Figure 9D

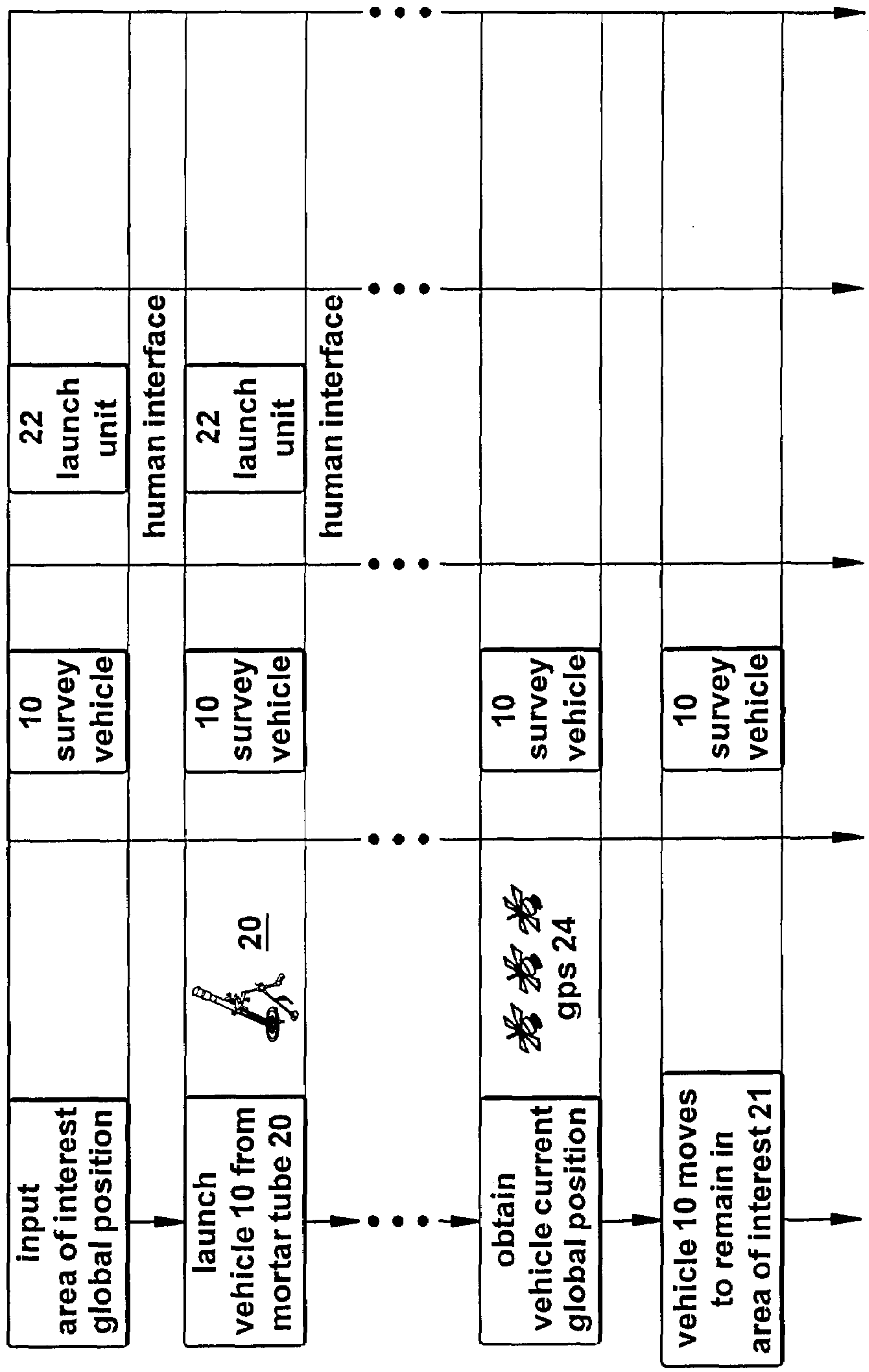

input
area of interest
global position
10
survey
vehicle
22
launch
unit
human interface
launch
vehicle 10 from
mortar tube 20
20
10
survey
vehicle
22
launch
unit
human interface
obtain
vehicle current
global position
gps 24
10
survey
vehicle
vehicle 10 moves
to remain in
area of interest 21
10
survey
vehicle

Figure 10A

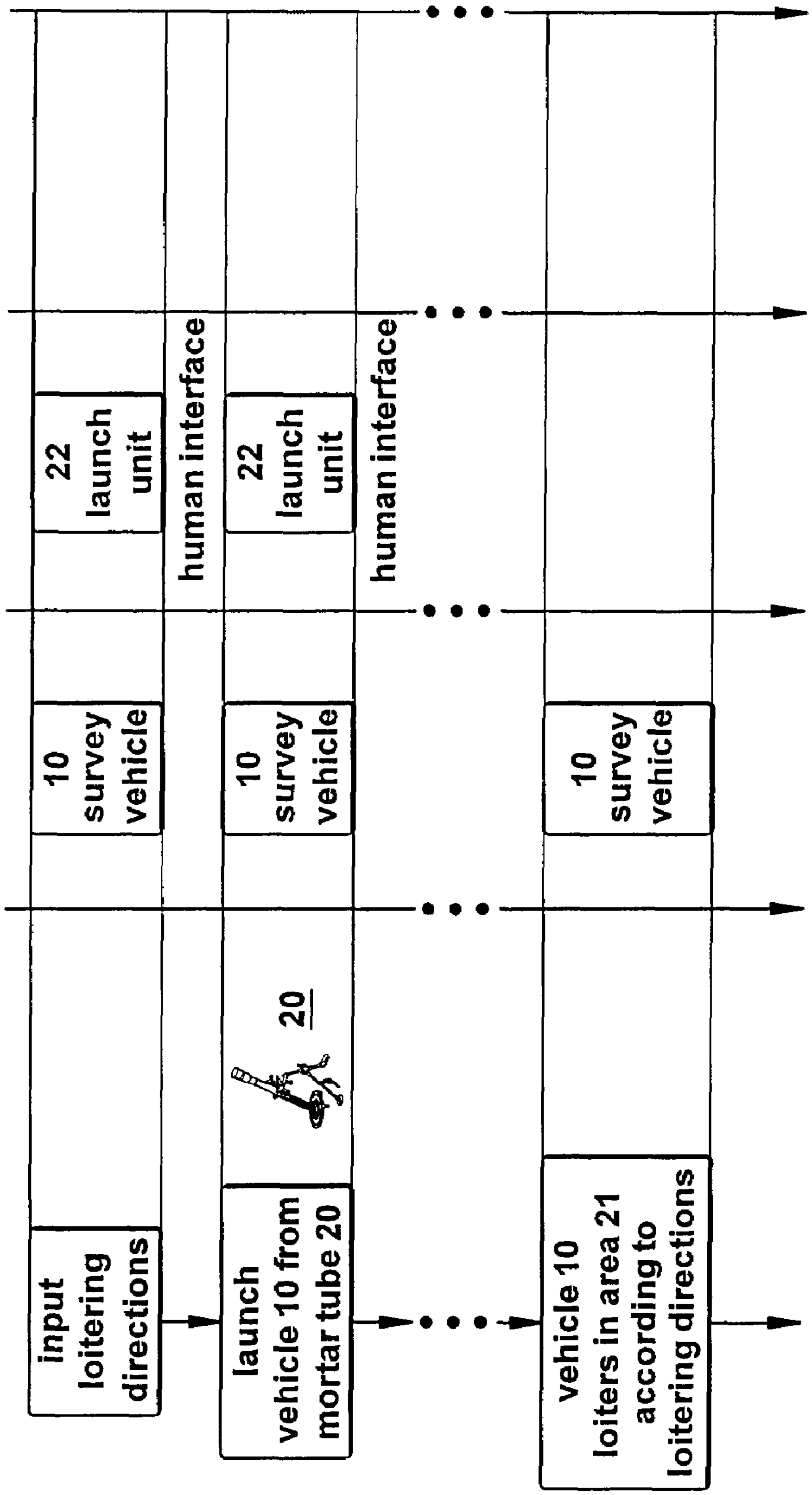

input loitering directions
10 survey vehicle
22 launch unit
human interface
launch vehicle 10 from mortar tube 20
20
10 survey vehicle
22 launch unit
human interface
vehicle 10 loiters in area 21 according to loitering directions
10 survey vehicle

Figure 10B

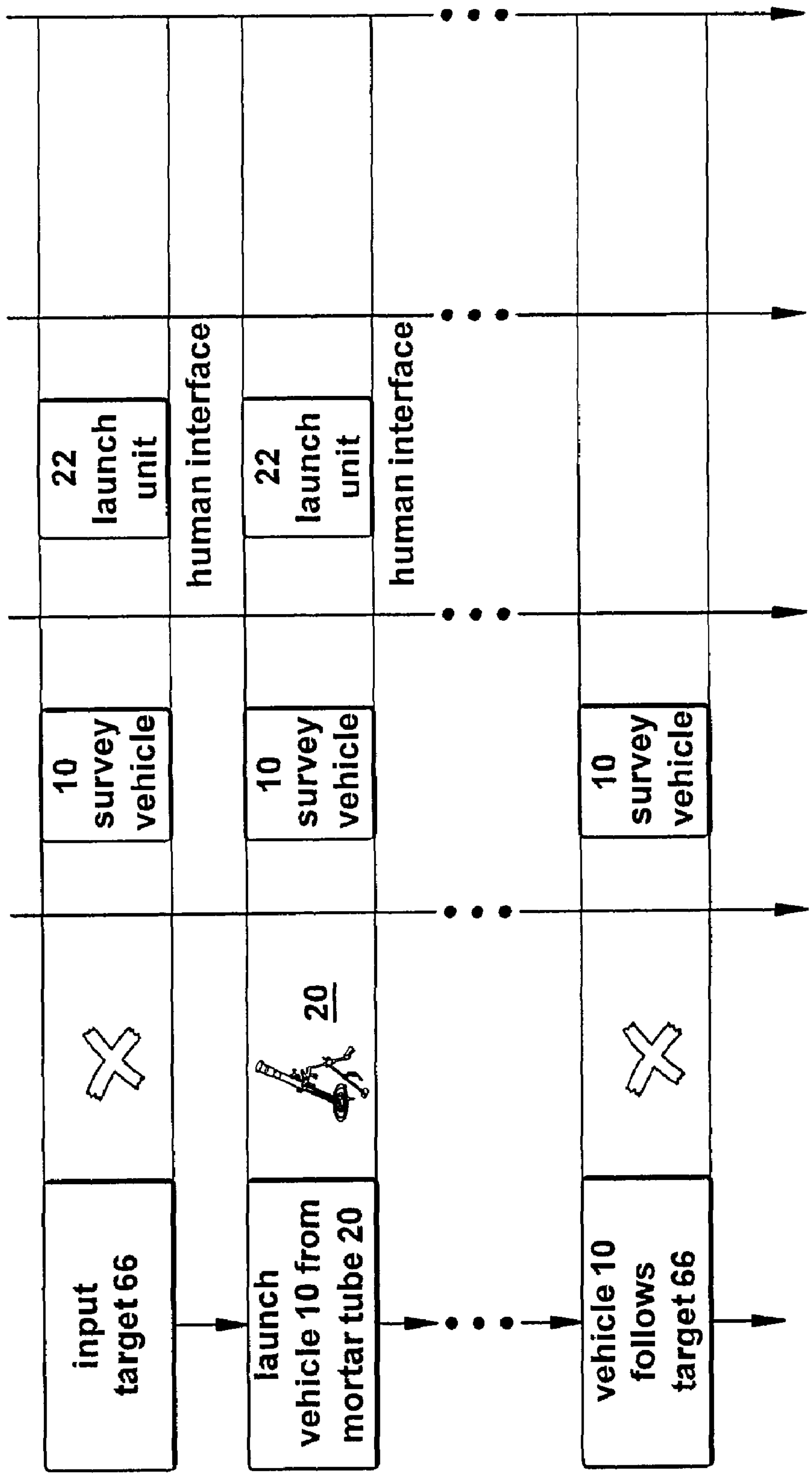

input target 66
launch vehicle 10 from mortar tube 20
vehicle 10 follows target 66
20
10 survey vehicle
10 survey vehicle
10 survey vehicle
22 launch unit
22 launch unit
human interface
human interface

