IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF VIRGINIA
ALEXANDRIA DIVISION

GRAY MANUFACTURING COMPANY, INC., Plaintiff, v. ASHBURN VOLUNTEER FIRE AND RESCUE DEPARTMENT, Defendant.	Case No. 3:19cv801 **JURY TRIAL DEMANDED**

COMPLAINT AND JURY DEMAND

Plaintiff Gray Manufacturing Company, Inc. ("Gray"), for its complaint against Defendant Ashburn Volunteer Fire and Rescue Department, states:

Parties

1. Gray is a corporation duly organized and existing under the laws of the State of Missouri and having its principal place of business at 3501 S. Leonard Rd., St. Joseph, Missouri 64503.

2. Ashburn Volunteer Fire and Rescue Department is a non-profit corporation organized under the laws of the Commonwealth of Virginia, with its principal business office located at 20688 Ashburn Rd., Ashburn, Virginia 20147.

Jurisdiction and Venue

3. This is an action arising under the patent laws, Title 35, United States Code, for Ashburn Volunteer Fire and Rescue Department's infringement of infringement of U.S. Patent No. 10,457,536 B2 ("the '536 Patent").

4. This Court has subject-matter jurisdiction under 28 U.S.C. §§ 1331 and 1338(a).

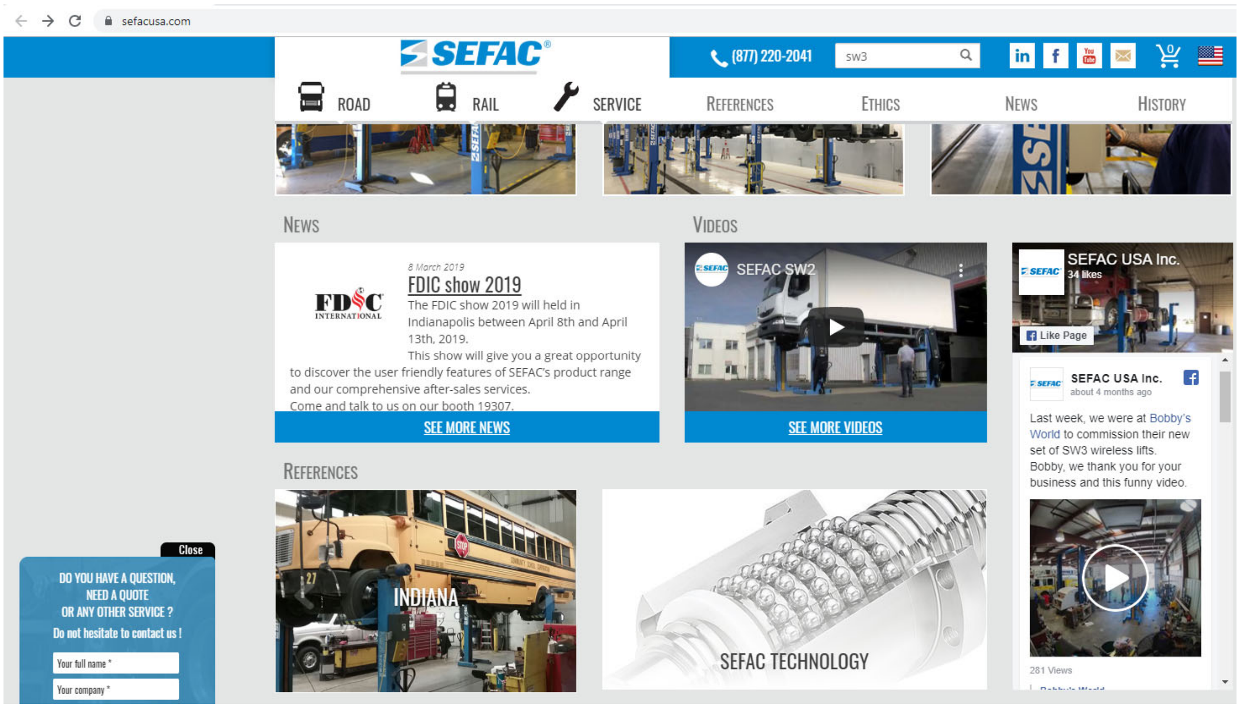
5. This Court has personal jurisdiction over Ashburn Volunteer Fire and Rescue Department because, on information and belief, it is registered as a non-profit corporation in Virginia, regularly conducts business in Virginia, and has committed infringing acts within Virginia, including by using a wireless portable vehicle lift system that infringes the '536 Patent and using the wireless portable vehicle lift system in methods that infringe the '536 Patent.

6. Venue is proper in this judicial district and division under 28 U.S.C. § 1400(b) for Ashburn Volunteer Fire and Rescue Department because it is incorporated in this judicial district. In addition, Ashburn Volunteer Fire and Rescue Department maintains a physical office and service garage located in Ashburn, Virginia, which is within this judicial district and division, that serves as its regular and established place of business. And, as described herein, Ashburn Volunteer Fire and Rescue Department has committed acts of infringement in this judicial district and division.

Background

7. The '536 Patent, entitled "Vehicle Lift System with Adaptive Wireless Communication," was duly and legally issued to Gray on October 29, 2019, by the United States Patent and Trademark Office. A copy of the '536 Patent is attached as Exhibit A.

8. Sefac USA Inc. offers for sale in the United States model SW3 wireless column lifts and posted a video link on the home page of its www.sefacusa.com website with the caption, "Last week, we were at Bobby's World to commission their new set of SW3 wireless lifts. Bobby, we thank you for your business and this funny video." A partial screenshot of that home page is reproduced below, with the link to the video appearing in the lower right corner:



9. Upon information and belief, the video depicts a set of the SW3 wireless column lifts being installed and operated in a service garage owned and operated by Ashburn Volunteer Fire and Rescue Department.

10. Upon information and belief, Ashburn Volunteer Fire and Rescue Department purchased the set of SW3 wireless column lifts from Sefac USA Inc. and is using those lifts in a wireless portable vehicle lifts system that directly infringes at least independent claims 1 and 11 and in methods that directly infringe at least independent claim 20 of the '536 Patent. A screenshot showing the SW3 wireless column lifts being used as a wireless portable vehicle lift system to lift a fire truck is reproduced below:

11. To illustrate infringement of the '536 Patent, Gray has attached hereto as Exhibit B a claim chart showing how a wireless portable vehicle lift system comprising the SW3 wireless column lifts and its methods of operation satisfy each of the claimed limitations of independent claims 1, 11 and 20 of the '536 Patent. The claim chart of Exhibit B is incorporated herein by reference in its entirety.

12. Ashburn Volunteer Fire and Rescue Department's activities described above are without authorization or license from Gray.

<u>Count I – Patent Infringement</u>

13. Gray incorporates by reference and re-alleges the allegations in Paragraphs 1-12, above, as if fully set forth herein.

14. Gray owns by assignment all right, title, and interest in and to the '536 Patent, including full rights to recover past and future damages thereunder.

15. Upon information and belief, Ashburn Volunteer Fire and Rescue Department has directly infringed one or more claims of the ‘536 Patent by using the SW3 wireless column lifts as a wireless portable vehicle lift system to lift fire trucks and other vehicles.

16. Gray has been, and continues to be, greatly damaged by reasons of these acts of infringement and, upon information and belief, Ashburn Volunteer Fire and Rescue Department will continue to infringe the ‘536 Patent.

17. Gray has suffered and will continue to suffer irreparable harm in its trade and business as a result of Ashburn Volunteer Fire and Rescue Department’s infringement of the ‘536 Patent, for which Gray is entitled to both preliminary and permanent injunctive relief pursuant to 35 U.S.C. § 283.

18. Gray has suffered and will continue to suffer monetary damages, in an amount not yet presently known, as a result of infringement of the ‘536 Patent.

19. Gray is entitled to monetary damages pursuant to 35 U.S.C. § 284 in an amount to be proven at trial.

Prayer for Relief

Based on the foregoing, Gray prays for judgment against Ashburn Volunteer Fire and Rescue Department as follows:

A. A finding that Ashburn Volunteer Fire and Rescue Department has directly infringed one or more claims of the ‘536 Patent under 35 U.S.C. § 271(a).

B. An order enjoining Ashburn Volunteer Fire and Rescue Department and its officers, directors, managers, members, employees, affiliates, agents, representatives, parents, subsidiaries, successors, and assigns; those in privity with them; and all others aiding, abetting, or acting in concert or active participation with them from:

(1) using, selling, and/or offering to sell in the United States any wireless portable vehicle lift system covered by the '536 Patent; or

(2) otherwise infringing the '536 Patent.

C. Compensatory damages under 35 U.S.C. § 284 in an amount adequate to compensate Gray for the infringement by Ashburn Volunteer Fire and Rescue Department.

D. Attorney fees under 35 U.S.C. § 285.

E. Pre- and post-judgment interest.

F. Costs of the action.

G. Such other and further relief as allowed at law or in equity that the Court deems just.

Jury Demand

Gray demands a trial by jury on all issues so triable.

October 29, 2019

Respectfully Submitted,

/s/ Siddhesh V. Pandit

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ATTORNEYS FOR PLAINTIFF

EXHIBIT A

US010457536B2

(12) **United States Patent**
Jaipaul et al.

(10) **Patent No.: US 10,457,536 B2**
(45) **Date of Patent: *Oct. 29, 2019**

(54) **VEHICLE LIFT SYSTEM WITH ADAPTIVE WIRELESS COMMUNICATION**

(71) Applicant: **Gray Manufacturing Company, Inc.**, St. Joseph, MO (US)

(72) Inventors: **Larry M. Jaipaul**, Clarence, NY (US); **John E. Fagan**, Norman, OK (US); **David Dwight Sandmann**, Oklahoma City, OK (US); **William R. Keck, Jr.**, Fillmore, MO (US); **Stephen J. Rucker**, Savannah, MO (US); **Ralph S. McKee**, St. Joseph, MO (US)

(73) Assignee: **Gray Manufacturing Company, Inc.**, St. Joseph, MO (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/284,775**

(22) Filed: **Feb. 25, 2019**

(65) **Prior Publication Data**

US 2019/0185305 A1 Jun. 20, 2019

Related U.S. Application Data

(63) Continuation of application No. 16/113,894, filed on Aug. 27, 2018, now Pat. No. 10,214,403, which is a

(Continued)

(51) **Int. Cl.**

B66F 7/10 (2006.01)
B66F 13/00 (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ***B66F 13/00*** (2013.01); ***B66F 3/46*** (2013.01); ***B66F 5/00*** (2013.01); ***B66F 7/10*** (2013.01); ***B66F 7/28*** (2013.01); ***H04B 7/24*** (2013.01)

(58) **Field of Classification Search**

CPC B66F 7/10; B66F 7/28; B66F 3/46; B66F 13/00; B66F 5/00; H04B 7/24

(Continued)

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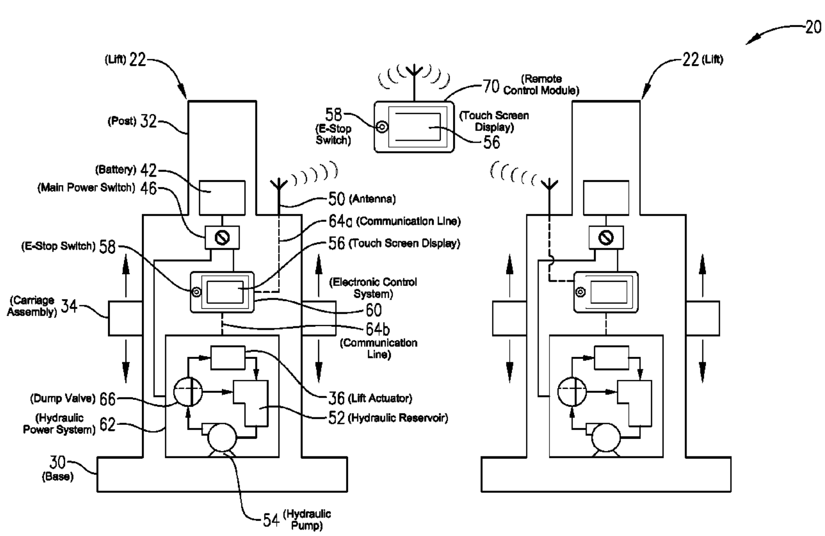
Primary Examiner — Anthony J Salata
(74) *Attorney, Agent, or Firm* — Hovey Williams LLP

(57) **ABSTRACT**

Wireless portable vehicle lift system incorporating one or more enhanced communication and/or control features. The lift system can incorporate enhanced wireless communication features such as the ability to automatically scan a plurality of communication channels, determine a clearest communication channel, and use the clearest communication channel for wireless communication.

30 Claims, 20 Drawing Sheets



Related U.S. Application Data

continuation of application No. 15/166,884, filed on May 27, 2016, now Pat. No. 10,059,576, which is a continuation of application No. 13/835,569, filed on Mar. 15, 2013, now Pat. No. 9,352,944.

(60) Provisional application No. 61/612,795, filed on Mar. 19, 2012, provisional application No. 61/697,406, filed on Sep. 6, 2012.

(51) **Int. Cl.**
B66F 7/28 (2006.01)
B66F 3/46 (2006.01)
B66F 5/00 (2006.01)
H04B 7/24 (2006.01)

(58) **Field of Classification Search**
USPC 187/203, 209, 210, 223, 227, 247, 285, 187/286, 290, 391, 392, 393
See application file for complete search history.

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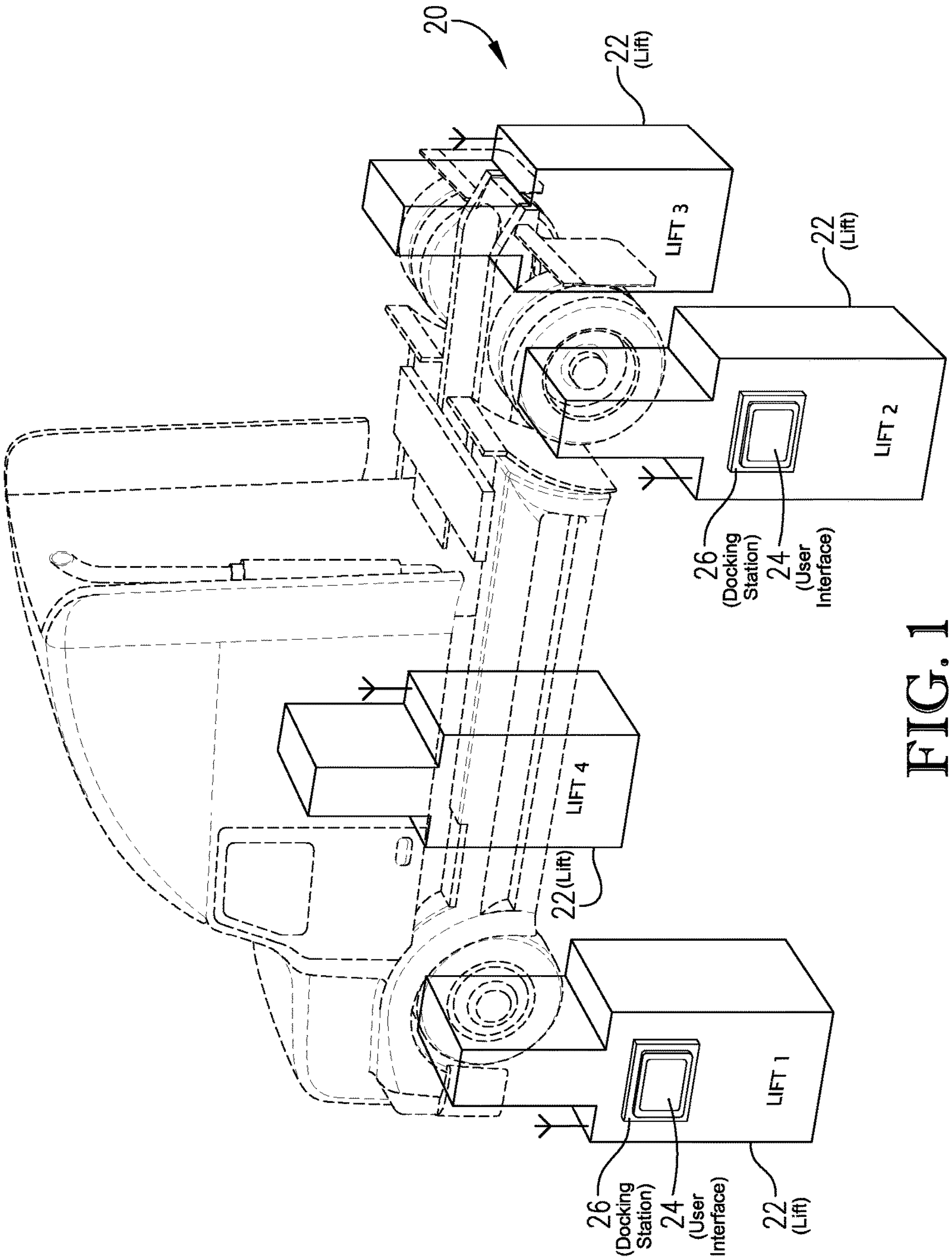

20
22 (Lift)
LIFT 3
22 (Lift)
LIFT 2
26 (Docking Station)
24 (User Interface)
LIFT 4
22 (Lift)
LIFT 1
26 (Docking Station)
24 (User Interface)
22 (Lift)

FIG. 1

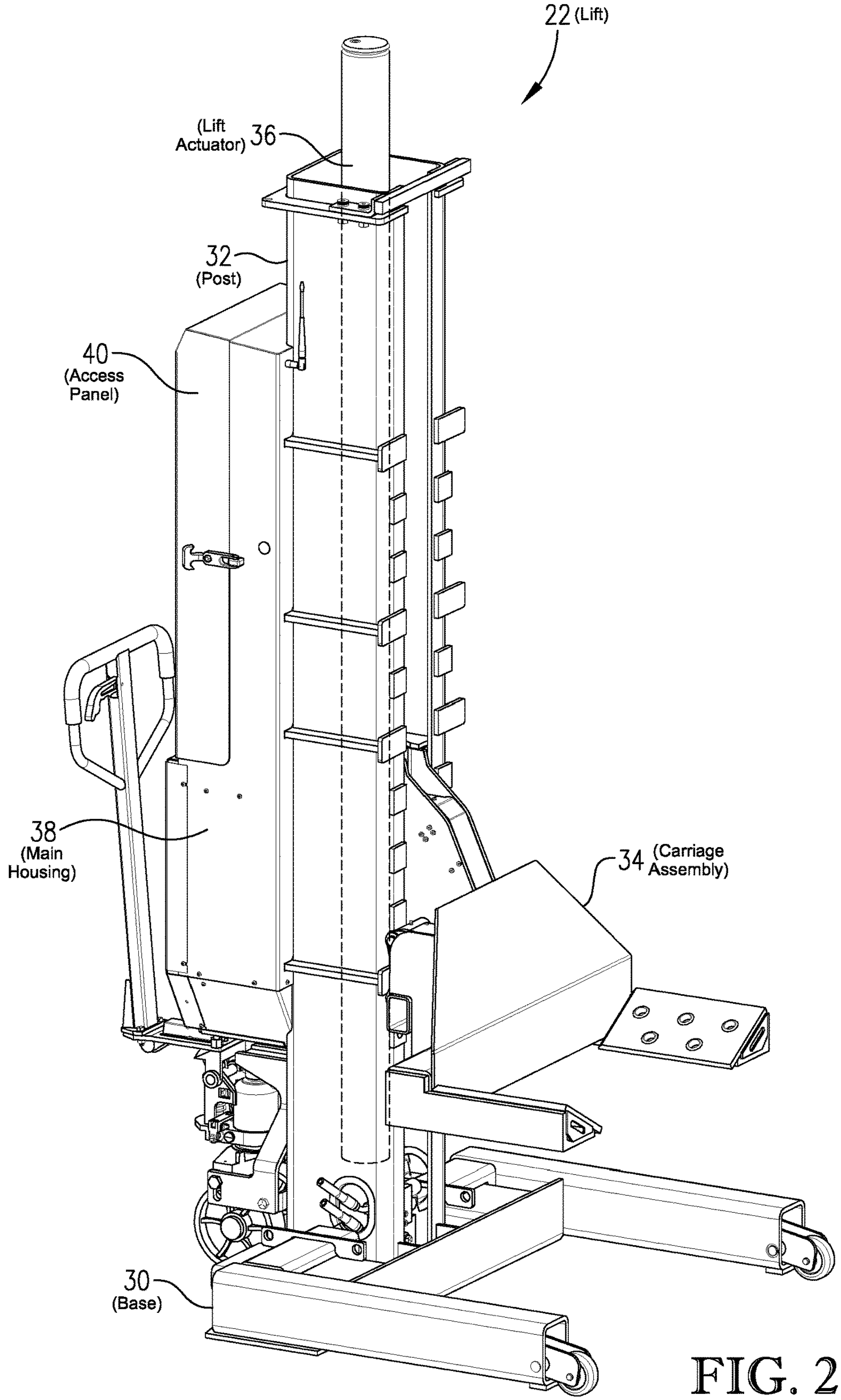
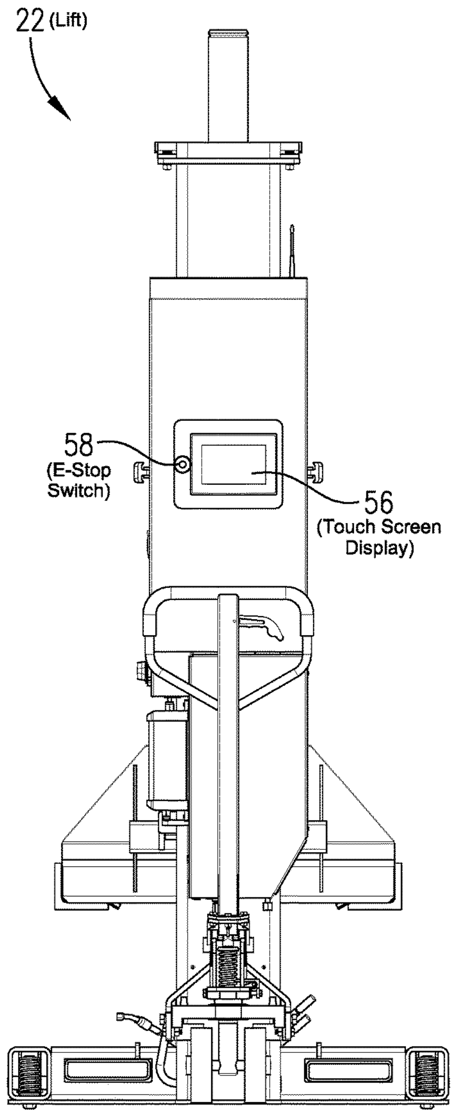
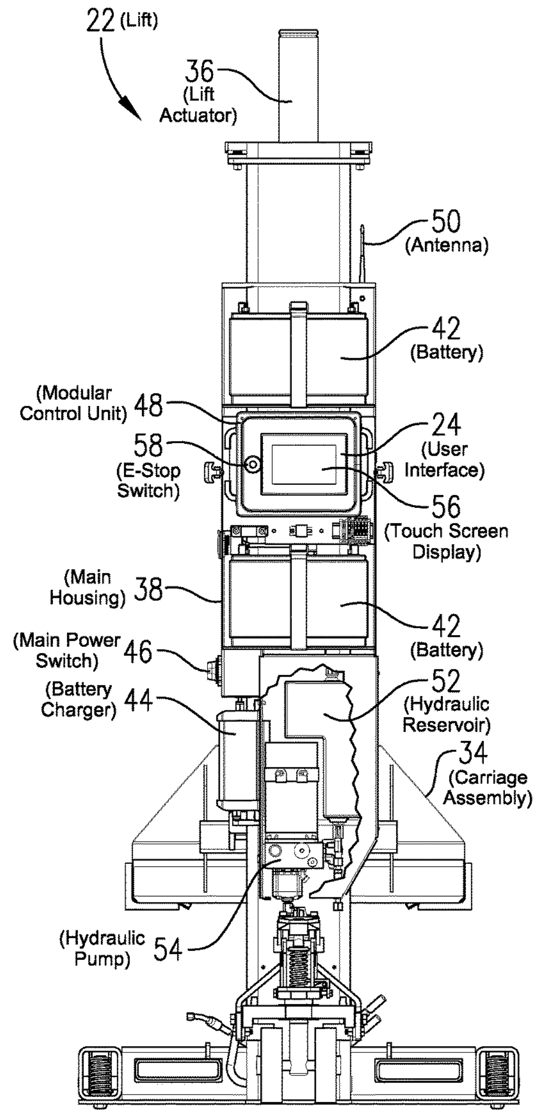

22 (Lift)
(Lift Actuator) 36
32 (Post)
40 (Access Panel)
38 (Main Housing)
34 (Carriage Assembly)
30 (Base)

FIG. 2



22 (Lift)
58
(E-Stop
Switch)
56
(Touch Screen
Display)

FIG. 3a



22 (Lift)
36
(Lift
Actuator)
50
(Antenna)
42
(Battery)
(Modular
Control Unit) 48
24
(User
Interface)
58
(E-Stop
Switch)
56
(Touch Screen
Display)
(Main
Housing) 38
42
(Battery)
(Main Power
Switch) 46
52
(Hydraulic
Reservoir)
(Battery
Charger) 44
34
(Carriage
Assembly)
(Hydraulic
Pump) 54

FIG. 3b

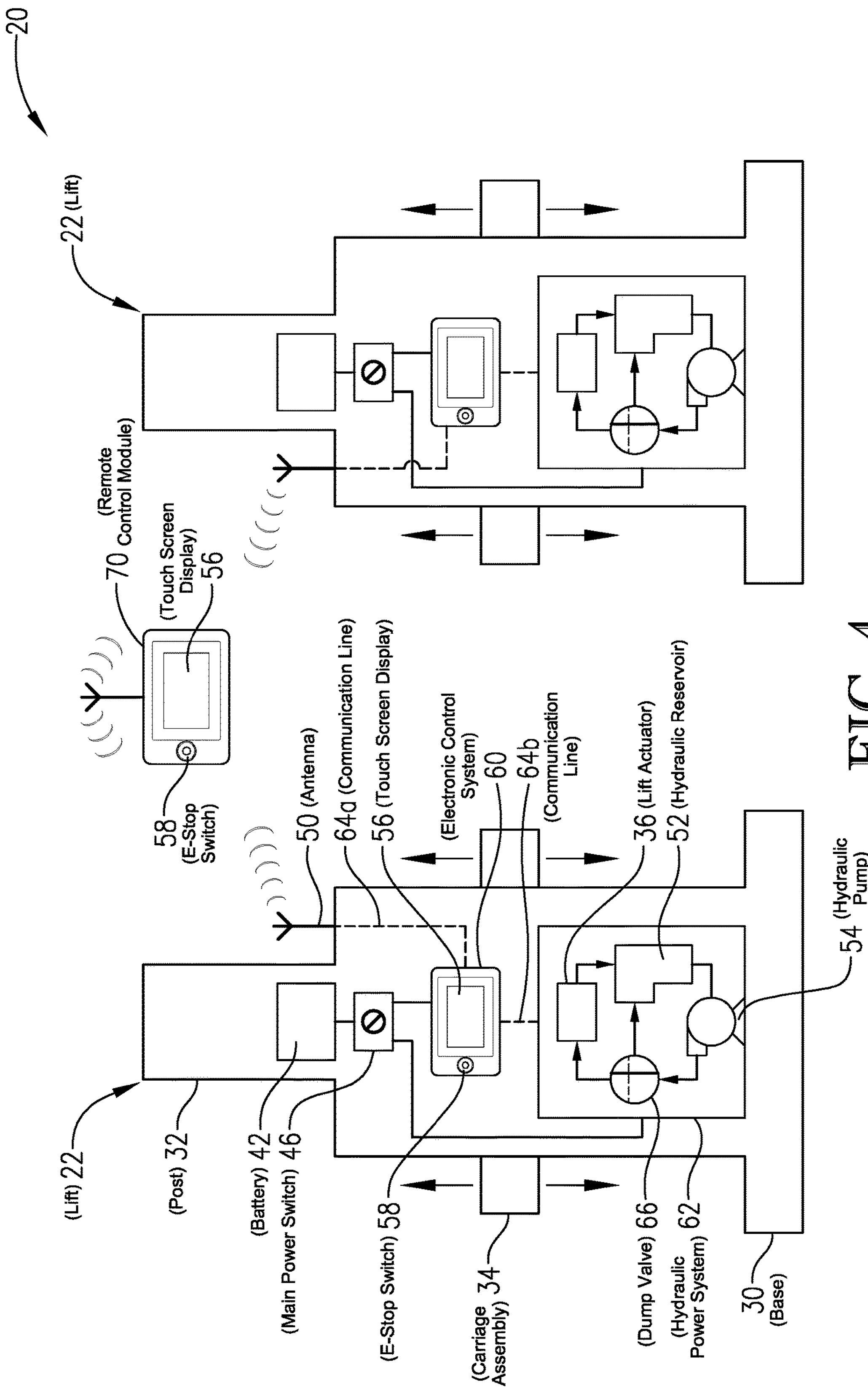

20
22 (Lift)
70 (Remote Control Module)
56 (Touch Screen Display)
58 (E-Stop Switch)
50 (Antenna)
64a (Communication Line)
56 (Touch Screen Display)
60 (Electronic Control System)
64b (Communication Line)
36 (Lift Actuator)
52 (Hydraulic Reservoir)
54 (Hydraulic Pump)
(Lift) 22
(Post) 32
(Battery) 42
(Main Power Switch) 46
(E-Stop Switch) 58
(Carriage Assembly) 34
(Dump Valve) 66
(Hydraulic Power System) 62
30 (Base)

FIG. 4

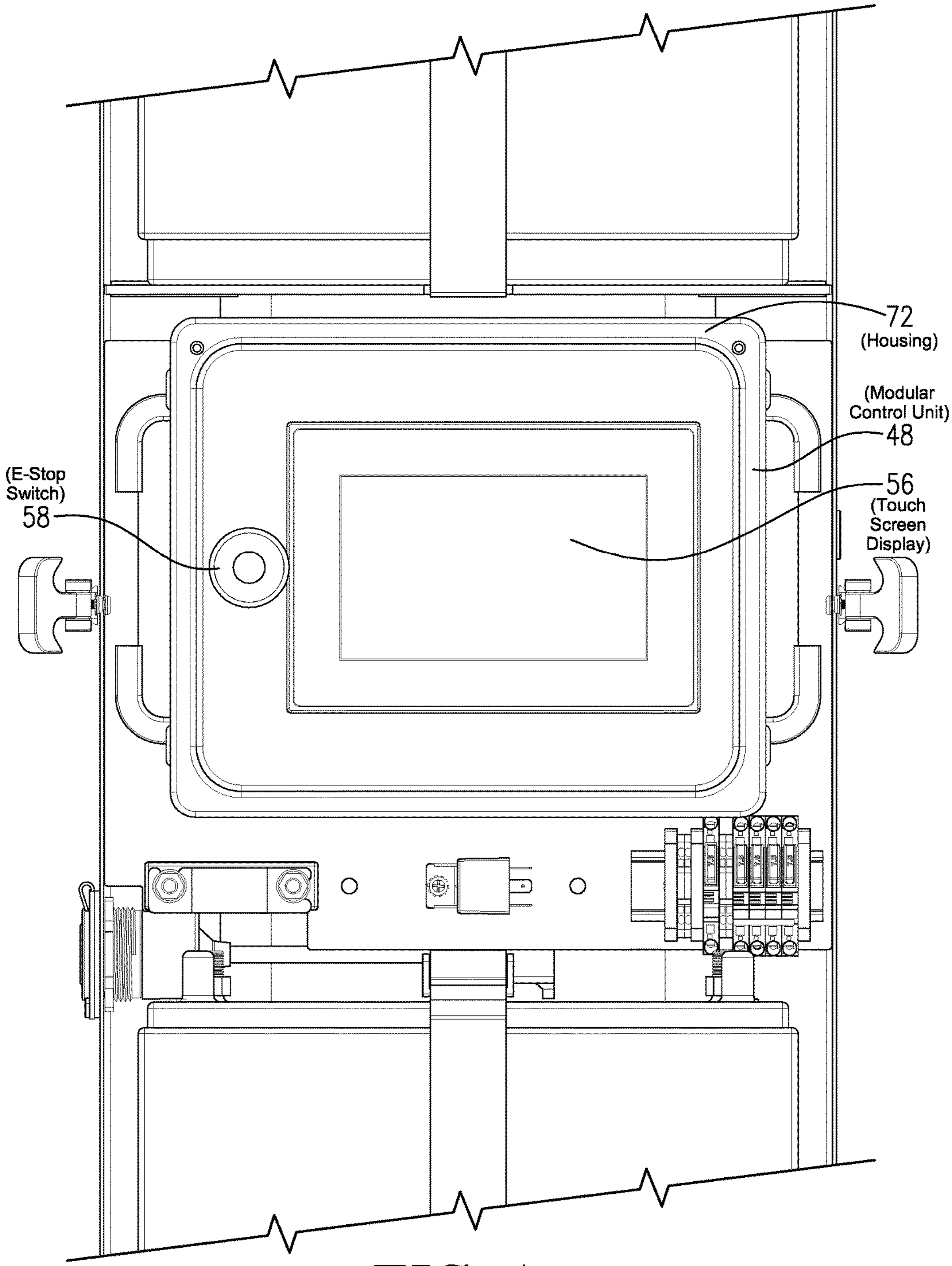

72
(Housing)
(Modular
Control Unit)
48
56
(Touch
Screen
Display)
(E-Stop
Switch)
58