Figure 10C

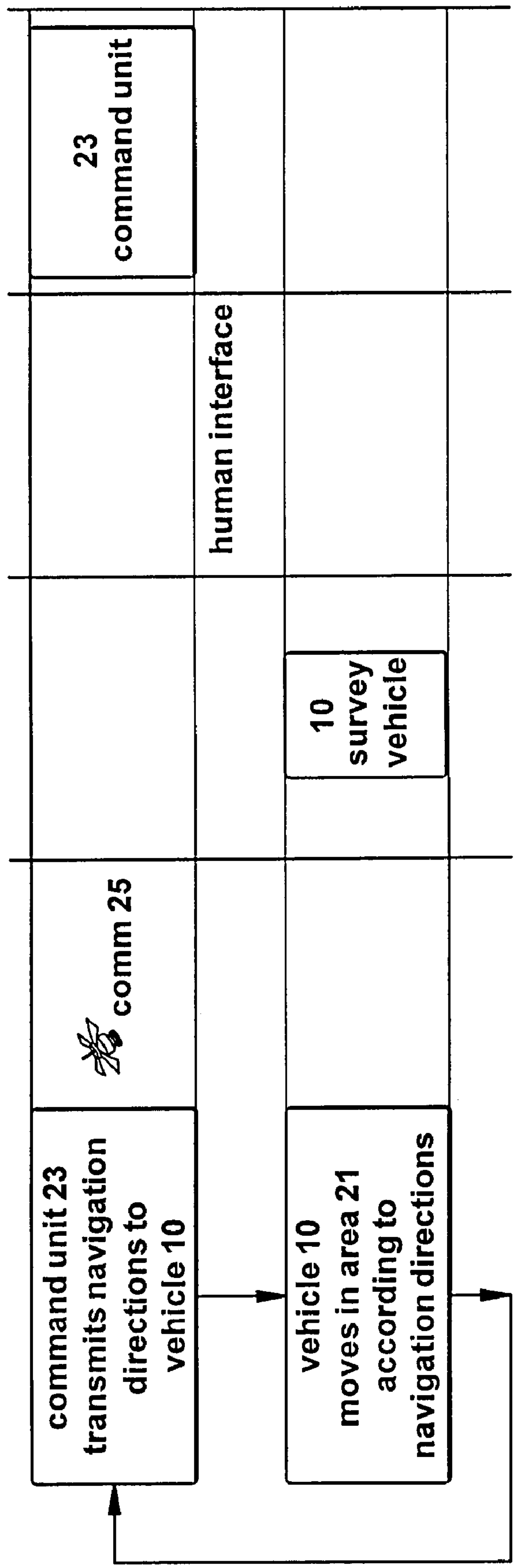

23
command unit
human interface
10
survey
vehicle
comm 25
command unit 23
transmits navigation
directions to
vehicle 10
vehicle 10
moves in area 21
according to
navigation directions

Figure 10D

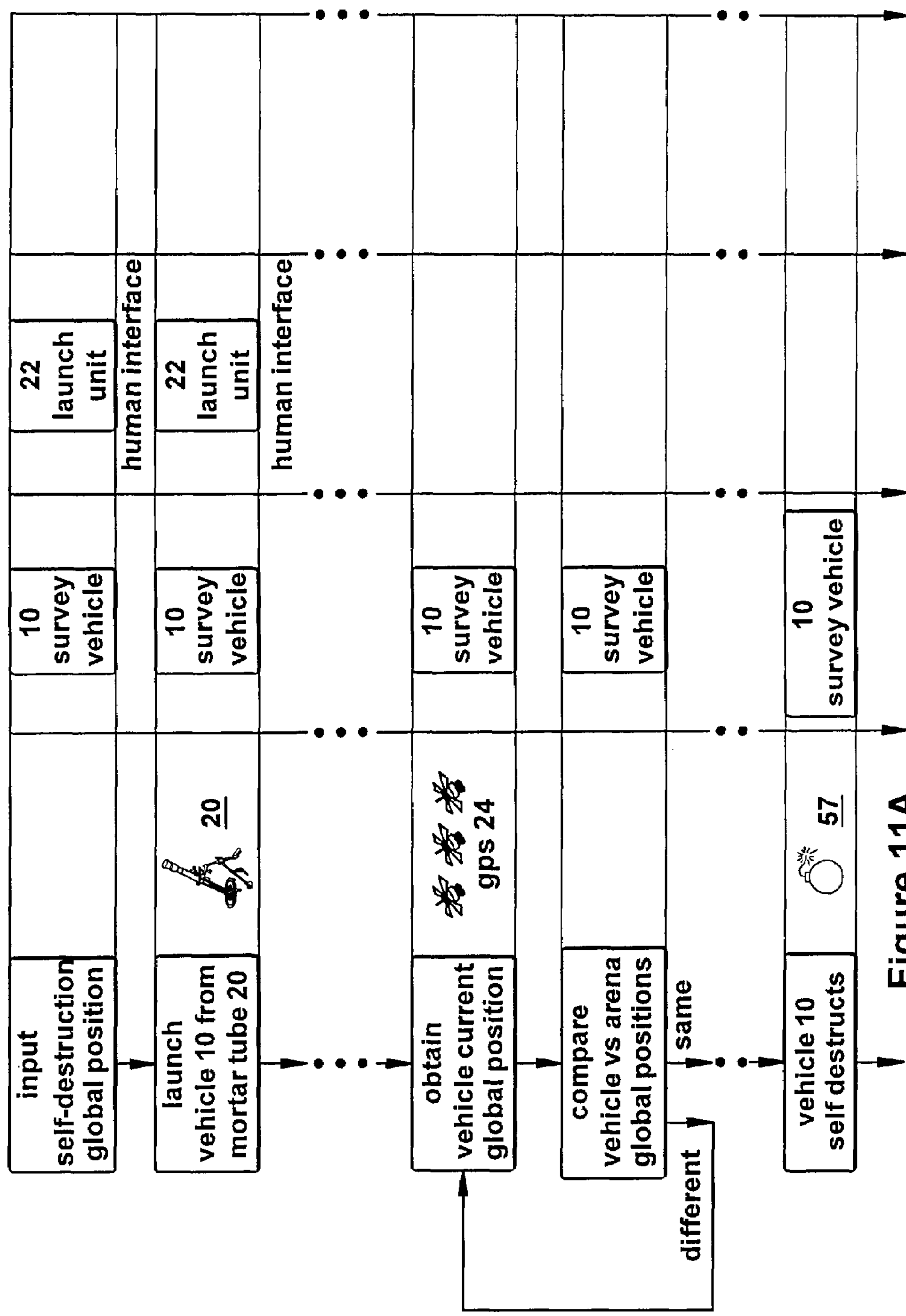
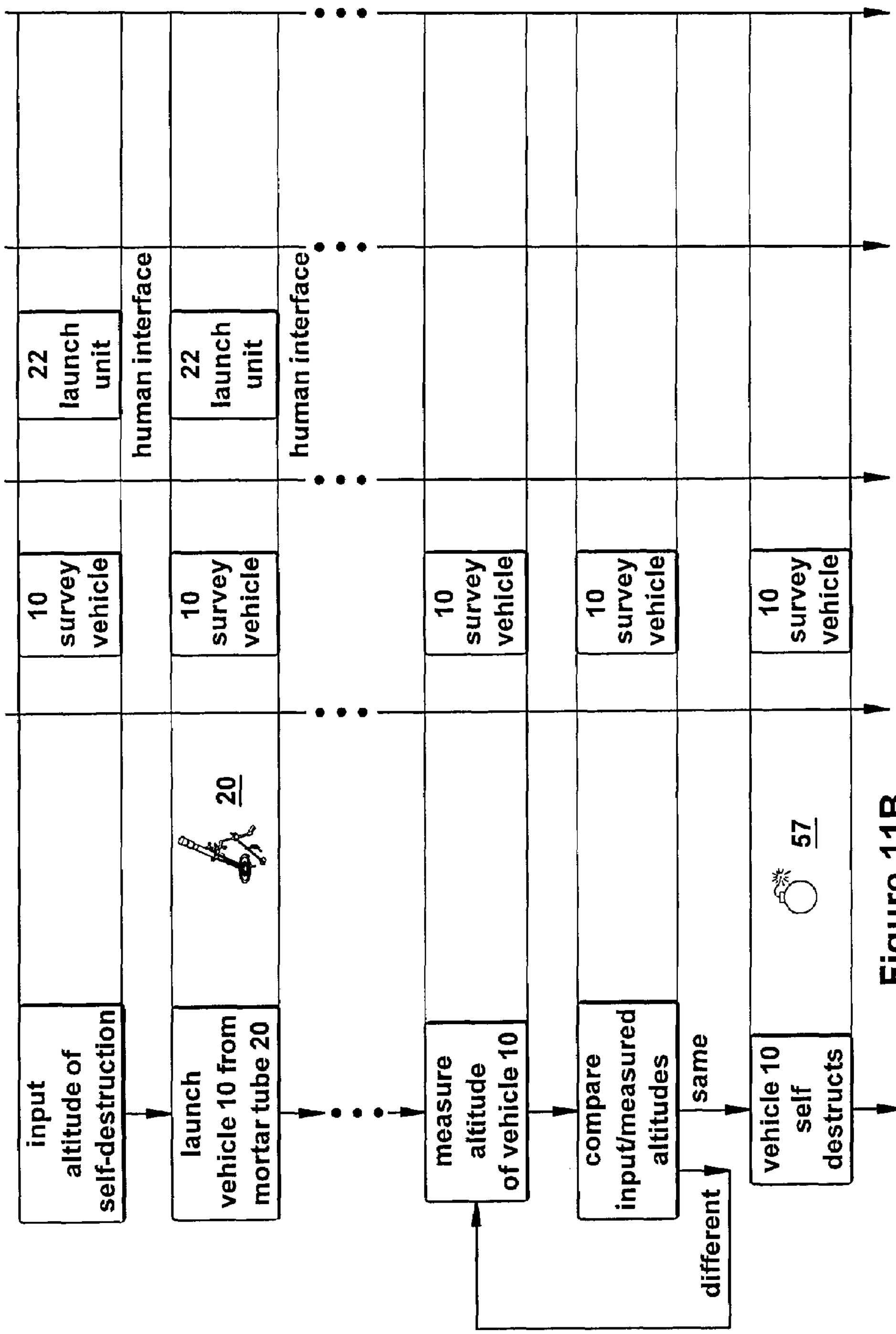

input self-destruction global position
10 survey vehicle
22 launch unit
human interface
launch vehicle 10 from mortar tube 20
20
10 survey vehicle
22 launch unit
human interface
obtain vehicle current global position
gps 24
10 survey vehicle
compare vehicle vs arena global positions
10 survey vehicle
same
different
vehicle 10 self destructs
57
10 survey vehicle