FIG. 5a

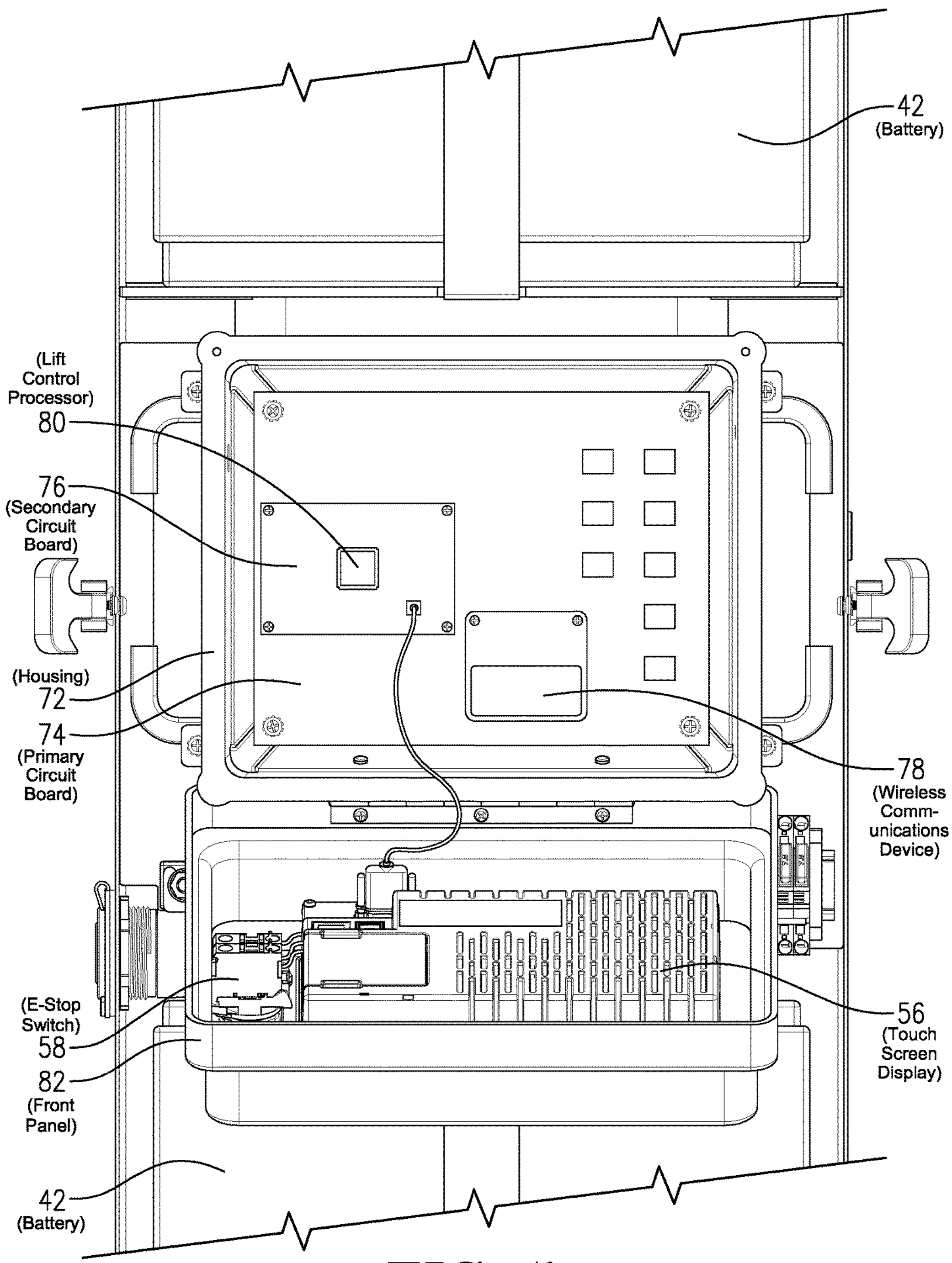

42
(Battery)
(Lift
Control
Processor)
80
76
(Secondary
Circuit
Board)
(Housing)
72
74
(Primary
Circuit
Board)
78
(Wireless
Comm-
unications
Device)
(E-Stop
Switch)
58
82
(Front
Panel)
56
(Touch
Screen
Display)
42
(Battery)

FIG. 5b

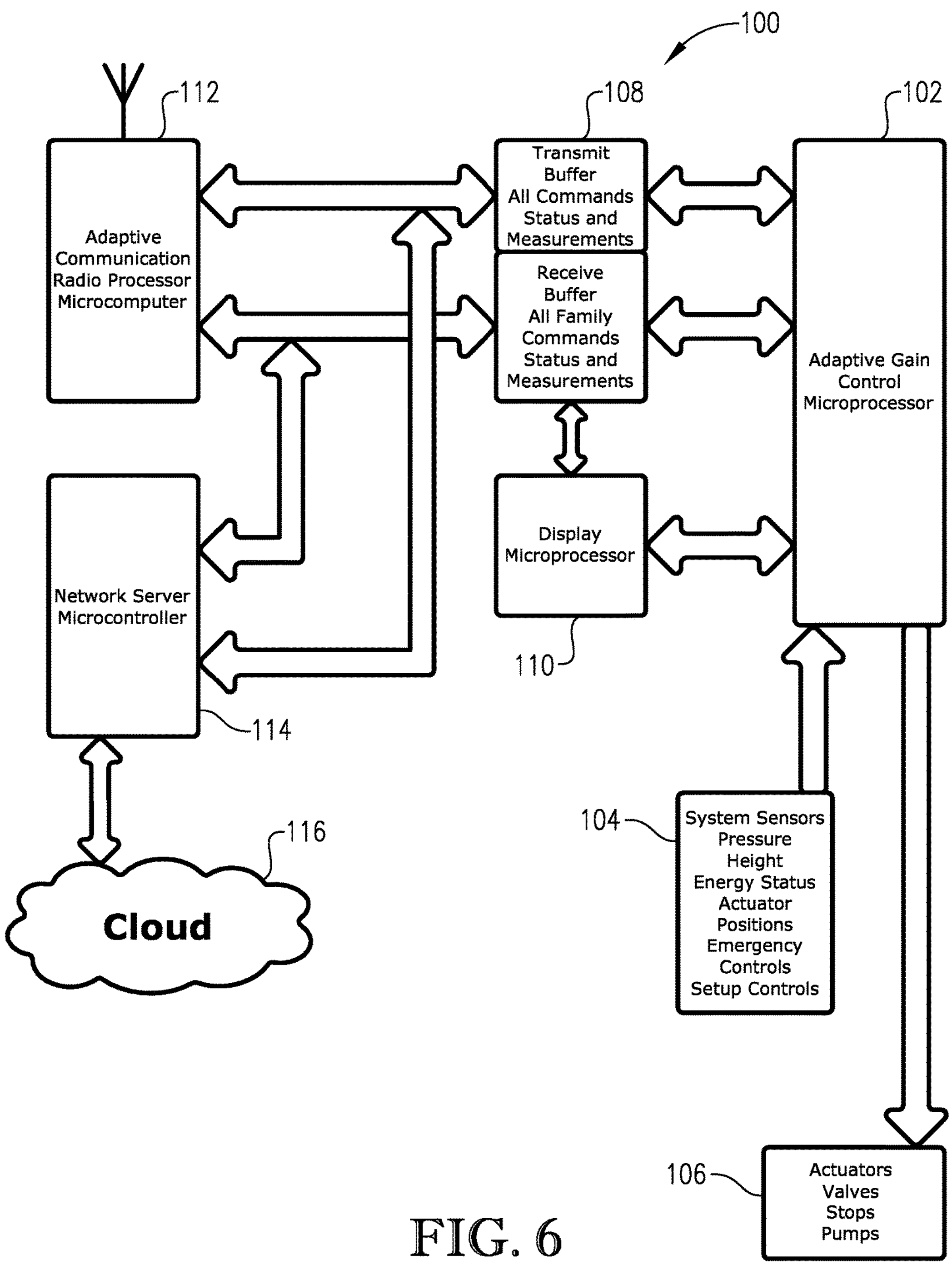

100
112
108
102
Adaptive Communication Radio Processor Microcomputer
Transmit Buffer All Commands Status and Measurements
Receive Buffer All Family Commands Status and Measurements
Adaptive Gain Control Microprocessor
Network Server Microcontroller
Display Microprocessor
110
114
104
System Sensors Pressure Height Energy Status Actuator Positions Emergency Controls Setup Controls
116
Cloud
106
Actuators Valves Stops Pumps

FIG. 6

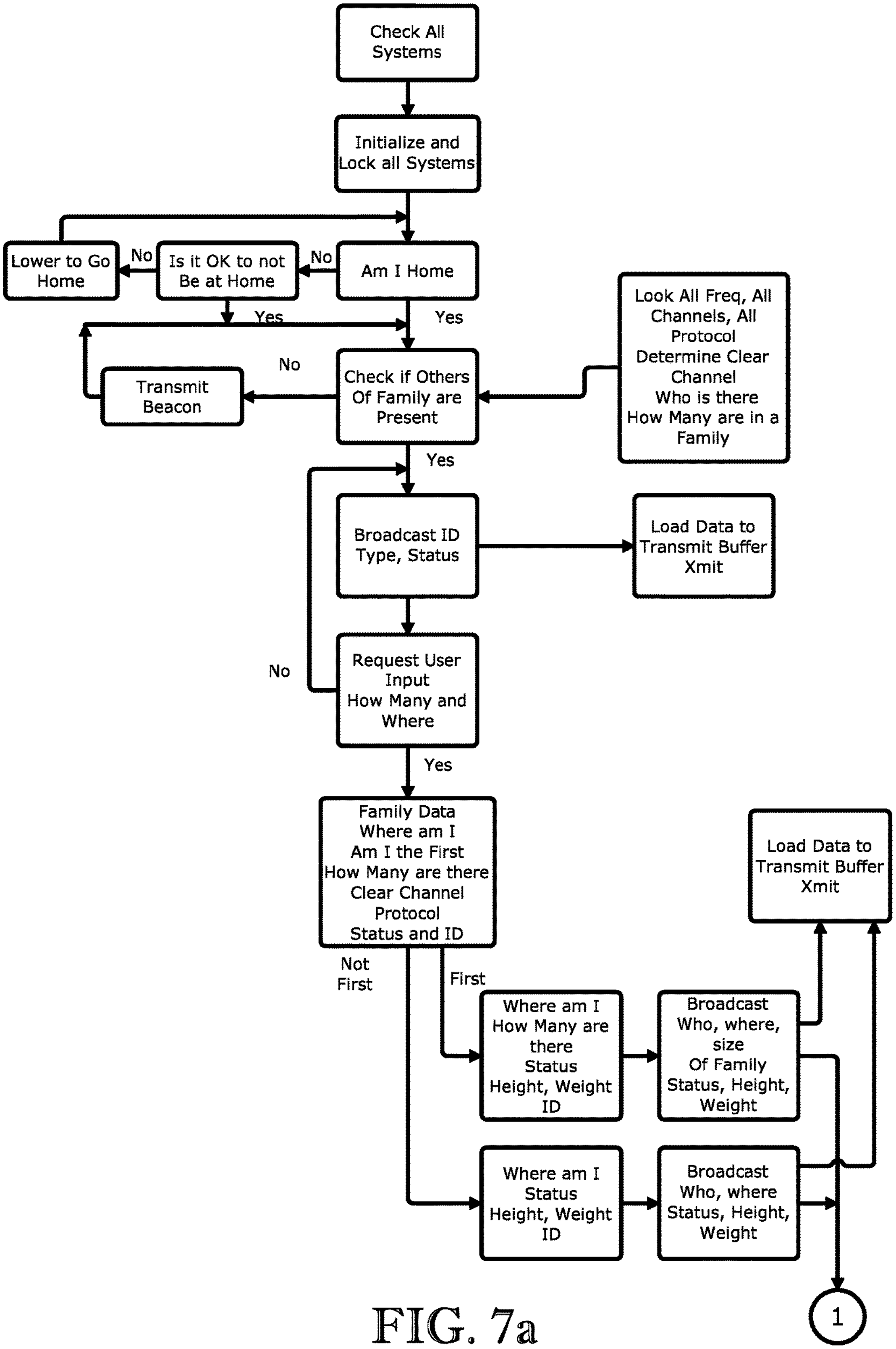

Check All Systems
Initialize and Lock all Systems
Lower to Go Home
No
Is it OK to not Be at Home
No
Am I Home
Yes
Yes
Look All Freq, All Channels, All Protocol Determine Clear Channel Who is there How Many are in a Family
No
Transmit Beacon
Check if Others Of Family are Present
Yes
Broadcast ID Type, Status
Load Data to Transmit Buffer Xmit
No
Request User Input How Many and Where
Yes
Family Data Where am I Am I the First How Many are there Clear Channel Protocol Status and ID
Load Data to Transmit Buffer Xmit
Not First
First
Where am I How Many are there Status Height, Weight ID
Broadcast Who, where, size Of Family Status, Height, Weight
Where am I Status Height, Weight ID
Broadcast Who, where Status, Height, Weight
1

FIG. 7a

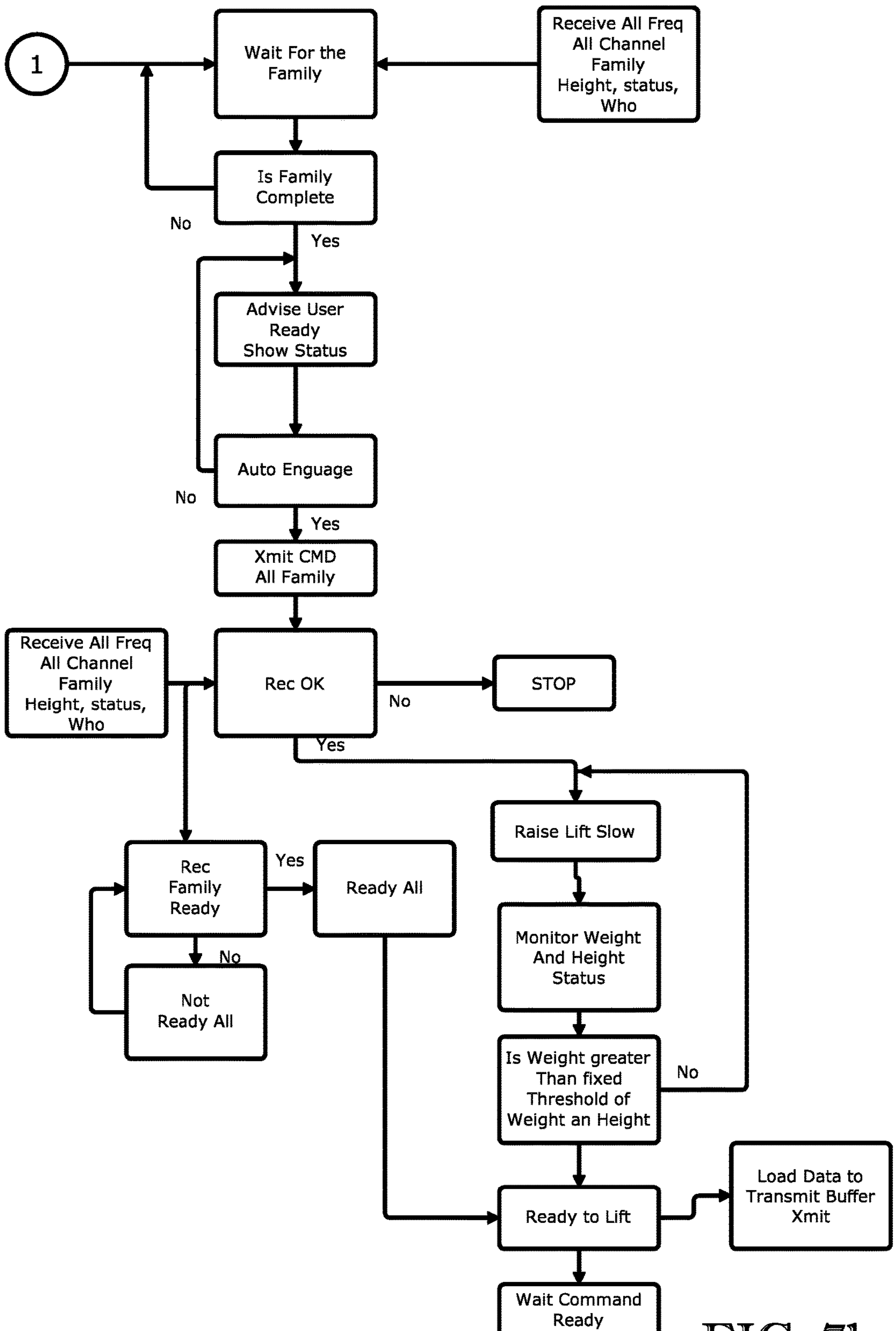

1
Wait For the Family
Receive All Freq All Channel Family Height, status, Who
Is Family Complete
No
Yes
Advise User Ready Show Status
Auto Enguage
No
Yes
Xmit CMD All Family
Receive All Freq All Channel Family Height, status, Who
Rec OK
No
STOP
Yes
Raise Lift Slow
Rec Family Ready
Yes
Ready All
No
Not Ready All
Monitor Weight And Height Status
Is Weight greater Than fixed Threshold of Weight an Height
No
Ready to Lift
Load Data to Transmit Buffer Xmit
Wait Command Ready

FIG. 7b

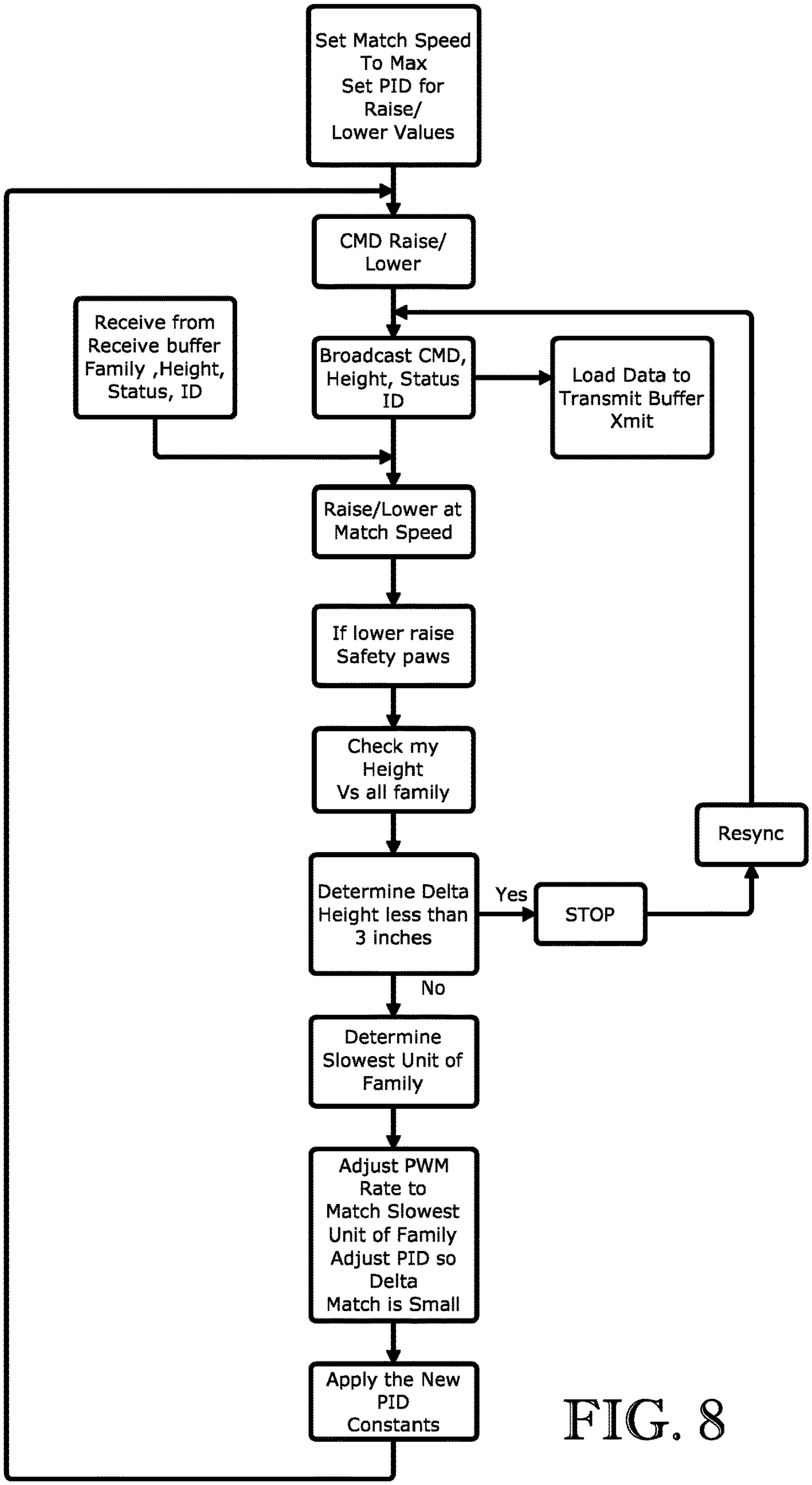

Set Match Speed
To Max
Set PID for
Raise/
Lower Values
CMD Raise/
Lower
Receive from
Receive buffer
Family ,Height,
Status, ID
Broadcast CMD,
Height, Status
ID
Load Data to
Transmit Buffer
Xmit
Raise/Lower at
Match Speed
If lower raise
Safety paws
Check my
Height
Vs all family
Resync
Determine Delta
Height less than
3 inches
Yes
STOP
No
Determine
Slowest Unit of
Family
Adjust PWM
Rate to
Match Slowest
Unit of Family
Adjust PID so
Delta
Match is Small
Apply the New
PID
Constants

FIG. 8

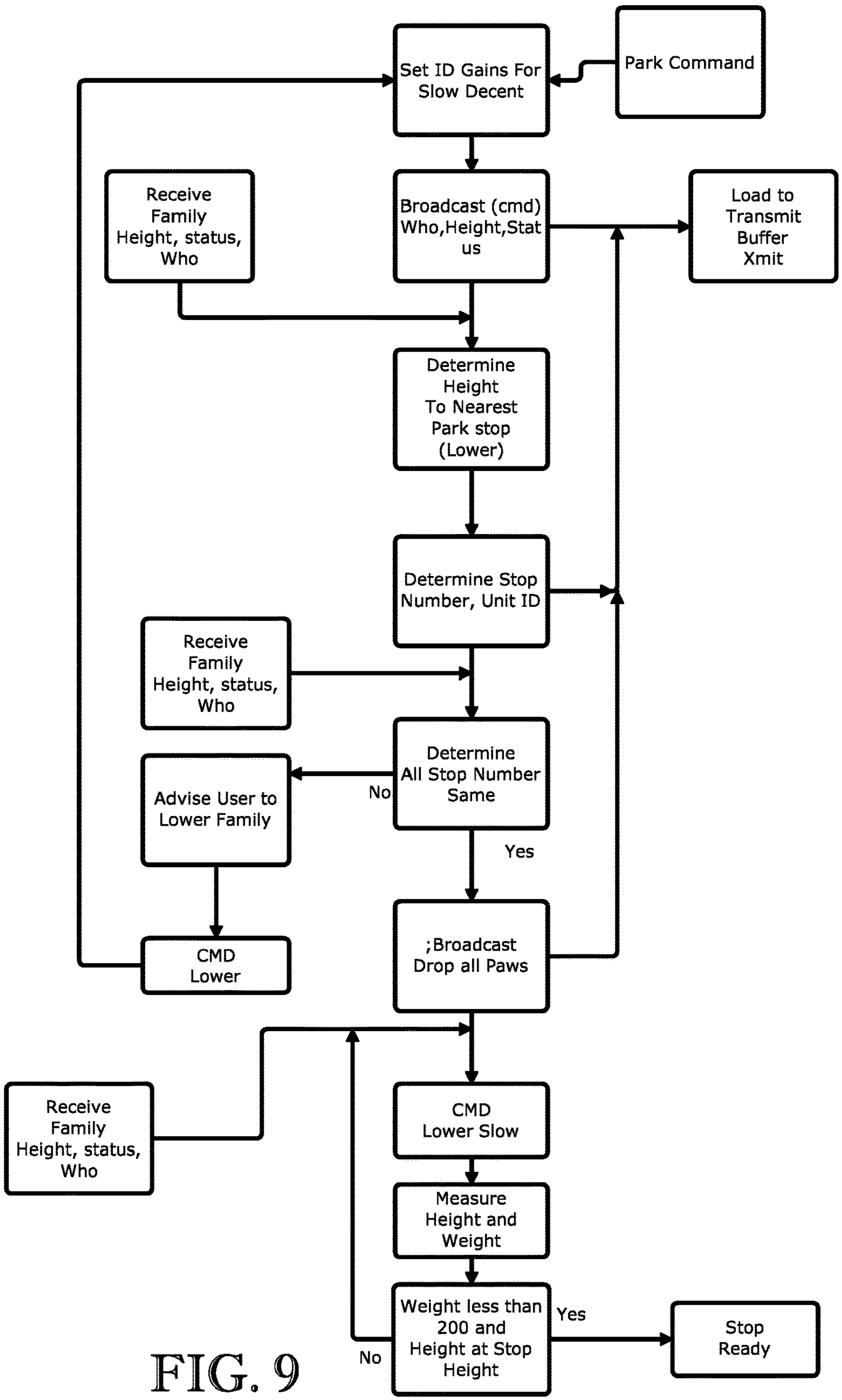

Set ID Gains For Slow Decent
Park Command
Receive Family Height, status, Who
Broadcast (cmd) Who,Height,Status
Load to Transmit Buffer Xmit
Determine Height To Nearest Park stop (Lower)
Determine Stop Number, Unit ID
Receive Family Height, status, Who
Determine All Stop Number Same
No
Advise User to Lower Family
Yes
CMD Lower
;Broadcast Drop all Paws
Receive Family Height, status, Who
CMD Lower Slow
Measure Height and Weight
Weight less than 200 and Height at Stop Height
Yes
No
Stop Ready

FIG. 9

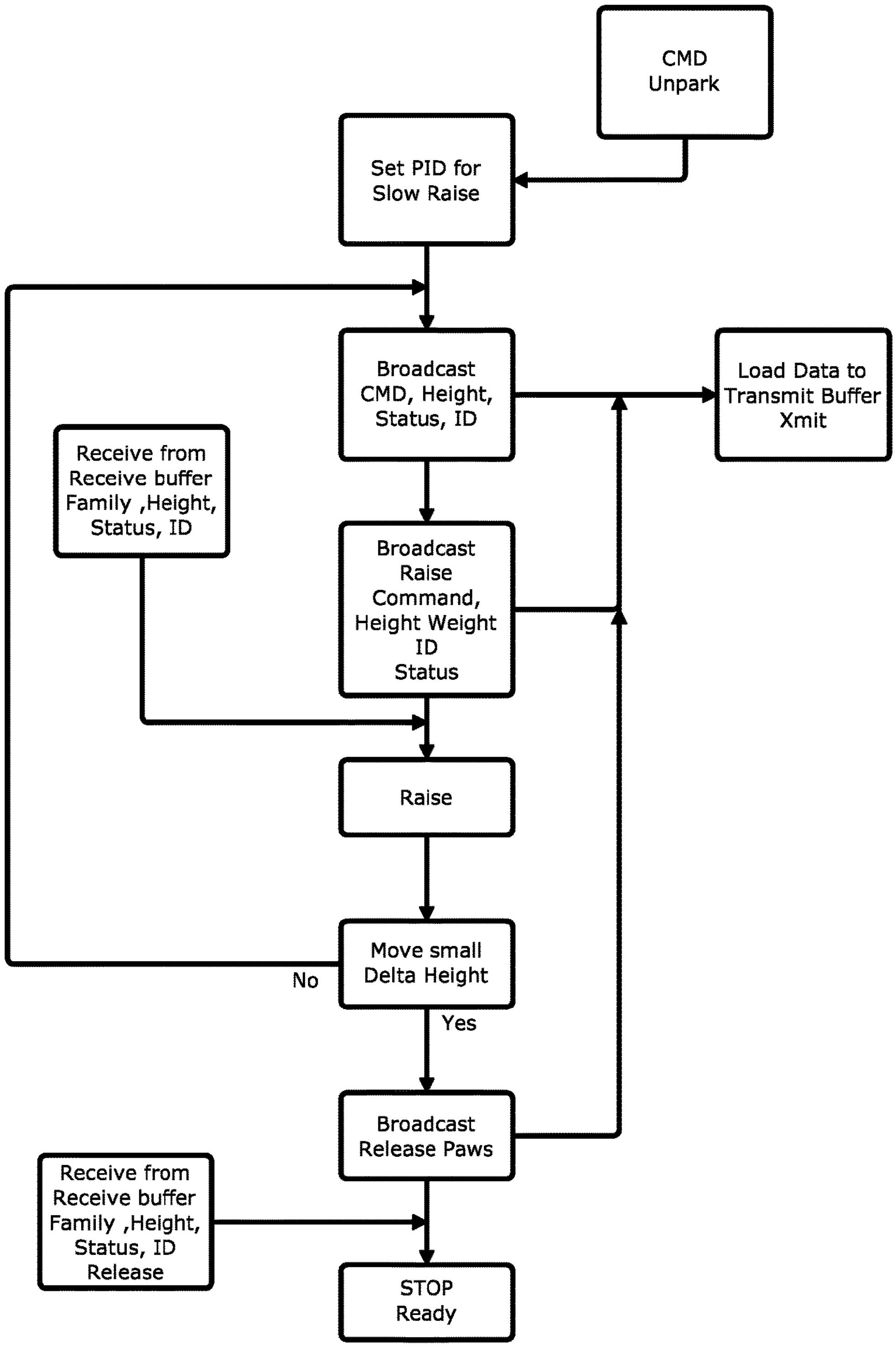

CMD
Unpark
Set PID for
Slow Raise
Broadcast
CMD, Height,
Status, ID
Load Data to
Transmit Buffer
Xmit
Receive from
Receive buffer
Family ,Height,
Status, ID
Broadcast
Raise
Command,
Height Weight
ID
Status
Raise
Move small
Delta Height
No
Yes
Broadcast
Release Paws
Receive from
Receive buffer
Family ,Height,
Status, ID
Release
STOP
Ready

FIG. 10

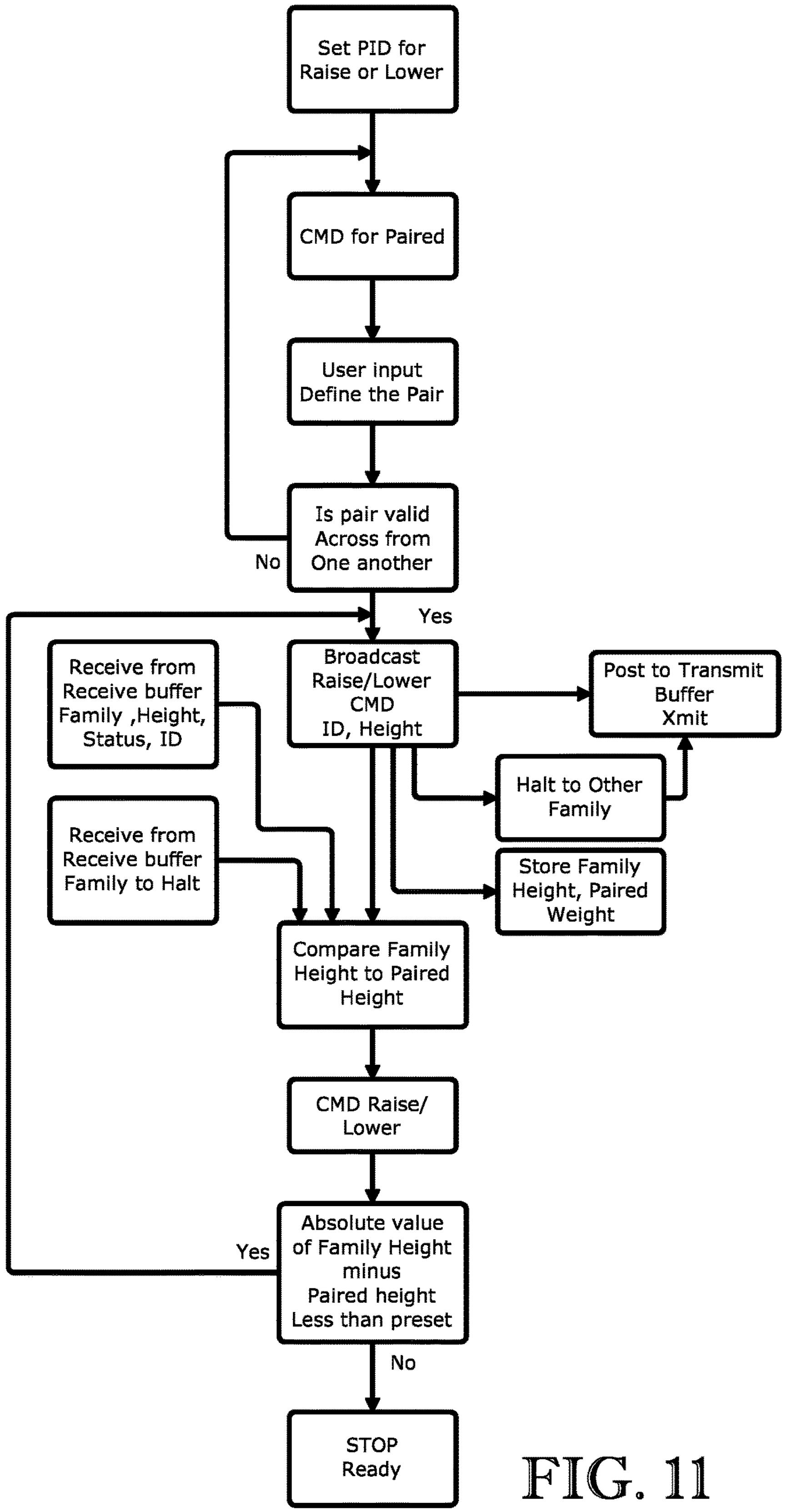

Set PID for Raise or Lower
CMD for Paired
User input Define the Pair
Is pair valid Across from One another
No
Yes
Receive from Receive buffer Family ,Height, Status, ID
Broadcast Raise/Lower CMD ID, Height
Post to Transmit Buffer Xmit
Halt to Other Family
Receive from Receive buffer Family to Halt
Store Family Height, Paired Weight
Compare Family Height to Paired Height
CMD Raise/ Lower
Absolute value of Family Height minus Paired height Less than preset
Yes
No
STOP Ready

FIG. 11

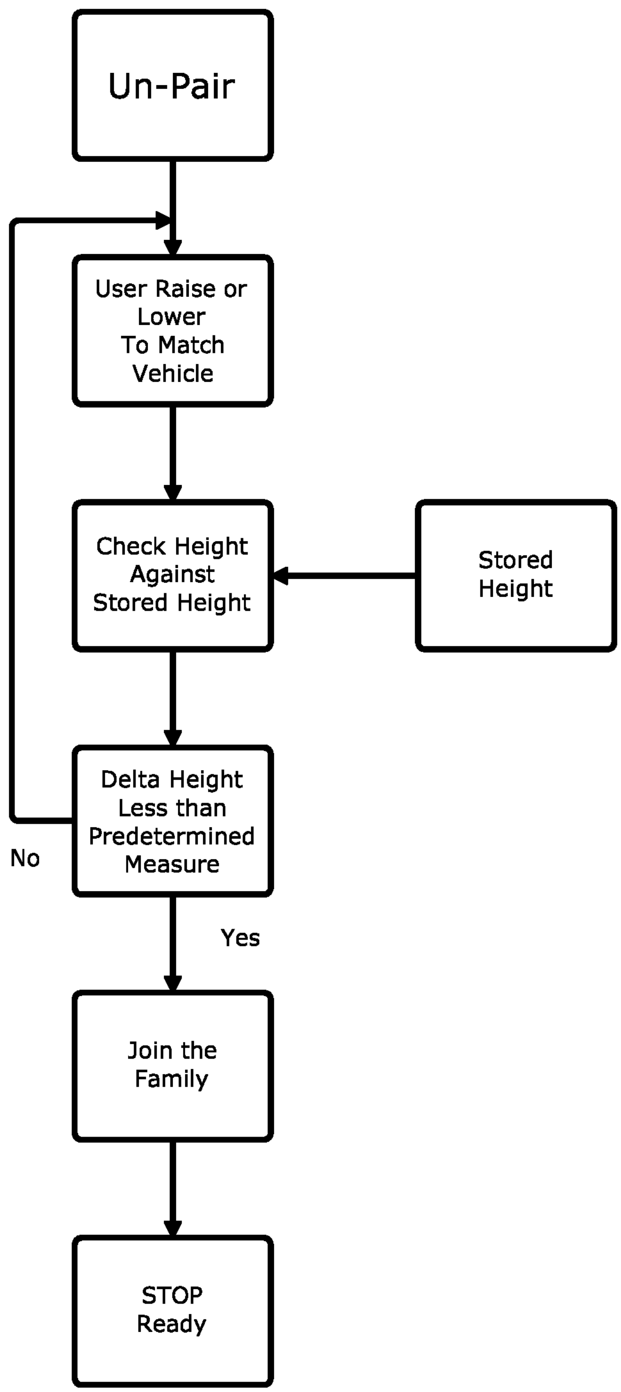

Un-Pair
User Raise or Lower To Match Vehicle
Check Height Against Stored Height
Stored Height
Delta Height Less than Predetermined Measure
No
Yes
Join the Family
STOP Ready