Figure 11A



input altitude of self-destruction
10 survey vehicle
22 launch unit
human interface
launch vehicle 10 from mortar tube 20
20
10 survey vehicle
22 launch unit
human interface
measure altitude of vehicle 10
10 survey vehicle
compare input/measured altitudes
10 survey vehicle
same
different
vehicle 10 self destructs
57
10 survey vehicle

Figure 11B

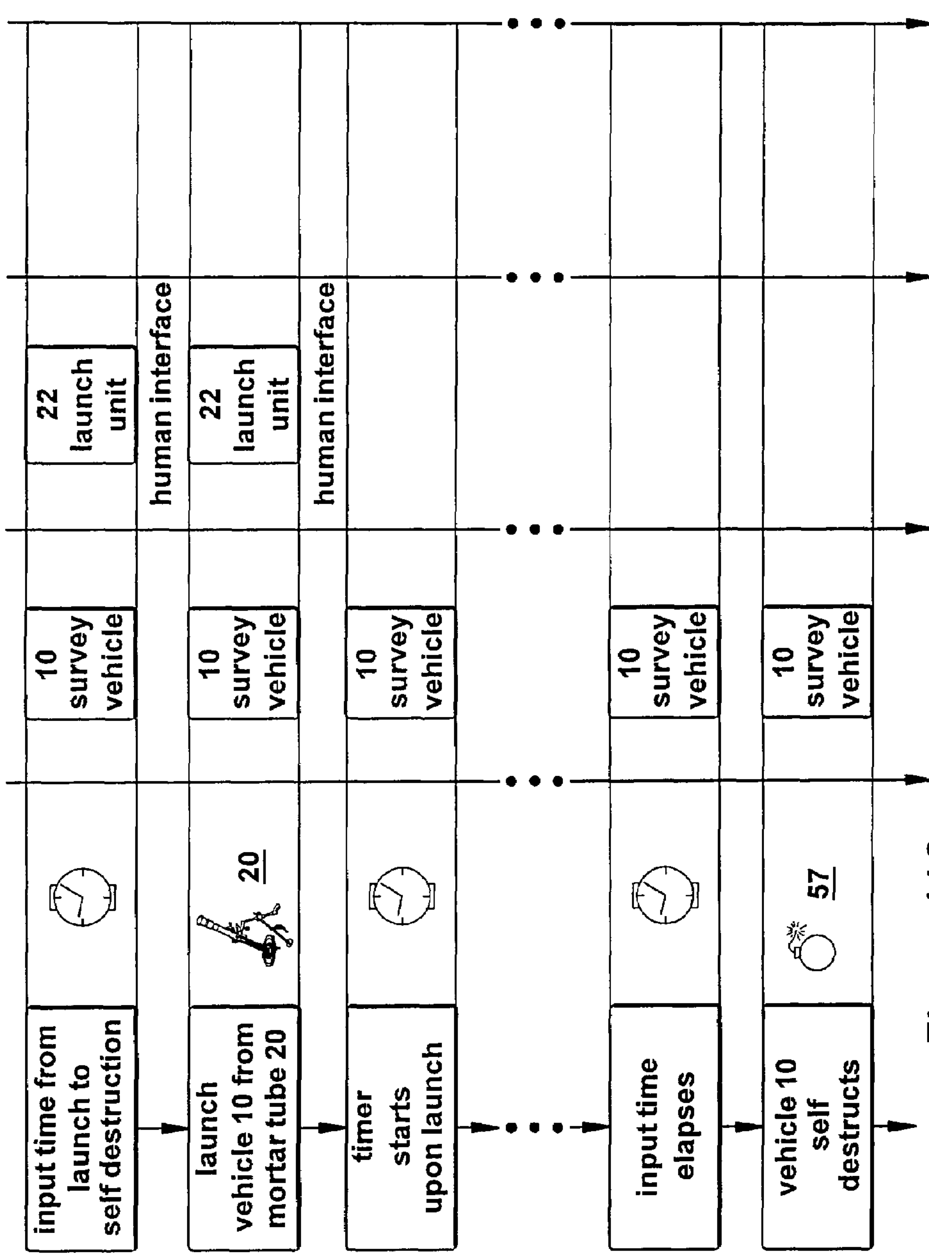

input time from launch to self destruction
launch vehicle 10 from mortar tube 20
timer starts upon launch
input time elapses
vehicle 10 self destructs
20
57
10 survey vehicle
10 survey vehicle
10 survey vehicle
10 survey vehicle
10 survey vehicle
22 launch unit
22 launch unit
human interface
human interface

Figure 11C

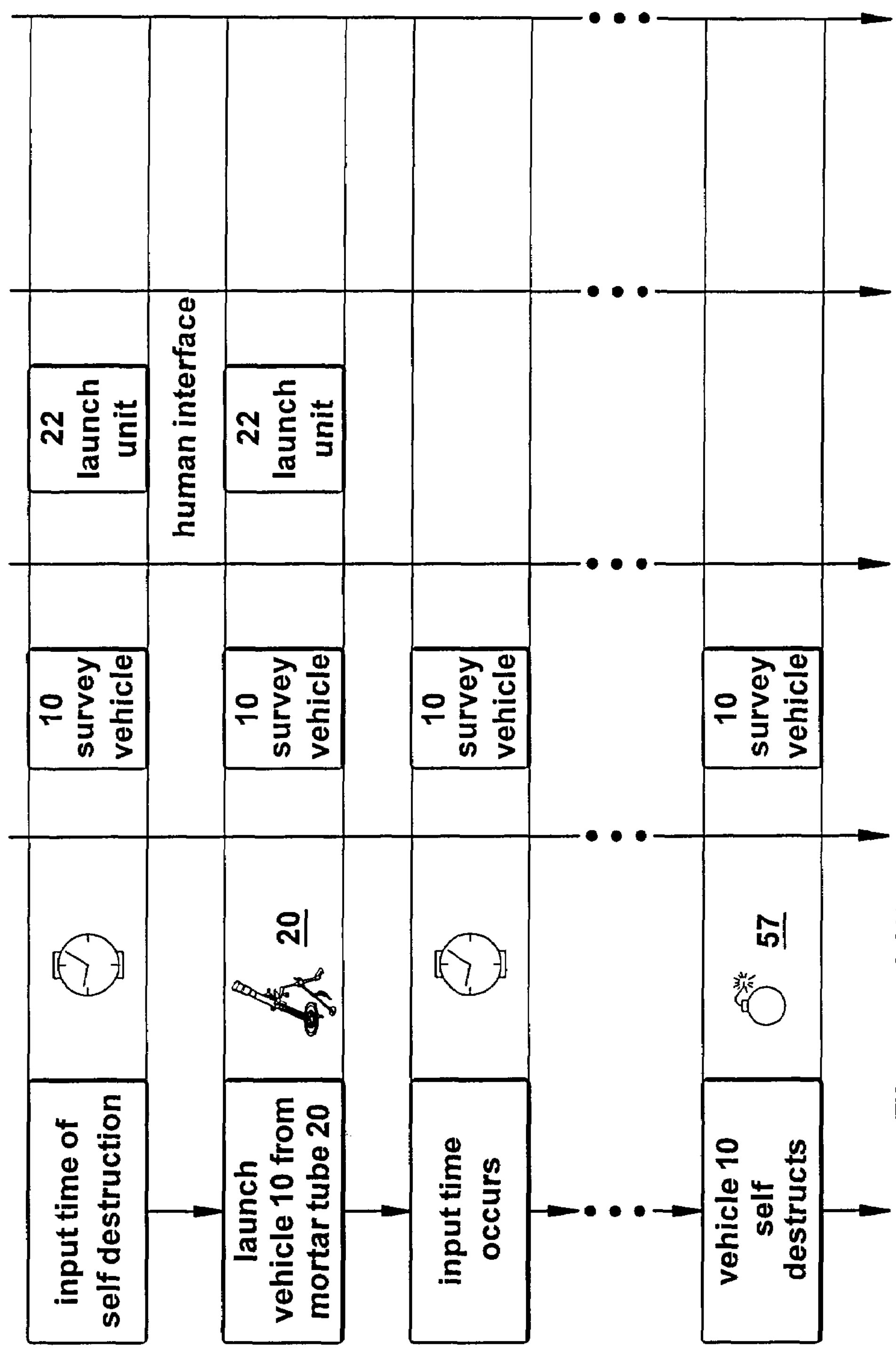

input time of self destruction
launch vehicle 10 from mortar tube 20
input time occurs
vehicle 10 self destructs
20
57
10 survey vehicle
10 survey vehicle
10 survey vehicle
10 survey vehicle
22 launch unit
22 launch unit
human interface

Figure 11D

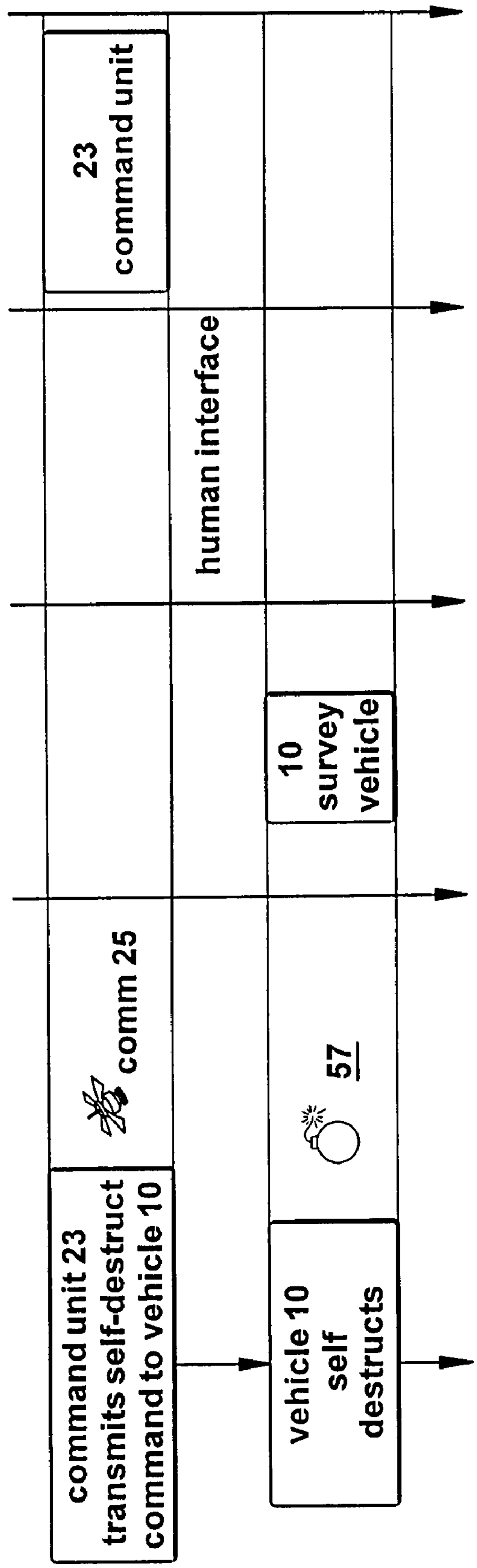

23
command unit
human interface
10
survey
vehicle
comm 25
57
command unit 23
transmits self-destruct
command to vehicle 10
vehicle 10
self
destructs