FIG. 12

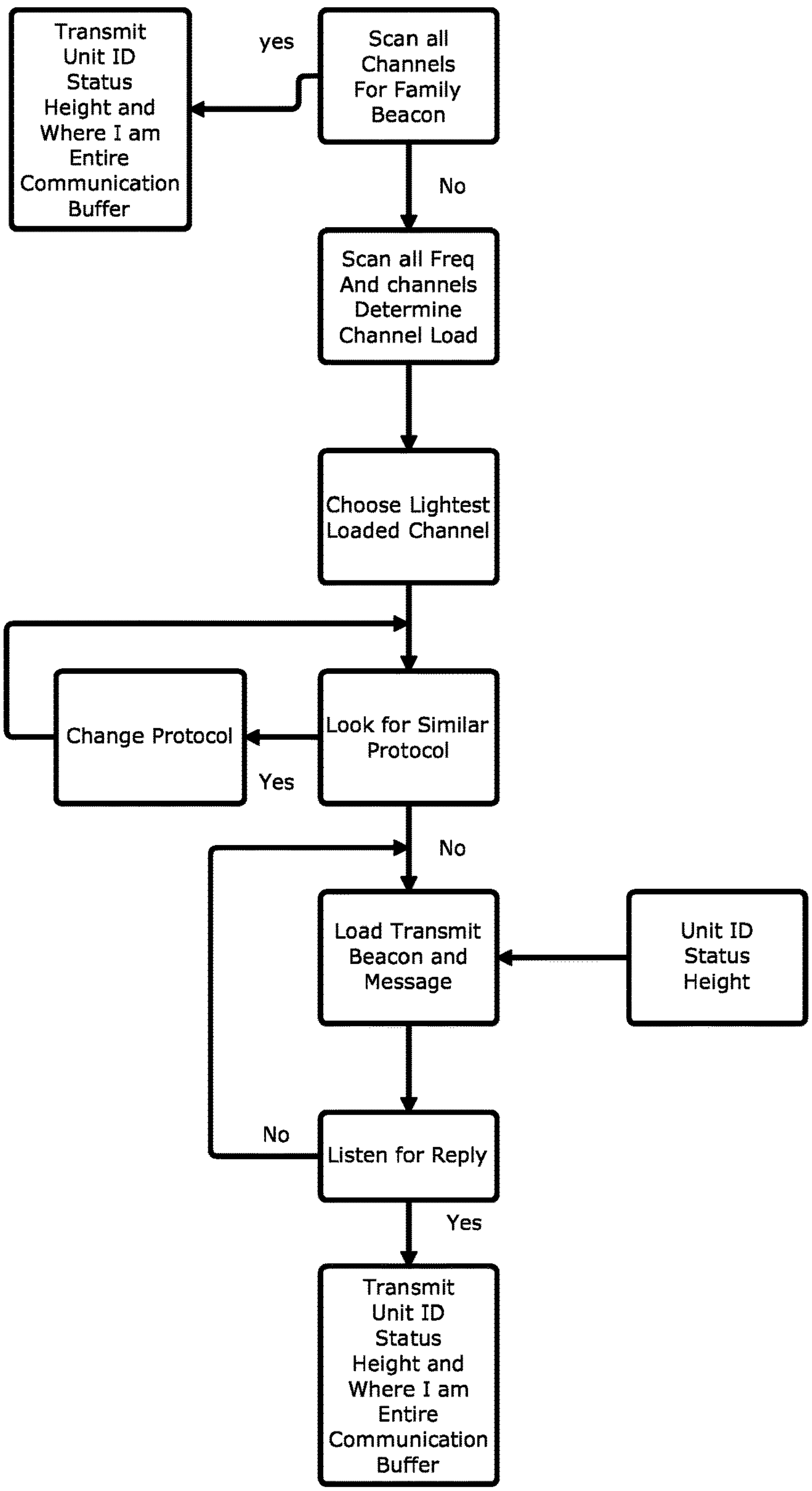

Transmit Unit ID Status Height and Where I am Entire Communication Buffer
yes
Scan all Channels For Family Beacon
No
Scan all Freq And channels Determine Channel Load
Choose Lightest Loaded Channel
Change Protocol
Yes
Look for Similar Protocol
No
Load Transmit Beacon and Message
Unit ID Status Height
No
Listen for Reply
Yes
Transmit Unit ID Status Height and Where I am Entire Communication Buffer

FIG. 13

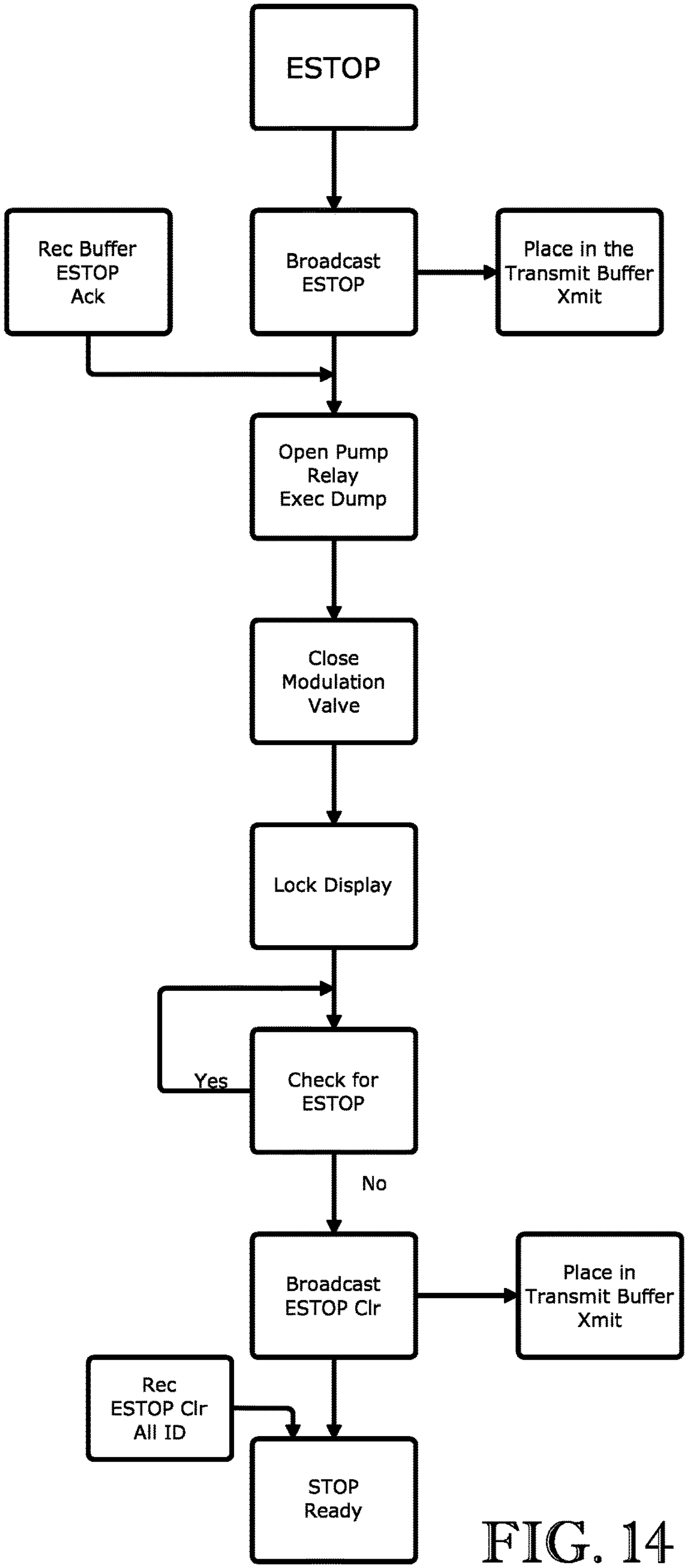

ESTOP
Rec Buffer
ESTOP
Ack
Broadcast
ESTOP
Place in the
Transmit Buffer
Xmit
Open Pump
Relay
Exec Dump
Close
Modulation
Valve
Lock Display
Yes
Check for
ESTOP
No
Broadcast
ESTOP Clr
Place in
Transmit Buffer
Xmit
Rec
ESTOP Clr
All ID
STOP
Ready