Figure 11E

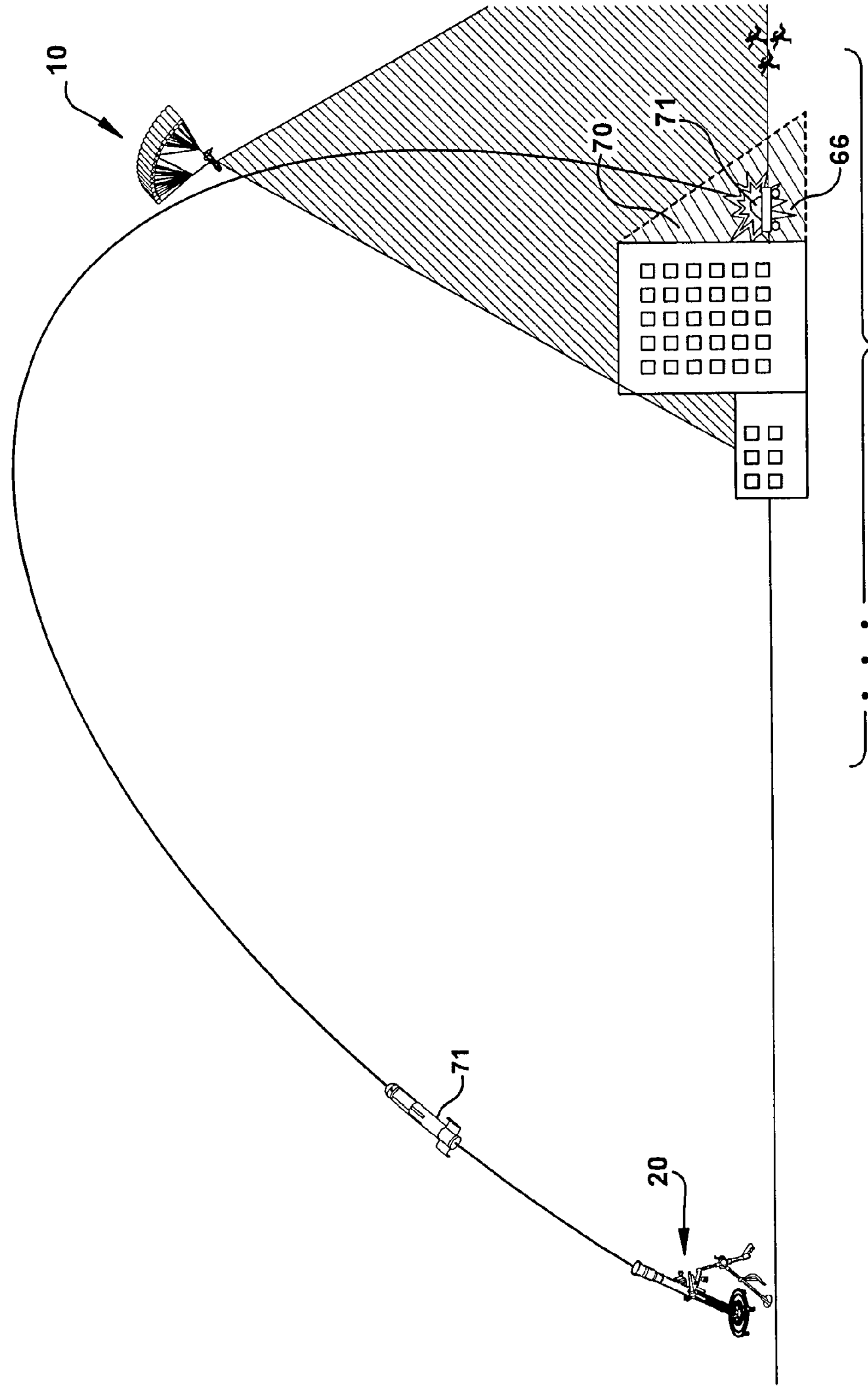


Figure 12A

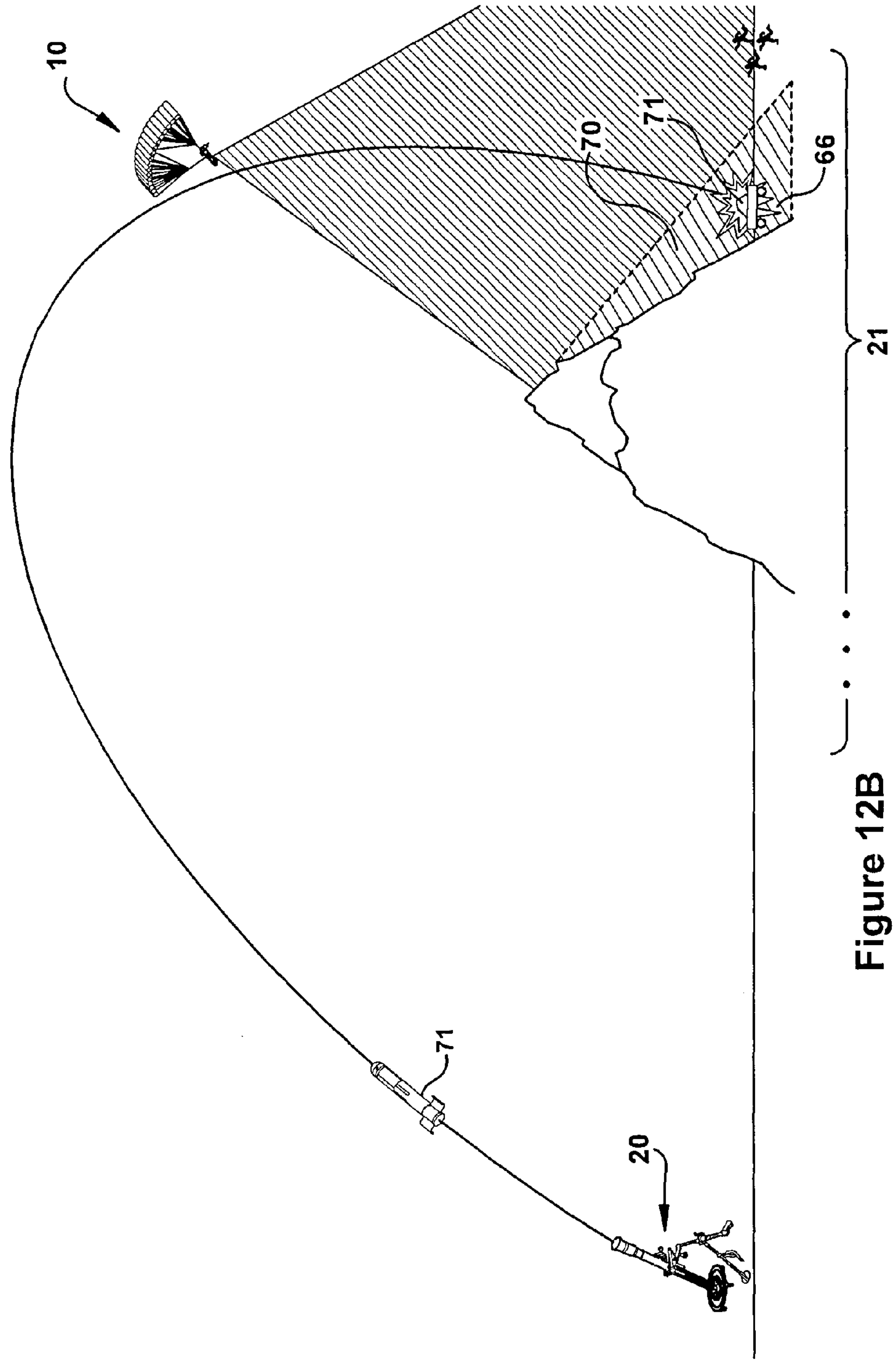


Figure 12B

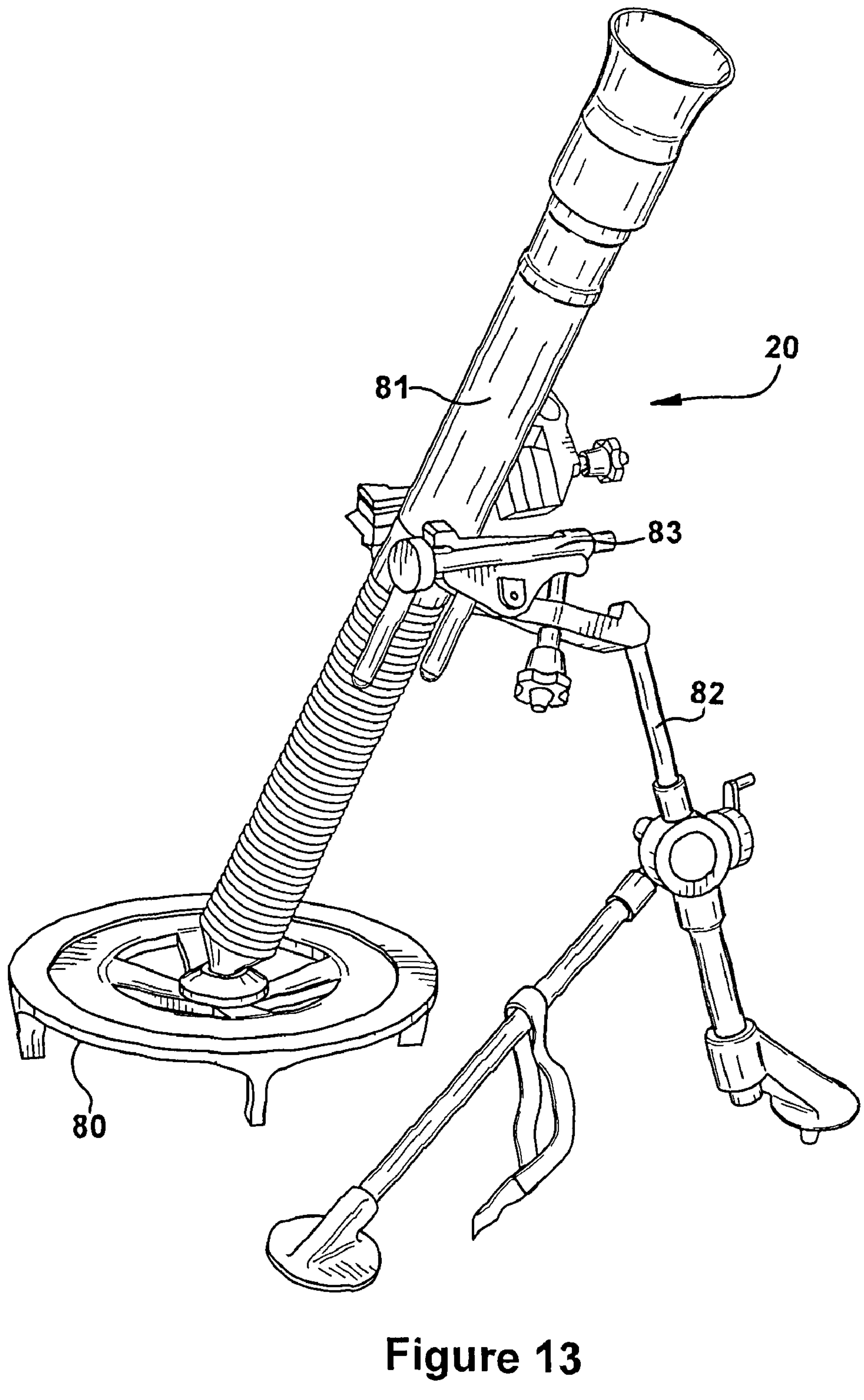


Figure 13

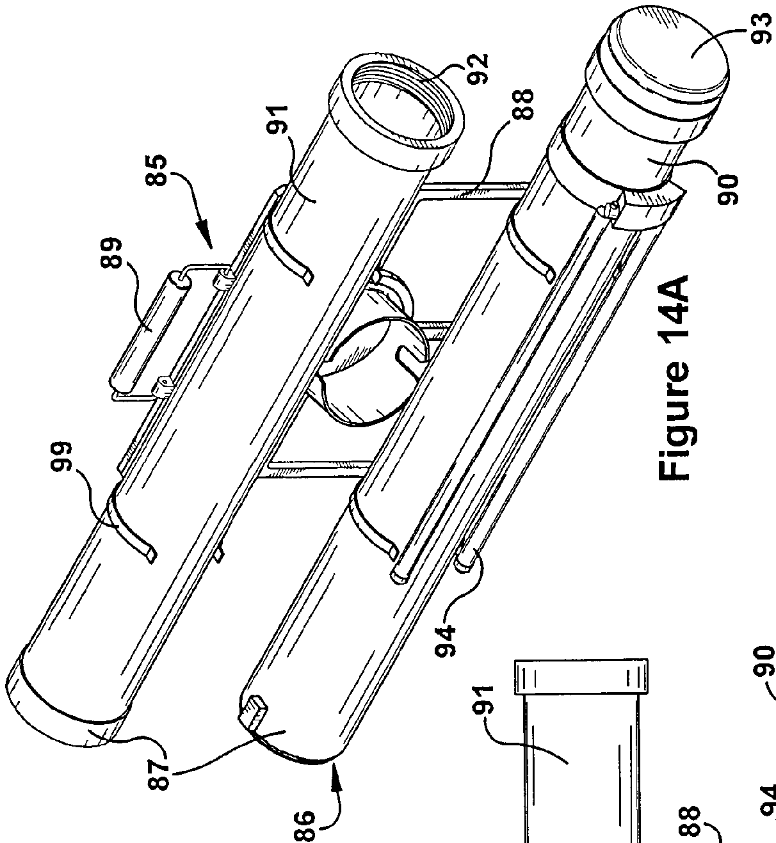


Figure 14A

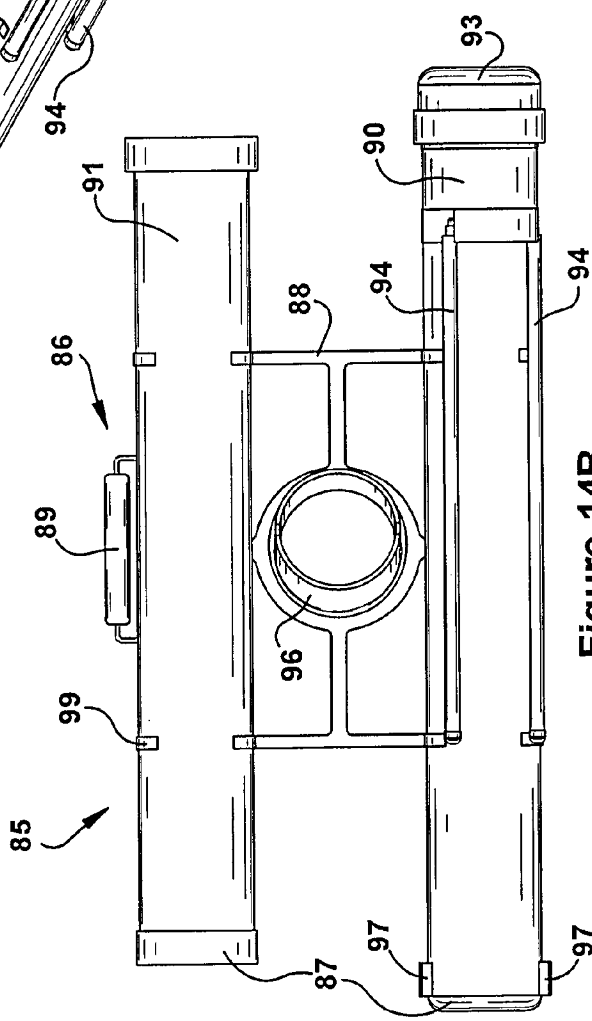


Figure 14B

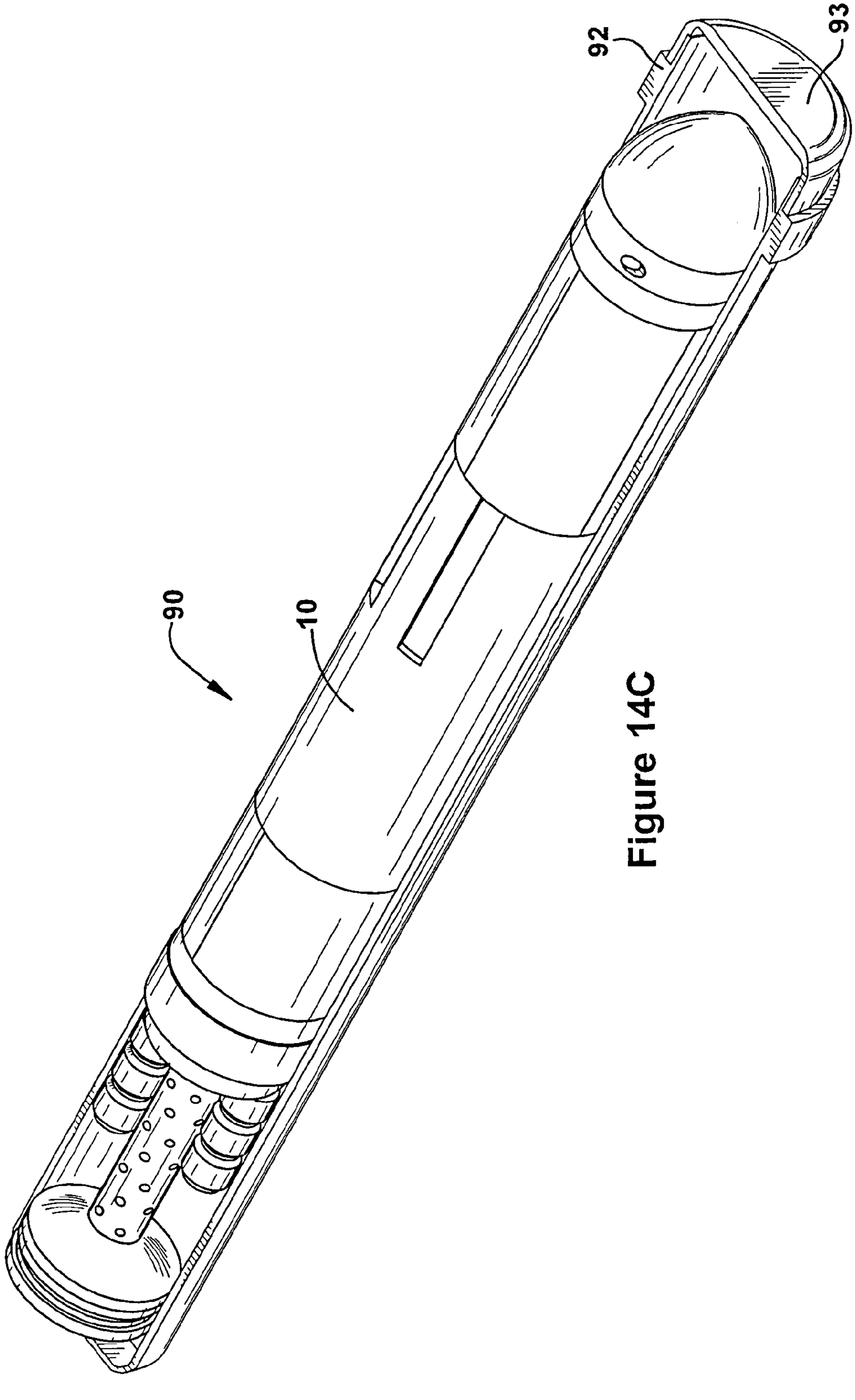


Figure 14C

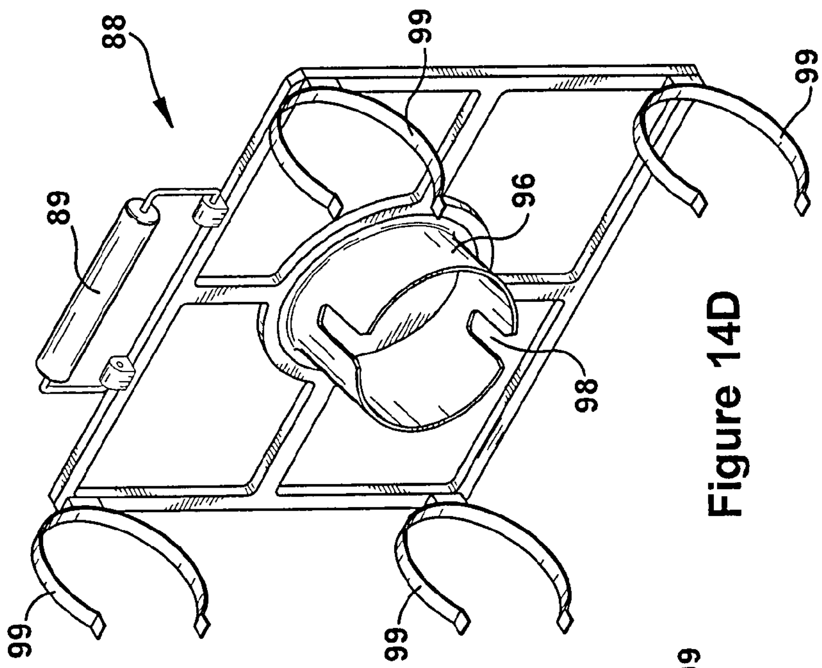


Figure 14D

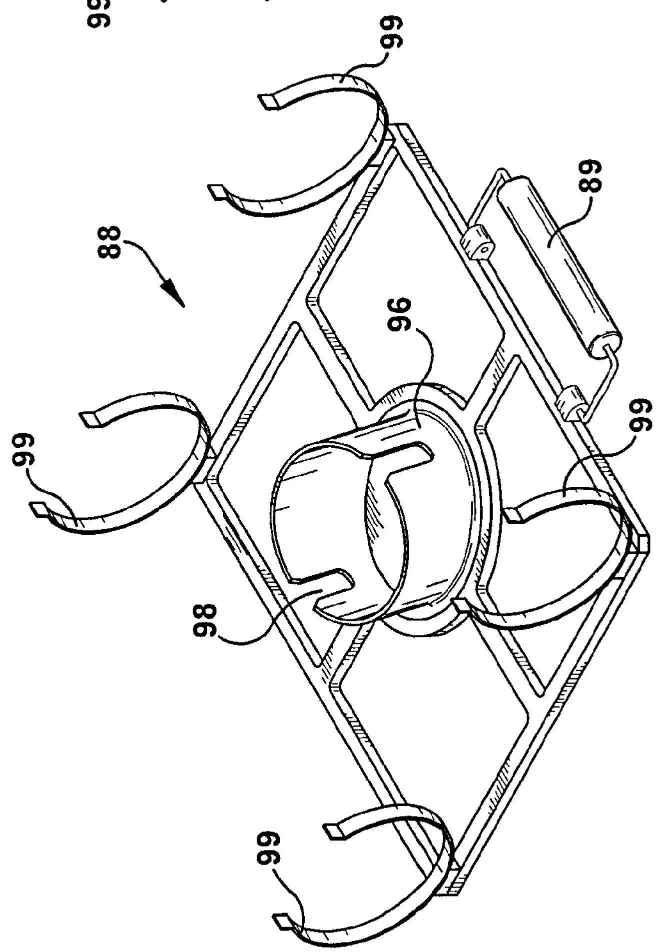


Figure 14E

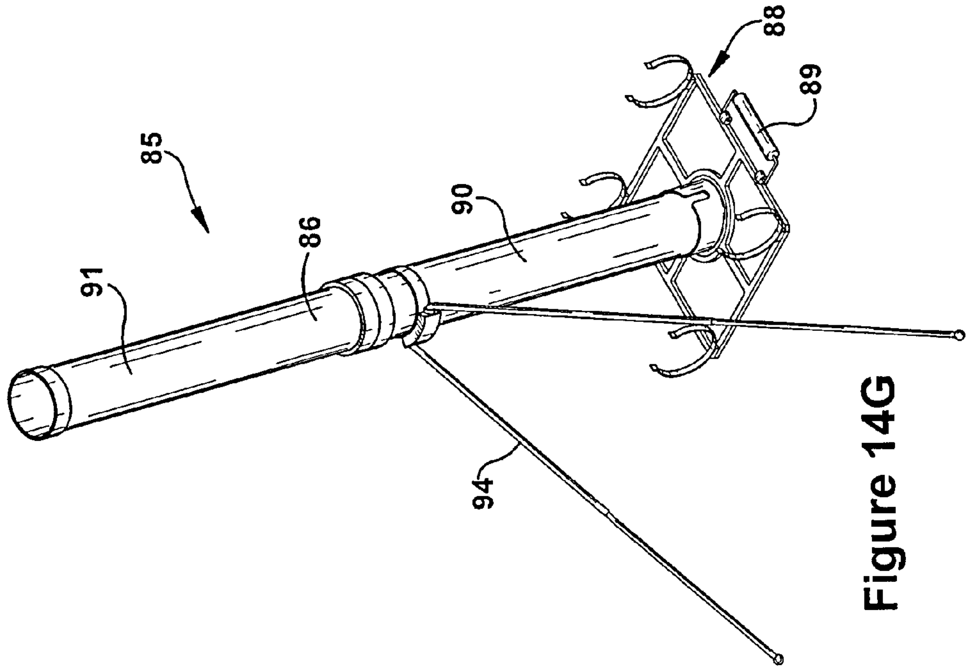


Figure 14G

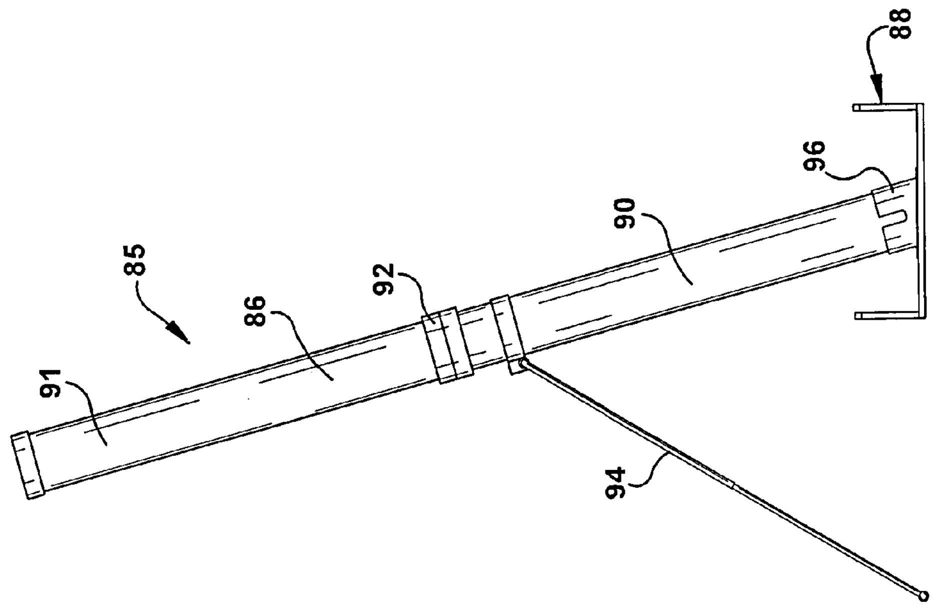


Figure 14F

UNMANNED SURVEILLANCE VEHICLE

RELATED APPLICATION

This claims priority under 35 U.S.C. §119(e) to U.S. Provisional Patent Application Ser. No. 61/092,159, filed on Aug. 27, 2008. The entire disclosure of this earlier application is hereby incorporated by reference.

GENERAL FIELD

An unmanned surveillance vehicle that is launched into an area of interest to collect visual survey data.

BACKGROUND

Military combat has always been a dangerous undertaking, to say the least. But the threat troops face today is unlike any they have encountered before. The enemy often consists of non-uniformed personnel operating individually or in small groups. And they strike populated urban areas with little or no regard for civilian causalities.

When an urban area is under attack, a common response strategy is to emplace ground forces on the city's outskirt. From this perimeter, buildings (and/or other vertical obstructions) obscure targets. They also create "dead spaces" unreachable by weapons with traditional ballistic trajectories. The enemy can be assumed to take full advantage of the hiding places and blind spots afforded by urban structures. And they can also be expected to niche target operations so that anything but a high-precision hit will result in collateral damage.

For these reasons, accurate and realtime surveillance data can be more critical in an urban combat area than in most other battlefields. At the same time, effective observation in such a setting is dangerous and difficult. An on-foot forward observer is often out of the question, as he quickly becomes a sitting duck for rooftop snipers. Even if a forward observer is lucky enough to slip past unfriendly fire, he may not be able to reach an effective vantage to gather meaningful intelligence.

Aerial surveillance erases most view-point problems and, if an unmanned vehicle is used to collect the survey data, human life is spared. But surveillance aircraft tend to be loud and thus audibly announce their approach to the enemy. And perhaps more importantly, an aerial vehicle (manned or unmanned) may not be available in a timely manner to support ground forces. Aerial surveillance vehicles do not come cheap, and keeping an inventory of even one vehicle near each major city has been considered cost prohibitive. Urban combat commonly occurs suddenly without warning, and waiting for aerial surveillance support to arrive is often not a viable option.