FIG. 14

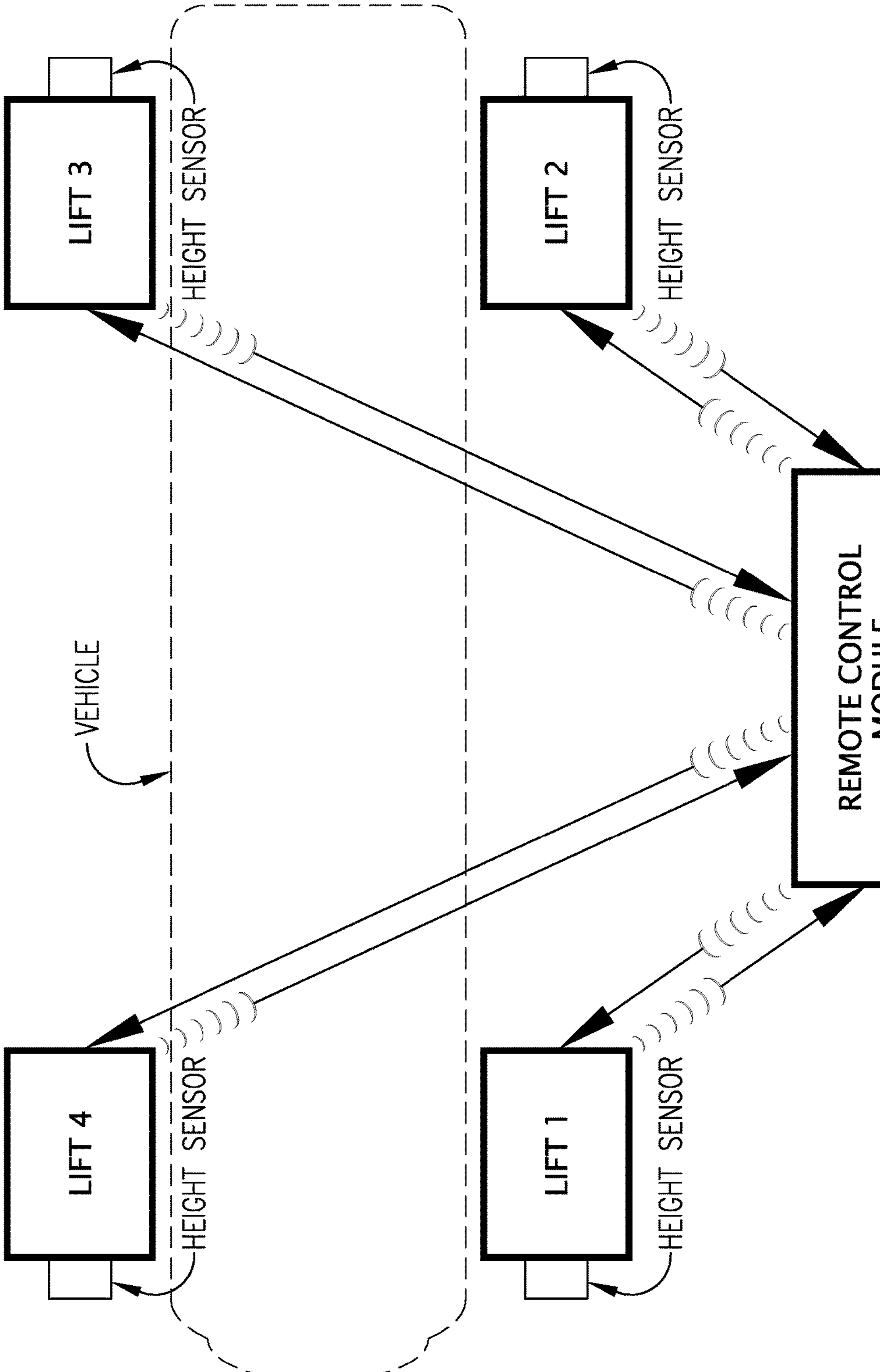

LIFT 3
HEIGHT SENSOR
LIFT 2
HEIGHT SENSOR
VEHICLE
REMOTE CONTROL MODULE
LIFT 4
HEIGHT SENSOR
LIFT 1
HEIGHT SENSOR

FIG. 15

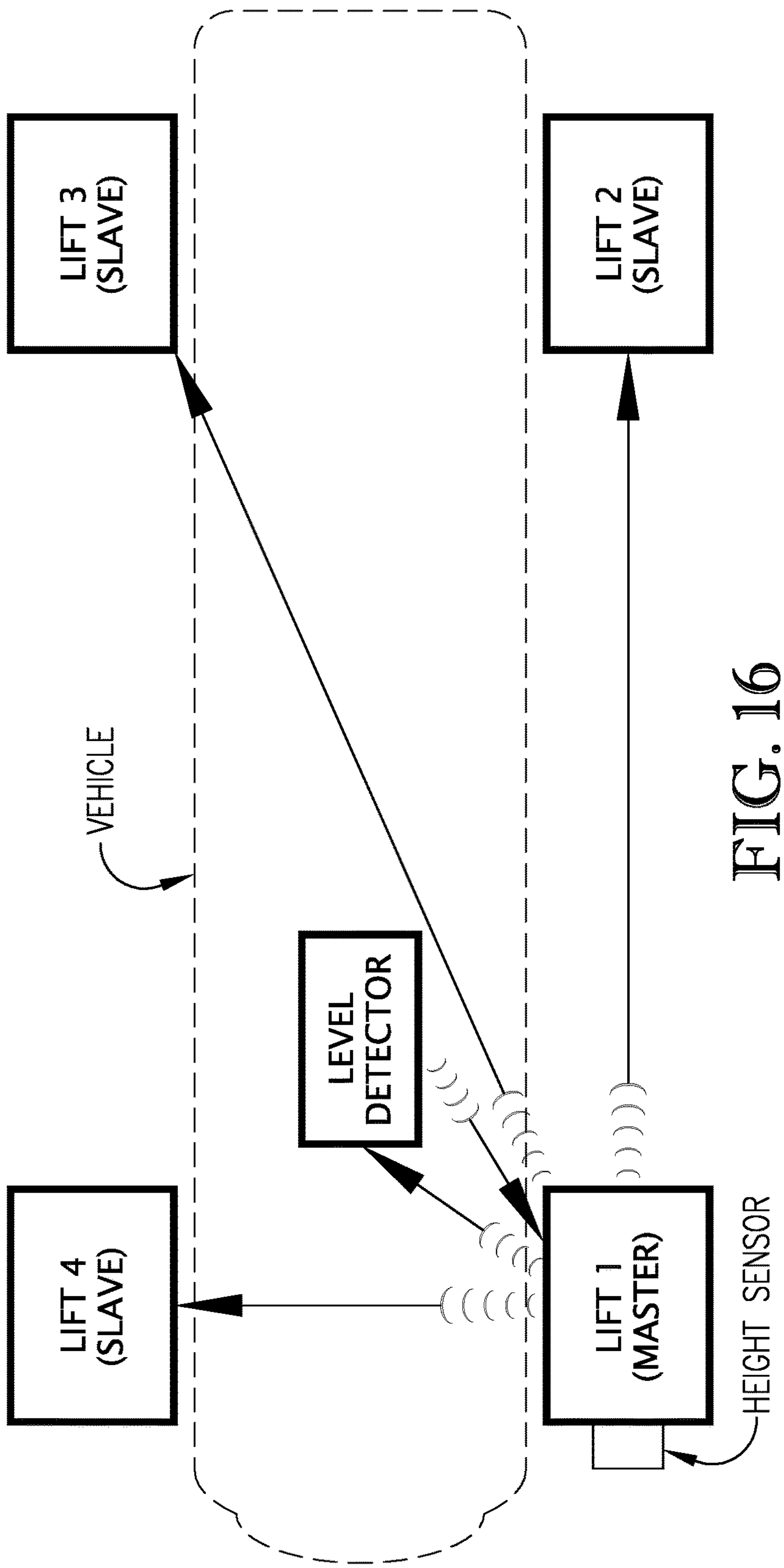

LIFT 3 (SLAVE)
LIFT 2 (SLAVE)
VEHICLE
LEVEL DETECTOR
LIFT 4 (SLAVE)
LIFT 1 (MASTER)
HEIGHT SENSOR

FIG. 16

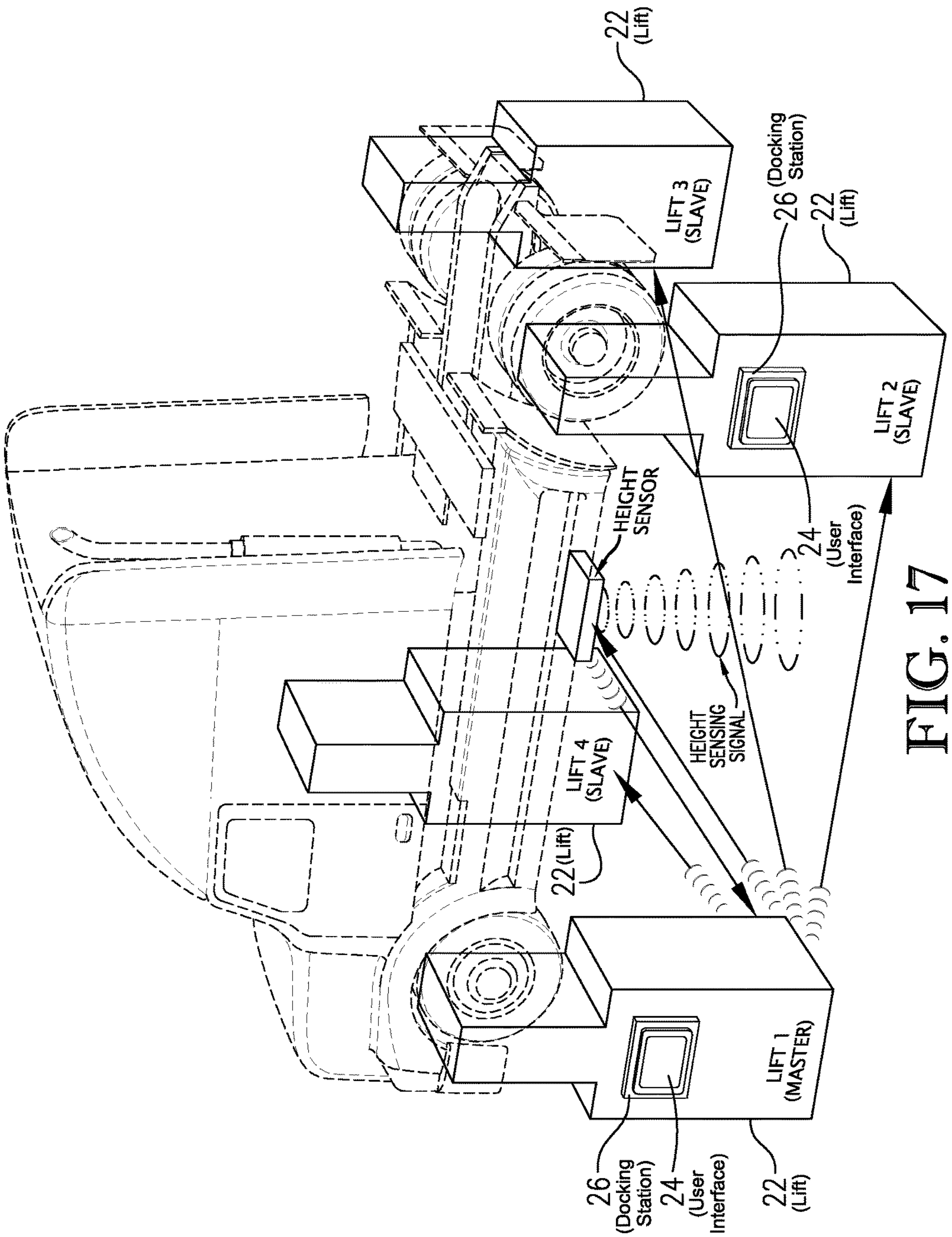

22 (Lift)
LIFT 3 (SLAVE)
26 (Docking Station)
22 (Lift)
LIFT 2 (SLAVE)
24 (User Interface)
HEIGHT SENSOR
HEIGHT SENSING SIGNAL
LIFT 4 (SLAVE)
22 (Lift)
LIFT 1 (MASTER)
26 (Docking Station)
24 (User Interface)
22 (Lift)

FIG. 17

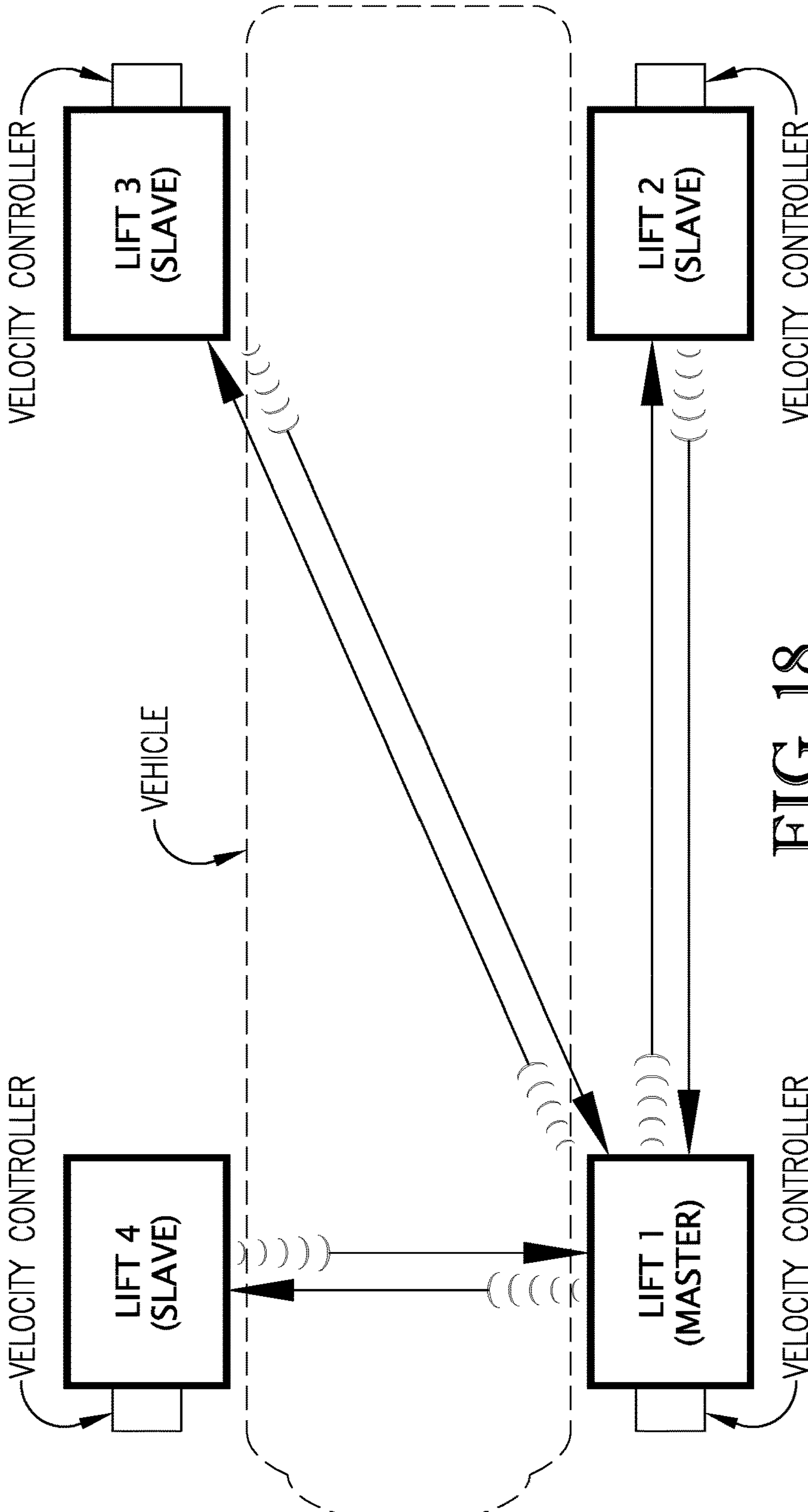

VELOCITY CONTROLLER
LIFT 3 (SLAVE)
LIFT 2 (SLAVE)
VELOCITY CONTROLLER
VEHICLE
VELOCITY CONTROLLER
LIFT 4 (SLAVE)
LIFT 1 (MASTER)
VELOCITY CONTROLLER

FIG. 18

VEHICLE LIFT SYSTEM WITH ADAPTIVE WIRELESS COMMUNICATION

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to and is a continuation of U.S. patent application Ser. No. 16/113,894, filed Aug. 27, 2018, which claims priority to and is a continuation of U.S. patent application Ser. No. 15/166,884, filed May 27, 2016, which claims priority to and is a continuation of U.S. patent application Ser. No. 13/835,569, filed Mar. 15, 2013, which claims priority to U.S. Provisional Patent Application Ser. No. 61/697,406, filed Sep. 6, 2012, and U.S. Provisional Patent Application Ser. No. 61/612,795, filed Mar. 19, 2012. The entire disclosures of all these patent applications are incorporated herein by reference to the extent they do not contradict statements contained herein.

BACKGROUND

1. Field of the Invention

The present invention relates generally to portable vehicle lifts. More particularly, the invention concerns wireless portable vehicle lift systems.

2. Description of the Prior Art

The need to lift a vehicle from the ground for service work is well established. For instance, it is often necessary to lift a vehicle for tire rotation or replacement, steering alignment, oil changes, brake inspections, exhaust work, and other automotive maintenance. Traditionally, lifting a vehicle has been accomplished through the use of equipment that is built-into the service facility, such as either lift units with the hydraulic actuator(s) installed below the surface of the floor or two and four post type lift systems installed on the floor surface. These built-in units are located at a fixed location at the service facility and adapted to engage the vehicle frame to lift the vehicle from the ground. However, built-in units tend to be relatively expensive and are sometimes not as useful as they might otherwise be due to their immobility.

In an effort to increase the versatility and mobility of lift devices and reduce the need to invest in permanently mounted lifting equipment, devices commonly known as a mobile column lifts (MCL's) have been developed. Traditional MCL's use a number connecting lines or wires to provide electrical power and/or communication of the MCL's. The lines or wires that are connected between the MCL's allow the vehicle to be raised or lowered in a coordinated synchronous fashion. However, the lines and wires used to connect the MCL's extend across and are looped within the working area. The presence of these wires and lines in the work area poses a hazard to people working near the vehicle, and the connecting lines may be damaged by vehicles driving over them.

An apparatus for lifting a vehicle using multiple MCL's is described in U.S. Pat. No. 6,634,461, the entire disclosure of which is incorporated herein by reference. The lifting devices disclosed in the '461 patent are coordinated by wireless signals, such as radio frequency (RF) signals, and powered by rechargeable batteries in each lift unit. By these means, the lifting devices of the '461 patent eliminate the need for both power cables and control cables.

Although the lifts system disclosed in the '461 patent represented a significant advancement in the field of portable

vehicle lifts, efforts to improve lift safety, reliability, efficiency, ease of operation, and cost effectiveness continue.

SUMMARY OF THE INVENTION

In one embodiment of the present invention, there is provided a wireless mobile column lift system comprising at least two portable lifts and an electronic control system for controlling the lift system. Each of the lifts includes (a) a base for supporting the lift on a floor or the ground; (b) a post rigidly coupled to the base and extending upwardly therefrom; (c) a carriage assembly configured to engage a wheel of a vehicle, wherein the carriage assembly is coupled to said post and configured for vertical shifting relative to the post; (d) a lift actuator for raising and lowering said carriage assembly relative to the post; and (e) one or more batteries configured to provide power for the lift. The electronic control system includes a wireless communication system configured to provide wireless communication among the lifts in the lift system and a user interface associated with each of the lifts. The user interface on each of the lifts comprises a touch screen display. The wireless communication system is configured to automatically scan communication frequencies and select a frequency with minimal noise. The electronic control system is configured to provide continuous wireless communication between each of the lifts and every other one of the lifts in the lift system. The user interface further comprises one or more function buttons separate from the touch screen display. The electronic control system is configured to permit all of the lifts to be controlled via a single user interface located on one of the lifts. The touch screen display is configured to display a real time animation of the position of the lifts during lifting and lowering. The touch screen display is configured to display the height of each of the lifts in the lift system, the weight supported by the lifts, and the battery status of the lift. The electronic control system is configured to track and/or store lift data relevant to safety, maintenance, and/or proper operation of the lift system. The electronic control system is configured to provide a notification of maintenance needs base on the lift data.

In another embodiment of the present invention, there is provided a wireless mobile column lift system comprising at least two portable lifts and an electronic control system for controlling the lift system. Each of the lifts includes (a) a base for supporting the lift on a floor or the ground; (b) a post rigidly coupled to the base and extending upwardly therefrom; (c) a carriage assembly configured to engage a wheel of a vehicle, wherein the carriage assembly is coupled to the post and configured for vertical shifting relative to the post; (d) a lift actuator for raising and lowering the carriage assembly relative to the post; and (e) one or more batteries configured to provide power for the lift. The electronic control system includes a wireless communication system configured to provide wireless communication among the lifts in the lift system and a user interface associated with each of the lifts. The user interface on each of the lifts comprises a touch screen display. The wireless communication system is configured to automatically scan communication frequencies on a continual basis and automatically adjust one or more wireless communication parameters based on the scan of communication frequencies. The electronic control system is configured such that each lift is capable of tracking its own actions and the actions of all other lifts in the lift system. The touch screen display is configured to prompt the operator of the lift system to enter a pass code prior to operating the lift system. The electronic control system is configured to access a database containing one or more stored authorized pass codes. The electronic control system is configured to render the lift system inoperable if the pass code entered by the operator does not match one of the authorized stored pass codes stored in said database. The user interface further comprises one or more function buttons separate from the touch screen display. The electronic control system is programmed so that movement of the lifts requires operator input from at least one of the function buttons. The user interface comprises an emergency stop button separate from the touch screen display. The electronic control system is configured to permit all of said lifts to be controlled via a single user interface located on one of the lifts. Each of the lifts in the lift system is substantially identical. The touch screen display is configured to display a real time animation of the position of the lifts during lifting and lowering, the height of one or more of the lifts in the lift system, the weight supported by one or more of the lifts in the lift system, and the battery status of one or more of the lifts in the lift system. The electronic control system is configured to provide a notification of maintenance needs. The electronic control system is configured to permit paired operation of a selected pair of the lifts. Each of the lifts comprises a mechanical load holding device and the touch screen display is configured to display information about the mechanical load holding devices.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a simplified representation of a wireless portable lift system utilizing four individual lifts to perform a coordinated lift of a vehicle, where one or more of the lifts is equipped with a user interface that is readily detachable from the lift;

FIG. **2** is a perspective view showing the front and side of a wireless portable lift configured in accordance with certain embodiments of the present invention;

FIG. **3***a* is a back elevation view of the wireless portable lift of FIG. **1**;

FIG. **3***b* is a back elevation view of the wireless portable lift of FIG. **1**, with certain portions of the main housing being remove or cut away to show individual components of the lift's electrical supply system, electronic control system, and hydraulic power system;

FIG. **4** is a simplified representation of a wireless portable lift system, showing the major components of an emergency stop system configured in accordance with certain embodiments of the present invention;

FIG. **5***a* is an enlarged view of the modular control unit of the wireless portable vehicle lift shown in FIG. **3***b*, where the housing of the modular control unit is closed to protect its internal components;

FIG. **5***b* shows the modular control unit of FIG. **5***a* with the housing opened to provided access to the internal components;

FIG. **6** is a schematic diagram of the main components of an electronic control system for a wireless portable lift system configured in accordance with certain embodiments of the present invention;

FIG. **7***a* is sheet one of a two-part a flow diagram for an overall method of operating a wireless portable lift system;

FIG. **7***b* is sheet two of the two-part flow diagram (started in FIG. **6***a*) for an overall method of operating a wireless portable lift system;

FIG. **8** is a flow diagram showing steps involved in operating a wireless portable lift system to raise and lower a vehicle;

FIG. **9** is a flow diagram showing steps involved in parking a wireless portable lift system;

FIG. **10** is a flow diagram showing steps involved in un-parking a wireless portable lift system;

FIG. **11** is a flow diagram showing steps involved in operating a wireless portable lift system in a paired mode;

FIG. **12** is a flow diagram showing steps involved in un-pairing a wireless portable lift system;

FIG. **13** is a flow diagram showing steps involved in operating an adaptive communication system of a wireless portable lift system;

FIG. **14** is a flow diagram showing the steps involved in executing an emergency stop for a wireless portable lift system;

FIG. **15** is a simplified representation of a wireless portable lift system employing a remote control module for wirelessly communication with individual lifts of the system;

FIG. **16** is a simplified representation of a wireless portable lift system employing a level detector that can be attached to the vehicle and can communicate vehicle level information to one or more of the lifts;

FIG. **17** is a simplified representation of a wireless portable lift system employing a height detector that can be attached to the vehicle and can communicate vehicle height information to one or more of the lifts; and

FIG. **18** is a simplified representation of a wireless portable lift system employing lift velocity controllers at each lift to ensure that the lifted vehicle remains substantially level during lifting.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which may be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriately detailed structure.

Referring now to the drawings in detail, and initially to FIG. **1**, numeral **20** generally designates a wireless portable vehicle lift system having four individual lifts **22**. Although FIG. **1** depicts a four lift system, it should be understood that any combination of two or more lifts can be used. For example, the lift system **20** can employ two, four, six, or eight individual lifts **22**. In certain embodiments, each of the portable lifts **22** is substantially identical. It should also be understood that lift system **20** is not limited for use with vehicles, but also may be used to raise or lower other objects relative to a floor or ground surface, such as aircraft, industrial machinery, shipping containers, construction subassemblies, and the like.

The wireless portable vehicle lift system **20** depicted in FIG. **1** can be equipped with an electronic control system that controls the lifts **22** in response to operator commands. The electronic control system can include a wireless communication system that wirelessly communicates lift control signals to, from, and/or among the lifts **22**.

As shown in FIG. **1**, of the individual lifts **22** of the lift system **20** can be equipped with a user interface **24** that, after initial set-up of the lift system **20**, permits the entire lift system to be controlled via a single user interface **24**. As discussed in detail below, the user interface **24** can include a touch screen display that enables enhanced operating features of the lift system **20**. For example, when the user interface **24** includes a touch screen display, the touch screen display can be programmed to display a real time animation of the lift positions and/or the vehicle position as the vehicle is lifted and/or lowered by the lift system **20**.

In certain embodiments of the present invention, the user interface **24** can include a remote control module that can be readily detached from the lift **22** and used to wirelessly control the lift system **20**, while the lift operator stands away from the lift system **20**. The remote control module can have a touch screen display incorporated therein. When the user interface **24** includes a remote control module, each lift **22** can be equipped with a docking station **26** that allows the remote control module to be removably attached to the lift **22**. The docking station **26** can be configured to allow for easy physical connection and disconnection of the remote control module to and from the lift **22**. Further, the docking station **26** can be configured to allow for easy electrical connection and disconnection of the remote control module to and from the lift **22**. The electrical connection between the remote control module and the lift **22** can permit wired communication between the remote control module and the lift **22** when the remote control module is received in the docking station. Thus, the remote control module can be used to control the lift system **20** whether it is attached to or detached from the lift **22**. The lift **22** can be equipped with a charger for charging a battery of the remote control module when the remote control module is received on the docking station **26**.

In certain embodiments, the user interface **24** can employ a remote control module equipped with wireless communication capability and multimedia functionality. Examples of such remote control modules include portable electronic devices such as notebook computers, tablet computers, PDAs, and smart phones. In certain embodiments, both the remote control module and each lift **22** can be capable of independently accessing the internet, so that the remote control module can control the lift system **20** via the internet.

When the remote control module has both wireless communication capability and multimedia functionality, the remote control module can be used to not only wirelessly control the lifts **22**, but also to contact the lift manufacture or service provider for technical support and/or training. The wireless communication between the remote control module and the lift manufacture or service provider can be accomplished via satellite, the internet and/or via a cellular phone network.

To facilitate communication between the operator of the lift system **20** and the entity providing technical support or training, the remote control module can be equipped with a camera, a microphone, and/or a keyboard. The camera can be a still camera or a video camera that allows the operator of the lift system **20** to transmit images or video of the lift system **20** and/or the environment around the lift system to the entity providing technical support or training. The microphone allows the operator of the lift system **20** to verbally communicate with personnel at the technical support or training entity using the remote control module. When the remote control module is equipped with a video camera and a microphone, technical support and/or training can be facilitated via video conference. The keyboard on the remote control module can permit communication between the operator of the lift system **20** and the technical support or training entity via textual messaging. In certain embodiment, the user interface **24** can also include a voice activated command module.

When the lift system **20** is equipped with wireless internet capability (via a remote control module or otherwise), technical support or training can be greatly enhanced. In addition to the technical support and training features described above, support can also be provided in the form of remote diagnostics, remote troubleshooting of lift problems, and remote tracking and/or storing of lift information. Lift information tracked and/or stored can included any lift data that may be relevant to the safety, maintenance, and/or proper operation of the lift system **20**. This lift data can be regularly gathered and stored for use in diagnosing lift problems, notifying lift owners of maintenance needs, and/or warning lift owners of improper lift operation.

In certain embodiments of the present invention, the electronic control system comprises a distributed wireless server network configured to collect operational and maintenance data about the lift system. The distributed wireless server network can be capable of being remotely accessed by owners, operators, and/or manufactures of the lift so as to provide real time data to remote parties. Such real time data can include operational status, lift operational data, and/or lift diagnostics data.

Turning now to FIGS. **2**, **3***a*, and **3***b*, a wireless portable lift **22** configured in accordance with one embodiment of the present invention is illustrated. The lift **22** can include a base **30**, a post **32**, a carriage assembly **34**, a lift actuator **36**, and a main housing **38**. The base **30** supports the lift on the floor or the ground. The post **32** is rigidly coupled to the base **30** and extends upwardly therefrom. The carriage assembly **34** is configured to engage the wheel of a vehicle and is vertically shiftable relative to the post **32**. The lift actuator **36** is received in the post **32** and is operable to vertically raise and lower the carriage assembly **34** relative to the post **32** and the base **30**. The main housing **38** is attached to the post **32** and encloses many of the components of that make up the control and power systems of the lift **22**. The main housing **38** includes a removable access panel **40** for providing access to various components of the control and power systems.

FIG. **3***b* provides a view of the back of the lift **22** with the access panel **40** being removed to show certain internal components located in the upper portion of the main housing **38**. In FIG. **3***b*, a lower portion of the main housing **38** is also cut away to show certain internal components located in the lower portion of the main housing **38**.

The lift **22** generally includes an electrical power supply, an electronic control system, and a hydraulic power system. More specifically, FIG. **3***b* shows that the electrical power supply system of the lift **22** can include two rechargeable batteries **42**, a battery charger **44**, and a main power switch **46**; the electronic control system of the lift **22** can include a modular control unit **48** and an antenna **50**; and the hydraulic power system of the lift **22** can include a hydraulic reservoir **52** and a hydraulic pump **54**. Many other components of the power supply system, electronic control system, and hydraulic power system of the lift **22** are not shown in detail in FIG. **3***b*, but will be described in greater detail below. FIG. **3***b* shows that the modular control unit **48** includes a user interface **24** that includes a touch screen display **56** and an emergency stop (E-stop) switch **58**.

FIG. **4** provides a simplified representation of a wireless portable lift system **20**, where each lift **22** is equipped with an enhanced E-stop system. As shown in FIG. **4**, each lift can include a base **30**, a post **32**, a carriage assembly **34**, a power source (e.g., battery **42**), a main power switch **46**, an electronic control system **60**, and a hydraulic power system **62** for vertically shifting the carriage assembly **34** relative to the post **32**. The electronic control system **60** can be used to control the hydraulic power system **62**. The electronic control system **60** can include a touch screen display **56**, an E-stop switch **58**, an antenna **50**, and communication lines **64***a, b*. The hydraulic power system **62** can include a hydraulic reservoir **52**, a hydraulic pump **54**, a dump valve **66**, and a hydraulic actuator **36** (e.g., a hydraulic cylinder). The combination of the E-stop switch **58** and the dump valve **66** provides the lift system **20** with enhanced safety, as described below.

As shown in FIG. **4**, the dump valve **66** can be shiftable between a powering configuration (shown by the vertical solid line in the dump valve **66** of FIG. **4**) and a recirculating configuration (shown by the horizontal dashed line in the dump valve **66** of FIG. **4**). When the dump valve **66** is in the powering configuration, the dump valve **66** routes hydraulic fluid from the hydraulic pump **54** to the hydraulic actuator **36** for use in raising the carriage assembly **34** relative to the post **32**. When the dump valve **66** is in the recirculating configuration, the dump valve **66** routes (recirculates) hydraulic fluid from the hydraulic pump **54** back to the hydraulic reservoir **52**, bypassing hydraulic actuator **36**.

An important feature of the dump valve **66** is that it is biased toward the recirculating configuration and is only shifted into the powering configuration when electrical power is supplied to the dump valve **66**. As such, if electrical power is cut to the dump valve **66**, the dump valve **66** automatically shifts into the recirculating configuration. Once the dump valve **66** is in the recirculating configuration, the hydraulic actuator **36** cannot be used to raise the carriage assembly **34**, even if the pump **54** continues to run, because hydraulic fluid is diverted around the hydraulic actuator **36** and back to the reservoir **52**.

In order to raise the carriage assembly **34**, electrical power must be provided to the dump valve **66** to shift the dump valve **66** into the powering configuration. Such instructions to raise the carriage assembly **34** can be received via the touch screen display **56**. Upon receiving the raise instructions input from the touch screen display **56**, the electronic control system **60** can communicate a dump valve power-up signal to all the lifts **22** of the system **20**. This dump valve power-up signal ensures that all the dump valves **66** of all the lifts **22** are shifted into a powering configuration in order to raise the lifts **22**.

In certain embodiments of the present invention, each lift **22** has an E-stop switch **58**. When the E-stop switch **58** is actuated by an operator of the lift system **20**, the electronic control system **60** sends a signal via communication line **64***b* to cut electrical power to the dump valve **56** of the lift **22** on which the E-stop switch **58** was actuated. In addition, when the E-stop **58** switch is actuated, the electronic control system **60** of the lift **22** on which the E-stop was actuated wirelessly transmits an E-stop signal for receipt by the other lifts **22** of the system **20**. Once the E-stop signal is received by the other lifts **22**, power is cut to the dump valves **66** of all the lifts **22** of the system **20**.

As depicted in FIG. **4**, the lift system **20** can optionally employ a remote control module **70** to wirelessly control the lifts **22** from a location spaced from the lift system **20**. In embodiments where the lift system **20** is controlled using the remote control module **70** that is not rigidly coupled to the lifts **22**, the remote control module **70** communicates wirelessly with components of the lifts **22** that are physically coupled to the lifts **22**. In one embodiment, the remote control module **70** can be a user interface that is readily attached to and detached from one of the lifts **22**. In certain embodiments, only one of the lifts **22** of the lift system is equipped with a detachable remote control unit **70**. In other embodiment, each of the lifts of the lift system **20** includes an identical detachable remote control unit **70**.

As depicted in FIG. **4**, the remote control module **70** can be equipped with a touch screen display **56** and an E-stop switch **58**. When the E-stop switch **58** on the remote control module **70** is actuated, the remote control module **70** wirelessly transmits an E-stop signal, which the results in power being cut to all the dump valves **66** on all the lifts **22** of the system **20**. In one embodiment, the E-stop signal transmitted by the remote control module is directly received by each of the lifts **22** of the system **20**. In another embodiment, the E-stop signal transmitted by the remote control module **70** is received by a master lift of the system **20**, and the master lift thereafter communicates the E-stop signal to the remaining slave lifts of the system.

Referring again to FIG. **4**, in accordance with certain embodiments of the present invention, the hydraulic power system **60** of the lift **22** can include one or more features for enhancing performance and reliability of the hydraulic power system **60**. For example, as shown in FIGS. **3***b* and **4**, the hydraulic pump **54** can have a fluid inlet that is located below the fluid outlet of the hydraulic reservoir **52**. This configuration can be advantageous in that it facilitates gravity feed of hydraulic fluid from the hydraulic reservoir to the hydraulic pump **54**. This gravity-feed feature provides improved energy efficiency (battery life) over conventional portable lift systems because the hydraulic pump **54** is not required to pump hydraulic fluid up from the reservoir **52** every time the lift **22** is actuated. In addition, the tank used as the hydraulic reservoir **52** can have an enhanced physical configuration. In certain embodiment the hydraulic reservoir **52** can be non-cylindrical, with substantially planar side walls. In one embodiment, the hydraulic reservoir **52** has a generally inverted L configuration, with the hydraulic pump **54** and/or dump valve **66** being at least partly received in the gap of the inverted L.

Referring now to FIGS. **5***a* and **5***b*, where there is provided an enlarged view of the modular control unit **48** originally described with reference to FIG. **3***b*. FIG. **5***a* shows the front of the modular control unit **48** in its assembled configuration, while FIG. **5***b* shows the modular control unit in an open configuration, revealing its internal components. As depicted in FIG. **5***b*, the modular control unit **48** can include a housing **72** into and/or onto which all components of the unit **48** are mounted. Specific components mounted on/in the modular control unit **48** include a touch screen display **56**, an E-stop switch **58**, a primary circuit board **74** (motherboard), a secondary circuit board **76** (daughter board), and a wireless communication device **78**. The wireless communication device **78** can be a radio frequency transceiver. In one embodiment the wireless communication device is an adaptive frequency hopping transceiver. In additions, one or both of the circuit boards **74**, **76** can include a lift control microprocessor **80** for processing information relating to the lift sensors and actuators.

The primary circuit board **74**, secondary circuit board **76**, and wireless communication device **78** are mounted inside the housing **72**, where they are protected from the external environment. The touch screen display **56** and E-stop switch **58** are mounted in openings in the front panel **82** of the housing **72**, so that they can be accessed by a lift operator when the housing **72** is closed. In certain embodiments, the front panel **82** of the housing **72** can be equipped with a docking station so that a remote control module that includes the touch screen display **56** can be releasably attached to the modular control unit **48**.

One advantage provided by the modular control unit **48** is that it can easily be removed from the lift and replaced by another modular control unit **48**. Most of the key components of the lifts electronic control system are included in the modular control unit **48**. Thus, if a problem with the lifts electronic control system is experienced, a new modular control unit can simply be shipped to the lift owner and easily swapped out for the old one. This avoids downtime and expense associated with having a service technician travel to the lift location to diagnose and repair a problem with the electronic control system.

To facilitate easy change out the modular control unit **48**, the modular control unit **48** can be equipped with electronic communication plugs for electrically connecting the modular control unit **48** to other components of the lift. In certain embodiments, the modular control unit is equipped with not more than five, not more than four, or not more than three electronic communication plugs. For example, one electronic communication plug can be used to connection the wireless communication device **78** of the modular control unit **48** with the antenna **50**; one electronic communication plug can be used to connect the E-stop switch **58** of the modular control unit **48** to the dump valve **66**; and one electronic communication plug can be used to connect one or both of the circuit boards **74**,**76** to various sensors or actuators of the lift **22**.

Referring generally to FIGS. **1**-**4**, several enhanced performance and safety features suitable for implementation into the wireless portable lift system **20** will now be briefly described. In particular, the lift system **20** can be provided with an auto-engage performance feature, an auto-resynchronize performance feature, a motion sensing safety feature, obstruction detection safety feature, a physical lockout-tagout safety feature, a pass code safety feature, a training verification safety feature, and/or a dual input safety feature. These various performance and safety features are described immediately below with reference to FIGS. **1**-**4**.

In certain embodiments of the present invention, the electronic control system **60** of the wireless portable vehicle lift system **20** can be programmed with an auto-engage function that simultaneously raises the carriage assemblies **34** of all of the lifts **22** until the carriage assemblies **34** engage the vehicle wheels and then stops each of the carriage assemblies **34** in an engaged position upon engagement with the wheels. When the lift system **20** is equipped with auto-engage functionality, each of the lifts **22** can include a weight sensing mechanism configured to detect the weight supported by the carriage assembly **34**. The auto-engage function is configured to stop the carriage assembly **34** when the weight sensing mechanism senses a weight above a preset engagement weight. The electronic control system **60** can programmed to use the engaged positions to determine an initial level configuration for the carriage assemblies **34**.

In certain embodiments of the present invention, the electronic control system **60** of the portable vehicle lift system **20** can be programmed with an auto-resynchronization function that automatically resynchronizes the vertical positions of the carriage assemblies **34** after an unsynchronized condition has been identified. The electronic control system **60** can be configured to automatically detect the existence of the unsynchronized condition and provide the lift operator with a visual indication of the unsynchronized condition.

In certain embodiments of the present invention, each of the lifts **22** of the system **20** can include a lift motion indicator for providing an audible and/or visual warning when the lift **22** is being raised and/or lowered. The lift motion indicator can include a light configured to flash during raising and/or lowering of the lift **22**. The lift motion indicator can additionally or alternatively include an audible alarm that beeps during raising and/or lowering of the lifts **22**.

In certain embodiments of the present invention, the lift system **20** can be equipped with an obstruction detection system for detecting foreign objects located below the lifted vehicle prior to lowering the lifted vehicle. The obstruction detection system can be configured to scan the area within the perimeter of the lifts **22** for foreign objects. Such scanning can utilize optical, thermal, acoustical, infrared, and/or microwave energy to detect foreign objects.

In certain embodiments of the present invention, the lift system can be equipped with a physical lockout-tagout system for preventing unauthorized operation of the lift system. The physical lockout-tagout system can include at least one removable key associated with each lift, wherein insertion or removal of one or more of the keys from one or more of the lifts disables the lift system.

In certain embodiments of the present invention, the touch screen display of the user interface **24** can be programmed to include a pass code screen that prompts the operator to enter a pass code prior to operating the lift system **20**. Such a pass code screen can include an input section for the operator to input a pass code. The electronic control system **60** can include onboard database, or can have access to a remote database, containing one or more stored authorized pass codes. If a pass code is entered that does not match one of the stored authorized pass codes, the lift system **20** can be rendered inoperable.

In certain embodiments of the present invention, the touch screen display of the user interface **24** can be programmed to include a training verification screen that queries the lift operator as to whether the operator has been trained to operate the lift system **20**. The training verification screen can include an input section for the operator to confirm or deny whether the operator has been trained to operate the lift system **20**. The lift system **20** can be rendered inoperable if the operator denies having been trained on the lift system **20**.

In certain embodiments of the present invention, the electronic control system **60** of the lift system **20** can be programmed so that movement of the lifts requires dual operator input from at least two locations on the touch screen display of the user interface **24**. The user interface **24** can also include one or more function buttons separate from the touch screen display. In certain embodiments, the electronic control system **60** is programmed so that movement of the lifts requires dual operator input from via both the touch screen display and at least one of the function buttons.