SUMMARY

A surveillance vehicle is provided that can gather meaningful intelligence from an effective vantage point without endangering human life. Visual survey data can be collected and transmitted in real time (or almost real time) to the command unit, so that targets can be immediately identified and pursued. The surveillance vehicle is transportable to a weapon launch site and can be launched from a conventional or standard mortar tube. In this manner, the surveillance vehicle can be initiated in a timely manner to support ground forces, without the need for special or specific launch equipment.

DRAWINGS

FIGS. **1**A-**1**D show the surveillance vehicle **10** in a pre-launch condition, a just-launched condition, a post-launch condition, and a survey condition, respectively.

FIGS. **2**A-**2**F schematically show the surveillance vehicle **10** launched and then loitered to survey an area of interest.

FIG. **3** shows certain parts of the vehicle's vessel **11**, namely a canister **30** (partially removed), a sail-deployer **31**, and an instrument bank **32**.

FIGS. **4**A-**4**H shows the stage-by-stage condition of vessel **11** when the vehicle **10** is converted from the post-launch condition to the survey condition.

FIG. **5** schematically shows the vehicle's instrument bank **32**.

FIG. **6** schematically shows a command unit **23** receiving surveillance data from the vehicle **10**.

FIGS. **7**A-**7**C collectively diagram a sequence of steps (and the involved components) from launch to target pursuit.

FIGS. **8**A-**8**E each diagram a sequence of steps (and the involved components) for ascertaining the vehicle's arrival at the area of interest.

FIG. **9**A is a schematic drawing a survey-data collector (e.g., a camera) and its mounting to the vehicle canister **30**.

FIGS. **9**B-**9**D each diagram a sequence of steps for moving a collecting lens to change its field of view.

FIGS. **10**A-**10**D each diagram a sequence of steps for moving the vehicle **10** within the area of interest.

FIGS. **11**A-**11**E each diagram a sequence of steps for self-destructing the vehicle **10**.

FIGS. **12**A-**12**B each show a dead-space target and the pursuit thereof, the dead space being caused by a building in FIG. **12**A and by a mountain in FIG. **12**B.

FIG. **13** shows a standard launch tube **20** for launching the surveillance vehicle **10** (and possibly subsequent ammunition rounds).

FIGS. **14**A-**14**G show a portable kit **86** (and components thereof that includes a surveillance vehicle **10** and launch equipment therefor.

DESCRIPTION

Referring now to the drawings, and initially to the FIGS. **1**A-**1**D, a surveillance vehicle **10** is shown that can gather meaningful intelligence from an effective vantage point without endangering human life. With the vehicle **10**, a surveillance mission can be initiated in a timely manner to support ground forces. And visual survey data can be collected and transmitted in real time.

The vehicle **10** generally comprises a vessel **11** (FIGS. **1**A-**1**D) and a parasail **12** (FIG. **1**D). In a pre-launch condition (FIG. **1**A), a tail **13** and propellant **14** are attached to the vessel **11**. In a just-launched condition (FIG. **1**B), the tail **13** falls away from the vessel **11** and the propellant **14** burns off. In the post-launch condition (FIG. **1**C), the vessel's flight fins **15** span outward.

In the pre-launch, just-launched, and post-launch conditions (FIGS. **1**A-**1**C), the parasail **12** is stowed within the vessel **11**. In the survey condition (FIG. **1**D), the parasail **12** is deployed to allow the vessel **10** to float at an elevated altitude (e.g., of at least 100 feet). The parasail **12** comprises a canopy **16**, chords **17** connected to the canopy **16**, and pull lines **18** connecting the chords **17** to the vessel **11**. The parasail **12** can be colored to blend in with the sky for camouflage purposes.

The pull lines **18** can be attached to a movement member within the vessel **11** (e.g., a servo-activator) which pulls/pivots the lines **18** to direct travel of the vehicle **10** after parasail **12** is deployed.

Referring now to FIGS. **2**A-**2**E the surveillance vehicle **10** is schematically shown in a combat context. In FIG. **2**A, the vehicle **10** is in its pre-launch condition and loaded in a conventional (and/or standard) mortar-launch tube **20**. In FIG. **2**B, the vehicle **10** is launched towards an urban area of interest **21**. The launching can be performed by a launch unit **22**, as commanded by a command unit **23**, these units (as well as the launch tube **20**) being located remote from the area of interest **21** (e.g., on the city's outskirt).

In FIGS. **2**C and **2**D, the vehicle **10** is in the post-launch condition, traveling towards the area of interest **21** and obtaining its current global position from the GPS constellation **24**. The vehicle **10** follows a traditional ballistic trajectory and, in FIG. **2**D, reaches the level of the trajectory. In FIG. **2**E, the vehicle **10** is in its survey condition, whereat the vessel **11** floats above the area of interest **21**, thanks to the deployed parasail **12**. The vehicle **10** transmits data to, and receives data from, the command unit **23**, via a communication satellite **25**.

Certain parts of the vessel **11** are shown isolated from the parasail **12** in FIG. **3**. The vessel **10** comprises a canister **30**, a sail deployer **31**, and an instrument bank **32**. And as can be seen by briefly referring to FIGS. **4**G-**4**H, the vessel **10** also comprises a propulsion device **33**.

The canister **30** comprises a stowage space **40** in which the parasail is stowed, a chamber **41** which houses the instrument bank **32**, and a compartment **42** holding the propulsion device **33**. The sail deployer **31** has arms **43** that reach into the sail stowage space **40**. The deployment arms **43** are pivotally mounted to a pedestal **44** located in or adjacent to the instrument chamber **41**. Prior to deployment (and as shown in FIG. **3**), the arms **43** are angled perpendicular to the pedestal **44**. The parasail's pull lines **18** can be attached to the distal ends of the arms **43** (as well as the pulling members discussed above).

FIGS. **4**A-**4**H show the stage-by-stage state of the vessel **11** as the vehicle **10** is converted from its post-launch condition to its survey condition. These figures also show that the sail stowage space **40** is enclosed by doors **45** and, with particular reference to FIG. **4**E, that the compartment **42** has a cover **46**.

The vessel **11** begins as cylindrical bullet-like shape defined by its canister **30** and resembling a conventional mortar round. (FIG. **4**A.) The fins **15** almost immediately spread outward from the canister **30** to steady the flight of the vehicle **10**. (FIG. **4**B.) When deployment of the parasail **12** begins, the deployer arms **43** lift upward and the doors **45** swing open. (FIG. **4**C.) Upon complete parasail deployment, the arms **43** are fully upright and the doors **45** re-closed (FIG. **4**D.) The cover **46** on the propulsion compartment **42** then falls away from the canister **30**, the propeller's motor **47** then drops, and the propeller's blades **48** then unfold. (FIGS. **4**E-**4**H.)

FIG. **5** schematically shows the instrument bank **32** of the vehicle **10**, and its interaction with other components in a combat context. The instrument bank **32** comprises a positioner **50**, a controller **51**, a collector **52**, a processor **53**, a transmitter **54**, a receiver **55**, a battery **56**, and a self destructor **57**.

The positioner **50** has an input for inputting the global position of the area of interest **21** by the launch unit **22** and an antenna for obtaining the global position of the vehicle **10** from the constellation **24**.

The controller **51** provides all of the computational processing to guide the surveillance unit using initial and real time GPS coordinates, preprogrammed flight paths, radio control and additional battlefield controls. Flight parameters include location, velocity, height and orientation. Coordinate calculations can be made either in the surveillance processor or in the ground control unit. Changes in the flight path and parameters are made in real time.

The collector **52** can be a camera designed to generate real time video with an appropriate resolution (e.g. 5.0 to >10 mega-pixels), Camera design can include image stabilization techniques in the form of internal lens stabilization, image plane stabilization and/or platform stabilization. The collector **52** can be designed using a single lens and with multiple detectors, or separate lenses could be used with the timing synchronized so that the images could be processed to generate composite images that will provide enhanced images for rapid determination of targets. Lenses can withstand the high-g acceleration during launch. A telephoto lens can be provided to allow zoom in on a given target for positive identification while also being able to give a wide field of view. The collector **52**, and/or its collecting lens, can be shielded prior to arrival in the area of interest **21** by, for example, the cover **46** or another openable component.

The processor **53** can provide multi-spectral imaging for significant enhancement to a video image with increased target detection of objects on the ground that are camouflaged or that appear to be targets and are not. Image enhancement is crucial to rapid interpretation of battlefield images and information. Targets on the battlefield want to remain hidden or camouflaged. The real time processing of video reduces the stress of image interpretation on the battlefield and greatly decreases the time needed to find and verify targets. Enhancement of the image can help prevent mistaking non-threatening areas, equipment or people from becoming targets. The processor **53** can also compensate for vessel movement.

The transmitter **54** and the receiver **55** allow communication to and from the command unit **23** (and/or other locations), in conjunction with, for example, the communication satellite **25**. The transmitter **54** can be selected to send video images in real time as well as telemetry and GPS data to the ground control unit. The transmitted signal can also be available to remote command units, aircraft and satellites and/or integrated into the overall battlefield communications system. The receiver **55** can be a high frequency receiver and designed to minimize the effects of attempted jamming of the receiver.

The battery **56** can be any power source capable of supplying the necessary power for electronics and flight controls, for a suitable period of time the batteries could be rechargeable or of a single charge battery pack with a long term storage capacity. Lithium-Ion and metal hydride high energy density batteries will usually have sufficient capacity to power the system over the intended flight time of the surveillance vehicle **10**.

The self destructor **57** can be a small explosive charge or some other means of rendering the vehicle **10** useless to the enemy when its mission is completed or otherwise exhausted.

Although the vehicle **10** is described primarily as a means for visually surveying the area of interest **21**, it could be adapted to serve other purposes. For example, the camera-like collector **52** could be replaced or supplemented with an NBC (nuclear, biological, and chemical) detection equipment could be installed to survey areas subjected to chemical attack or industrial accidents. Jamming equipment could be installed to deny the use of radio communications in a specific area. Alternatively, the unit could potentially be used as a repeater for short range communication equipment. If the instrument bank **32** is constructed in a modular fashion (as illustrated), such replacements or supplements could be efficiently accomplished.

FIG. **6** schematically shows the command unit **23**. The illustrated unit **23** comprises a receiver **60** for receiving survey data from the vehicle **10** (particularly its transmitter **54**), a mapper **61** for mapping the survey data, and an image screen **62** for visually displaying the survey data. The command unit **23** also comprises a transmitter **63** for transmitting navigation directions to the vehicle **10** (and particularly its receiver **55**). An analyzer **64** analyzes the survey data, a target identifier **65** identifies a target **66**, a planner **67** plans the pursuit of the target **66**, and a commander **68** orders the pursuit.

FIGS. **7**A-**7**C collectively diagram the sequence of steps (and the involved components) from launch to target pursuit in a combat context. Initially, the vehicle **10** is launched from the launch tube **20** and travels towards the area of interest **21**. (FIG. **7**A.) The actual launch of the vehicle **10** can be initiated by the launch unit **22** and, in most instances, will require human interface. While the command unit **23** in most instances orders the launch, it is not directly involved in the initiation logistics. That being said, the launch unit **22** and the command unit **23** could be the same unit and/or the command unit **23** could legislate launch initiation.

When the vehicle **10** ascertains arrival at the area of interest **21**, the parasail **12** is deployed and the propulsion device **33** is dropped. (FIG. **7**A.) This ascertainment can be accomplished in a variety of ways. For example, the vehicle **10** can continuously obtain its current global position (via its positioner **50**) and compare this to the global position of the area of interest **21** (e.g., input prior to launch). (see FIG. **8**A). Arrival at the area of interest **21** can be determined by the vehicle **10** reaching a certain altitude. (see FIG. **8**B.) The elapsing of a predetermined period of time can be the indication of arrival in the area of interest **21**. (see FIG. **8**C.) If the vehicle **10** is equipped with target-seeking instrumentation, a sighting of the target **66** can mean area-of-interest arrival. (see FIG. **8**D.) And/or the command unit **23** can notify the vehicle **10** of its arrival in the area of interest **21**. (see FIG. **8**E.)

Once in the area of interest **21**, the vehicle **10** collects visual survey data (e.g., via collector **52**). (FIG. **7**A) The collector **52**, or at least its collecting lens, can be mounted for pivotal movement relative to the vehicle canister **30** (see FIG. **9**A.) By pivoting or otherwise moving the collecting lens, the field of view can be adjusted. Pivoting/adjusting instructions can be preprogrammed (see FIG. **9**B) or provided by the command unit **23** (see FIG. **9**D). Additionally or alternatively, collecting-lens movement can follow a locked-onto target **66** (see FIG. **9**C).

The vehicle **10** moves aerially in the area of interest **21** while collecting, processing, and transmitting the visual survey data. (FIG. **7**B.) This maneuvering is effected by the parasail **12** (e.g., pulling of its lines **18**) and/or the propulsion device **33** (e.g., speed/direction of motor **47**). The vehicle **10** can initiate movement to remain in the area of interest **21** when global position data indicates a drifting therefrom (see FIG. **10**A). The vehicle **10** can loiter in the area of interest **21** in accordance with preprogrammed loitering directions (see FIG. **10**B). The vehicle's movement can be steered by a target **66** onto which it is locked (see FIG. **10**C). And/or the vehicle **10** can move according to navigation instructions transmitted by the command unit **23** (see FIG. **10**D).

The vehicle **10** transmits the collected survey data (e.g., via transmitter **54**) to the command unit **23**. Preferably, the survey data is processed (via processor **53**) before transmittal to the command unit **23**. This processing can include, for example, compensating for vehicle movement so that the transmitted data is stabilized. Image processing can instead be done at the command unit **23** or another transmitted-to location. But pre-transmittal processing of the data eliminates the need for the survey-data recipient to have accommodating processing equipment.

The command unit **23** receives the survey data (via receiver **60**), and it maps and analyzes this data (via mapper **61** and analyzer **64**). This mapping/analysis leads to identification of target **66** (via identifier **65**), so that target pursuit can be planned (via planner **67**). The target **66** can be then be pursued, as ordered by the command unit **23** (via commander **68**).

The surveying ability of the vehicle **10** can be especially advantageous for dead-space combat when combined with self-guiding weapons. Referring briefly to FIG. **12**A, a dead space **70** is located "behind" a building, the orientation being relative to the location of the launch tube **20**. The relevant dimensions of the dead space **70** can be estimated at being about ½ of the building's height. Needless to say, in a city crowded with buildings, dead spaces for the enemy to hide would not be in short supply. As shown in FIG. **12**B, the same phenomenon can occur with natural obstacles, such as mountains. In either or any event, once the dead space **70** has been identified as target **66** by the command unit **23**, its exact global position can be programmed into a precision guided mortar round **71**, and/or any GPS guided round.

The vehicle **10** can be designed to self-destruct (via its self-destructor **57**) to avoid, for example, confiscation by the enemy. (FIG. **7**C.) This self-destruction can be initiated by entering a predetermined global position (see FIG. **11**A), descending to an undesirable altitude (see FIG. **11**B), spending a pre-set period of time in the air (FIG. **11**C), coming of specified time (see FIG. **11**D), and/or receiving a command from the unit **23** to self destruct (see FIG. **11**E).

As alluded to above, the launch tube **20** can be a conventional or standard component used to launch mortar rounds. As shown in FIG. **13**, such a tube **20** typically comprises a base **80**, a barrel **81**, an easel **82** and an adjustable clamp **83**. The base **80** is anchored in the ground, while the easel **82** and the clamp **83** hold the barrel **81** at the correct orientation. The tube **20** is intended for repeated use in demanding combat climates. It is usually made of a heavy steel and weighs upward of 100 pounds, without the payload.

The vehicle **10** can instead be part of a portable kit **85**, such as is shown in FIGS. **14**A-**14**G, that can be toted (on foot) to the desired launch location. The portable kit **85** can include single-use launch tube **86** (i.e., it is retired after launch of the vehicle **10**). The launch tube **86** can be fabricated primarily of lightweight composites so that the weight of the kit **85** can be kept below fifty pounds, forty pounds, and/or thirty pounds. The combined cost of the vehicle **10** and the single-use tube **86** could be within a range allowing one to be kept in inventory by even relatively humble emergency response organizations.

The launch tube **86** comprises a barrel **87**, a stand **88**, and a handle **89**. In the illustrated embodiment, the launch tube **86** comprises a barrel pipe **90** and a barrel pipe **91** connected together end-to-end by threaded connections **92**. The vehicle **10** is contained within the barrel pipe **90** and a lid **93** seals the pipe's open upper end prior to launch. Locking or anti-tampering means can be incorporated into this closure for security purposes, so that the kit **85** can be kept with other emergency equipment until a situation arises. The pipe **90** is provided with a kickstand-like brace structure **94** for angling the barrel **87** for the desired launch projectile.

The stand **88** has a base mount **96** for receipt of the bottom end of the barrel **87** which, in the illustrated embodiment, is the bottom end of the barrel pipe **90**. Mating tabs **97** and slots **98** on the base mount **96** lock the barrel **87** against rotational movement. These locking components **97/98**, in combination with the brace structure **94**, hold the barrel **87** in a steady launch position.

The stand **88** can double as a rucksack for the launch tube **86** so that no extra weight or cost is added for suitcasing of the launch tube **86**. The handle **89** can be attached to the stand **88** for convenient carrying. And the stand **88** can comprise clamps **99** for clamping the barrel pipes **90** and **91** when carrying the kit **85** to a proposed launch site.

One may now appreciate that the surveillance vehicle **10** can gather meaningful intelligence from an effective vantage point without endangering human life. Although the surveillance vehicle **10** has been shown and described with respect to a certain embodiment or embodiments, it is obvious that equivalent alterations and modifications will occur to others skilled in the art upon the reading and understanding of this specification and the annexed drawings. In regard to the various functions performed by the above described elements (e.g., components, assemblies, systems, devices, compositions, etc.), the terms (including a reference to a "means") used to describe such elements are intended to correspond, unless otherwise indicated, to any element which performs the specified function of the described element (i.e., that is functionally equivalent), even though not structurally equivalent to the disclosed structure which performs the function. In addition, while a particular feature of the invention may have been described above with respect to only one or more of several illustrated embodiments, such feature may be combined with one or more other features of the other embodiments, as may be desired and advantageous for any given or particular application.

The invention claimed is:

1. A surveillance vehicle comprising a vessel and a parasail, wherein the vessel comprises:

a canister having a stowage space in which the parasail is stowed,

a sail deployer triggerable to deploy the parasail from the stowage space,

a propulsion device for aerial movement of the vessel to an area of interest,

a controller ascertaining arrival at the area of interest and triggering the sail deployer to deploy the parasail upon arrival above the area of interest, and

a collector for collecting visual survey data from the area of interest;

wherein:

the vehicle is convertible from a pre-launch condition to a survey condition,

when the vehicle is in the pre-launch condition, the parasail is stowed within the stowage space and the vessel is sized and shaped for launch from a mortar tube,

when the vehicle is in the survey condition, the parasail is deployed from the stowage space and the vessel is supported thereby at an altitude of at least 100 feet;

wherein the propulsion device includes a propeller, and a propeller motor used to drive the propeller;

wherein the parasail includes:

a canopy;

cords connected to the canopy; and

pull lines connecting the cords to the vessel; and

wherein the pull lines are attached to deployment arms within the vessel, to pull and/or pivot the pull lines after the parasail is deployed, to direct travel of the vehicle.

2. A surveillance vehicle as set forth in claim **1**, wherein the canister has a compartment holding the propulsion device, and wherein the controller prompts the propulsion device to drop from the compartment upon arrival at the area of interest.

3. A surveillance vehicle as set forth in claim **1**, wherein the vessel further comprises a transmitter transmitting collected survey data to a command unit remote from the area of interest.

4. A surveillance vehicle as set forth in claim **1**, wherein the vessel further comprises a positioner having an antenna for obtaining the global position of the vehicle, and wherein the positioner has an input for inputting the global position of the area of interest, whereby the controller can ascertain arrival at the area of interest based on the input global position of the area of interest and the obtained global position of the vehicle.

5. A surveillance vehicle as set forth in claim **1**, wherein the controller ascertains arrival at the area of interest based on the altitude of the vessel, based upon time elapsed from launch of the vessel, and/or based upon recognition of a target.

6. A surveillance vehicle as set forth in claim **1**, wherein the controller ascertains arrival at the area of interest and triggers the sail deployer without human interface.

7. A surveillance vehicle as set forth in claim **1**, wherein the controller controls the parasail and/or a propulsion unit to move within the area of interest based upon:

a comparison between the global position of the vehicle and the global position of the area of interest;

pre-programmed loitering directions;

a locked-on target and movement thereof; and/or navigation directions received from a remote command unit.

8. A surveillance vehicle as set forth in claim **1**, wherein the collector comprises a collecting lens, wherein the collecting lens is mounted for movement relative to the canister.

9. A surveillance vehicle as set forth in claim **8**, wherein the collecting lens of the collector is mounted for pivotal movement relative to the canister, and wherein the collecting lens is movable without human interface and/or based upon instructions received from a command unit remote from the area of interest.

10. A surveillance vehicle as set forth in claim **1**, wherein the vessel further comprises a processor which processes image data collected by the collector, and wherein the processor compensates for movement of the vessel.

11. A surveillance vehicle as set forth in claim **1**, wherein the vessel has a diameter less than 200 mm when the vehicle is in its pre-launch condition.

12. A surveillance vehicle as set forth in claim **11**, wherein the vessel has a 60 mm diameter, an 81 mm diameter, a 105 mm diameter, or a 155 mm diameter when the vehicle is in its pre-launch condition.

13. A surveillance vehicle as set forth in claim **1**, further comprising a self-destructor that is activated upon occurrence of predetermined event.

14. A surveillance vehicle as set forth in claim **1**, in combination with a command unit, wherein:

the surveillance vehicle is in its survey condition and located in the area of interest and the command unit is located remote from the area of interest,

the command unit comprises a receiver that receives collected survey data transmitted by the surveillance vehicle, and

the command unit also comprises a mapper that maps the received survey data and/or an image screen that displays the survey data.

15. A surveillance vehicle as set forth in claim **1**, in combination with a command unit that maps/displays survey data received from the surveillance vehicle, wherein the command unit comprises a target identifier that identifies a target on the mapped/displayed survey data, and wherein the target identifier requires human interface to identify the target.

16. A surveillance vehicle as set forth in claim **1**, in a portable kit further comprising a launch tube with a barrel, and wherein the surveillance vehicle is sealed within the barrel in the pre-launch condition.

17. The surveillance vehicle of claim **1**, wherein the vessel further comprises an NBC detector for detecting nuclear, biological, and/or chemical incidents in the area of interest, and/or a jammer for jamming radio communications in the area of interest.

18. A surveillance vehicle as set forth in claim **1**, wherein the vessel has flight fins that spread outward from the canister during flight of the vehicle.

19. A surveillance vehicle as set forth in claim **1**,

further comprising openable doors that enclose the stowage space;

wherein the doors swing open when the deployment arms lift to deploy the parasail; and

wherein the doors reclose after complete parasail deployment.

20. A surveillance vehicle comprising a vessel and a parasail, wherein the vessel comprises:

a canister having a stowage space in which the parasail is stowed,

a sail deployer triggerable to deploy the parasail from the stowage space,

a propulsion device for aerial movement of the vessel to an area of interest,

a controller ascertaining arrival at the area of interest and triggering the sail deployer to deploy the parasail upon arrival above the area of interest, and

a collector for collecting visual survey data from the area of interest;

wherein:

the vehicle is convertible from a pre-launch condition to a survey condition,

when the vehicle is in the pre-launch condition, the parasail is stowed within the stowage space and the vessel is sized and shaped for launch from a mortar tube,

when the vehicle is in the survey condition, the parasail is deployed from the stowage space and the vessel is supported thereby at an altitude of at least 100 feet;

wherein the propulsion device includes a propeller, and a propeller motor used to drive the propeller;

wherein the parasail includes:

a canopy;

cords connected to the canopy; and

pull lines connecting the cords to the vessel;

wherein the sail deployer has deployment arms that are attached to the pull lines; and

wherein the deployment arms are pivotally mounted to a pedestal that is within the canister.

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