FIG. **6** provides a schematic depiction of an electronic control system **100** for a wireless portable lift system, such as the lift system described above. The control system **100** of FIG. **6** includes of a parallel group of microprocessor and microcontroller systems each functioning in a specific task area in a coordinated manner to provide a high performance, safe lifting system. The control system **100** enables a complex coordinated lift involving anywhere from two to twenty independent lifts. The lift or lower must be performed rapidly, and with a high degree of safety and precision. Each individual lift involved in the lift ensemble must be capable of tracking its own actions together with the actions of all other lifts in the group and determining as part of a collective intelligence a lift or lower strategy keeping the lifts together, maintaining a high level of safety, precision, and lift integrity.

The task of lifting, safety checking, and coordination of the individual tasks in a wireless portable lift system is large and may be difficult or impossible to be done in a real time manner by a single processor in each lift that is single or even multi threaded. Because of the safety and performance requirements of the modern portable lift system the inventors have found that the task may advantageously be divided into functional areas with processors accomplishing their individual tasks in a near real time environment. The processors can be tied together with a network or by a direct memory access (DMA) technology. This method allows all of the processors to share a common area of memory **108** where the individual processors push and pop commands or data between one another and other processors in a multiple lift system in an achromous manner. This method provides for a very rapid response of the system to commands and to the varying conditions in the multi-lift system during a lift or lowering operation, or lift housekeeping tasks.

The use of parallel multi-processors is unique in the portable lift industry because up to this point the lifting task has been simple. However, recently the requirements on the lift systems has increased and has become more complicated. Thus making use of a single microcontroller would result in degraded safety, lack of capability, and lift performance. By dividing the task into a set of parallel, yet coordinated, set of microprocessors or microcontrollers the more complex tasks as well as the fundamental tasks can be performed more quickly, more safely and with greater precision.

In certain embodiments, the multiprocessor system consists of two, three, four, five or six processors in each lifting column. The control processor **102** in the individual lifting columns is an adaptive gain control processor. This processor **102** receives data from all of the sensors **104** in the lift system ensemble as well as the data from its own portable lift sensors including but not limited to pressure, energy use and energy levels, lift height, lift velocity, and parameters that check the environment for the safe use of the lift system. All of this data is used by the collective intelligence of the lifting ensemble to effectively perform a coordinated lift or lower of the ensemble. The adaptive gain processor **102** is also interfaced to all user portable lift ensemble control inputs and emergency requests from sensors or the lift's operator. This adaptive processor **102** performs control of all actuators, valves, pumps, stops, and emergency equipment **106**. This processor **102** gives and receives commands from the DMA data hub area of shared memory **108** for the system, as well as the local controls and display. The adaptive control processor **102** takes advantage of an artificial intelligence algorithm to perform its intended task. This is the ability of the control processor **102** to learn from its environment and use this data to more effectively and safely perform the lifting tasks.

Control of the individual portable lift system as well as the control of the ensemble of lifts has become more complex due to the increased capability of the newer lift systems and the higher margins of safety that are required. Current technology uses a simple text display and a raise lower switch as the input/output devices. The new lift systems must have more elegant and ergonomically designed human interfaces that inform the operator in a clear and concise manner of the operational aspects of the lift when in operation. The interface must allow the operator to easily and safely access the full functionality of the new features of the modern lift system. This interface system can consist of a touch screen display, voice actuated commanding and recognition systems and audio and visual feed back to the operator. This display can be capable of surveying the work area of the lift using such sensors as LIDAR or acoustic techniques, thus insuring a safe and accident free lift operation. The display processor **110** can communicate using the DMA interface to assure near real time functionality. However, a conventional network technology can be used, but it may result in degraded performance.

An integral part of the multi-processor lift system **100** is an adaptive communication system **112** for the communication between individual lifts in an ensemble that have a common lifting purpose. It is the responsibility of the communication system to keep all DMA areas of all lifts synchronized, and to provide emergency data in the event of an unplanned movement of the lift system or the user. Because communication is so critical in a high performance lift system the tolerance for error is very small. It is for this reason that an adaptive rather than a conventional data communication system is chosen.

The adaptive communication system **112** is frequency agile, protocol agile, and power agile. The system is capable of changing its RF channel if the current frequency is congested and determining a radio frequency of minimum noise content. This channel agility process occurs on a continual basis during the operation of the lift system. The communication system's **112** moves are coordinated between the individual adaptive communication processors in the lifting ensemble. The adaptive system **112** uses an artificial intelligence algorithm to learn and adapt to the area of operation. The system, in addition to conventional error processing such as parity and CRC checking, can change its message timing and protocol in order to assure no possibility that the system can be jammed or spoofed causing a hazardous movement of the lift system. The adaptive communication system **112** is capable of providing a separate isolated smart RF channel or link for the handling of emergency information in the event of the failure of one or more of the communication processors. The adaptive primary communication system and the smart emergency communication system are DMA devices allowing the information programmed for the individual lift columns to be moved rapidly from the display and control processor's memory to the other lifts in the ensemble in a near real time manner.

The adaptive communication processor provides the secure communication link between the individual portable lifts in a lifting ensemble. A smart network server processor/microcontroller **114** provides a link from the individual lifts to the cloud **116**. This link allows the lifts to be part of a collective the intelligence of all lifts of the model type, or that have the server processor/microcontroller **114** as part of their architecture and that have been manufactured by a common manufacturer. The network server processor/microcontroller **114** allows the individual lift to be part of a data sharing network by which individual lifts can share use data, maintenance data, and status, and operational status data with a common server or server family for the purpose of determination of maintained scheduling, malfunction determination, fault analysis, and software and firmware update. This data link takes advantage of local open or secures data networks or cellular data networks. This connection to the cloud **116** allows the remote operation of the lifts, and a remote diagnosis of faults, maintenance practices, and usage of the individual lifts.

The multi-processor architecture of control system **100** is configured to make the wireless portable vehicle lift system a high performance, extremely safe and secure, and versatile piece of shop equipment. The multi-processor architecture provides a new communication capability between individual lifts and a unique intelligent network of all lifts in a production family.

In view of the foregoing, in certain embodiments of the present invention, each of the portable lifts can be equipped with at least a first microprocessor and a second microprocessor that are configured to communicate with one another, perform distinct tasks operate in parallel, share a common memory, and/or communicate with one another using direct memory access (DMA) technology. Each of the portable lifts can include a common command buffer system for provide communication between the first and second microprocessors. The common command buffer system can include a transmit buffer for transmitting information to the first and second microprocessors and a common receive buffer for receiving information from the first and second microprocessors.

In certain embodiments, each of the portable lifts can further include a third microprocessor configured to communicate with the first and second microprocessors. The first, second, and third microprocessors can be configured to operate in parallel, share a common memory, and/or communicate with one another using DMA technology. The common transmit buffer, described above, can transmit information to the first, second, and third microprocessors and the common receive buffer can receive information from the first, second, and third microprocessors.

In certain embodiments, each of the portable lifts can further include a fourth microprocessor configured to communicate with the first, second, and third microprocessors. The first, second, third, and fourth microprocessors can be configured to operate in parallel, share a common memory, and/or communicate with one another using DMA technology. The common transmit buffer can transmit information to the first, second, third, and fourth microprocessors and the common receive buffer can receive information from the first, second, third, and fourth microprocessors.

In certain embodiments, each of the lifts can include a lift control system having one or more sensors and one or more actuators. One microprocessors of the lift can be a control microprocessor configured to process information related to the lift control system. The sensors of the lift control system can include a height sensor, a pressure sensor, an energy status sensor, a velocity sensor, and/or an actuator position sensor. The actuators of the lift control system can include the lift actuator, a down-stop actuator, an emergency stop actuator, a hydraulic valve, and/or a hydraulic pump.

In certain embodiments, each of the lifts further includes a user interface system having one or more input and/or output devices. One of the microprocessors of the lift can be the interface microprocessor that is configured to process information related to the user interface system. The user interface system can include a touch screen display. The interface microprocessor can be programmed to display at least 40, 80, 120, 160, 200, 240, 280, 320, 360, 400 unique operator interface screens on the touch screen display. Further, the user interface can include a voice actuated command module.

In certain embodiments, the lift system can include a wireless inter-lift communication system including one or more wireless transmitters and/or wireless receivers associated with each of the lifts. In such an embodiment, one of the microprocessors of the lift can be an inter-lift communication microprocessor configured to process information related to the inter-lift communication system. The wireless transmitters and/or wireless receivers of the inter-lift communication system can include a radio frequency (RF) transceiver.

In certain embodiments, the inter-lift communication microprocessor can be an adaptive communication microprocessor configured to automatically adjust one or more communication parameters to thereby maintain communication integrity and/or security. Such communication parameters can include frequency, protocol, and/or power. The adaptive communication system can be configured to automatically scan communication frequencies and select a frequency with minimal noise. In certain embodiments, the wireless inter-lift communication system can include an artificial intelligence system configured to gather wireless environment information about the local communication environment and control the wireless transmitters and/or wireless receivers based on the wireless environment information.

In certain embodiments, the lift system can include a wireless network server communication system transmitting information to and/or from a remote location. In such an embodiment, one of the microprocessors can be a wireless network server communication microprocessor configured to process information related to the network server communication system. The remote location can be at least 10, 50, 100, or 200 miles away from the location of the wireless portable vehicle lift system. The wireless network server communication system can be configured to communicate with the remote location via a cellular telephone network or the internet.

In certain embodiments, each of the lifts includes a control microprocessor configured to process information related to the lift control system, an interface microprocessor configured to process information related to the user interface system, an inter-lift communication microprocessor configured to process information related to the inter-lift communication system, and a wireless network server communication microprocessor configured to process information related to the network server communication system.

FIGS. **7***a* and **7***b* provide an overall flow diagram outlining major steps involved in operating a wireless portable lift system configured in accordance with certain embodiments of the present invention. When the lift unit is initially turned on, the lift unit will perform a self-check of all of the operable systems that control the movement of the lift system or display data or take commands from the operator. If all systems come back with a valid response the unit will determine its state of position (i.e., is the lift in the home position or is the lift in some position other than the home position thus telling the central processor that the lift may have been shut off or failed in the lift position). If the unit is in other than the home position it will measure the weight of the lift forks to determine if there is a vehicle on the lift or is the lift empty. If there is no weight on the system the lift will initiate a request to the operator to return to home. If there is weight on the system the lift system will assure that paws are engaged and that the lift remains in this position until grouped or manually lowered by the operator.

The lift now uses the radio link system in a pre-determined default channel and later looking to all available channels to determine if there are other lifts that the lift could be grouped with (i.e., lifts that have not been grouped but are on line and transmitting an identification). The radio will ignore all lifts that are already grouped or are part of another lifting ensemble. If there are no other lifts in the potential ensemble then the lift will initiate a beacon signal on a pre-determined channel indicating that it the first to be on line and it is looking for others that it could be potentially be grouped with. It determines of the 256 channels of communication that are available which one is the clearest channel and places that channel ID in the beacon message with its ID and type of lift.

If the lift determines that it is not the first of the lifts to be powered up by detecting the beacon of an unpaired lift then the lift will listen for the clear channel ID and then on the beacon frequency broadcast its ID, type of lift and its status. The lift will then initiate the control operator display and indicate that the unit is ready and ready for a lift assignment and continue to broadcast its ID, type, and status, and listen for other lifts that might be potential group members . . . ignoring lifts that already are in an ensemble. This loop will continue until the operator initiates the lift and assigns its position in a lifting ensemble. The communication between the adaptive communication device and the control processor is carried out using a communication buffer resident in the control processor. The display, communication processor, network server, and the control processor all function asynchronously using the communication buffer of the control processor. Commands, data, and status information is pushed and popped from the register in real time with each independent device acting on the buffer in real time manner (i.e., the system is interrupt driven). In the event of a interrupt failure the system is halted and reset to the initial state of turn on. This serves as an operational self-check of each system and prevents unexpected or un-programmed movement or actions on the part of the individual lift system.

If the system senses other unassigned or assigned but not complete grouped units. The system will anticipate a lift assignment. Once the unit is requested by the operator as a potential lift for a lifting system it will gather the data of the other lifts as to their position number, number of lifts in the system, unit IDs, statuses, heights, weights, and communication channels and protocols and await its lifting assignment. The unit will display on the operator console all other potential lifts and their current position in an assigned lifting ensemble. The operator must now assign the position of the lifting system. The lift will determine if it is a valid lift position from the data from the other lifts. If it is a valid lift position then the unit will broadcast its unit ID, status, height, weight, and current assigned position on request by the first unit in the lifting ensemble. At this point the lifts parameters and status are kept current in the transmit receive buffers so that the radio system can reply to inquiries by the first lift to enter the lifting ensemble.

If the lifting ensemble is not complete but the lift has an assignment the lift will continue to broadcast its ID, status, lifting position, and all lifting parameters in the communication buffer on request of the first unit in the ensemble. If the unit is the first in the ensemble the unit will beacon to all potential lifts requesting them to broadcast their IDs, status, and lifting parameters in their communication buffers, as well as broadcasting its own unit ID number, assigned position, number in the projected ensemble, channel numbers, and lifting parameters in its communication buffer. The lifting parameters include but are not limited to the status, height, weight, channels, state of emergency, lift rates, and lift acceleration, and move with ID.

Once the lifting ensemble is complete the first unit in the ensemble assumes a pseudo master of the ensemble as far as communication is concerned this unit serves to pole the other units as to their ID and lifting and command buffer data. Once the lift ensemble is ready it will either be in the home position or the position that the lift system was left in when it was turned off. If the system is in the home position the lifts will ask the user if he wants to auto engage the vehicle to be lifted. If the answer is yes the units are asked to reduce the lift gain and advance in a lifting mode until a predetermined weight is captured on each of the lifts and to then stop and wait for a home or a lift command from the operator. If the lifts are not in the home position each units height will be broadcast to determine if all of the lifts are within the synchronization limit, if so the operator will be asked if he or she wants to auto synchronize the system, meaning all of the lifts will be brought to ⅛ of an inch of each other in height were the lowest units are brought to the height of the highest unit. If the units are not within the predetermined auto synchronization limits the units will error out and the operator will have to manually bring the units into the auto sync region and restart the lift process. Or the operator will be asked if he or she wants to operate in the paired mode. Once all of the units are at the same height and weight either by an auto engage or by a manual or auto synchronization the ensemble is ready for a command to any of the units to lift or to lower or to park.

At this point there is no master or slave relationship between the units in the ensemble each of the units is an independent operator with each unit knowing all other units status and lift parameters via way of the common communication buffer that all units now have. All of the communication buffers are kept in sync by the way of the intelligent radio network of the column ensemble. All units operate off the same communication buffer so a single unit whose buffer is altered by the control operator forwards this communication buffer to all other units which assume the same status thus allowing the system to make a coordinated lift or lower or common stop, emergency shut down or system reset. There is only one intelligent radio that assumes the auto poling responsibility and that is the first unit to be put on line. Any of the units can assume the auto poling task by being the first one of the ensemble to be powered on. This first unit's only unique responsibility is the poling all of the other units in the ensemble and assuring that the communication buffers remain in sync. If any communication buffer is altered by the operator control or emergency stop the first unit's intelligent radio is responsible for the propagation of the new communication buffer during an operation or shut down.

By keeping a common communication buffer within all of the units and having an auto update of the buffers all of the units function as clones of each other thus lifting and lowering in the same manner. The first unit also has the task of choosing the lead lift device in any lifting or lowering operation. The lead lift is the slowest column lift during a lifting operation and the fastest column lift during a lowering operation. Each of the lifts tracks the lead lift adjusting its lifting or lowing gain to track the lead lift. Any of the lifts can become the lead lift by being the slowest during lifting and fastest during the lowering. The lead lift may not be the same during the lift as during lower. The lead lift is determined by the comparative velocity of each lift at the onset of the lift or lower operation. In the event of an emergency stop or system reset then the lift issuing the stop becomes the lead lift. The stopping lift remains the lead lift until the stop is cleared. The lift where the command to lift or lower is not the lead lift but the command lift the lead lift is driven only by performance during the lifting or lowering operation.

FIG. **8** provides a flow diagram outlining steps involved in raising and lowering a wireless portable lift system configured in accordance with certain embodiments of the present invention. A raise or lower operation is initiated by one of the lifting columns receiving a command from the operators console and this command alters the common communication buffer and command buffer in all of the units. An initial lift and lower gain that has been predetermined is chosen and the lift or lowering is begun. The velocity of each of the units is immediately reported to the common communication buffer and the slowest unit is determined by all of the columns at once. Each of the column lifts then adjusts its lifting or lowering gain so that its velocity is the same as the lead unit. Where the lead unit in a lift is the slowest and the lead on a lower is the fastest. This comparison continues during the entire lift or lower operation. The gain of each unit is manifested in the PWM rate that is being used by the control processor to control the orifice of the hydraulic valve from the pump/dump tank to the lifting cylinder of the column.

During the lifting or lowering operation, all of the lifts heights are continually monitored to determine if they are staying within a predetermined difference of height. In the event that one or more of the lifting columns does not remain within the predetermined lifting or lowering predetermined parameters the lifting or lowering operation is halted by the offending unit issuing a stop to the lift or lower operation. This unit is now the lead unit. The operator is given notice of the problem and is asked to go to the unit and manually bring the unit to within lifting or lowering difference specifications. Once the operator goes to the offending column and performs a manual re-synchronization on the offending column the ensemble lift or lower may be resumed by any of the columns operator consoles. This process is called resynchronization of the lift ensemble. The problem is broadcast by way of the common communication buffer so all of the units in the ensemble are on notice of the problem and it appears on all display consoles of the lifting ensemble.

The re-synchronization is usually not necessary except in very unusual lifting or lowering operations as the adaptive gain of the family of control processors works to prevent lift synchronization error. The error should only occur when the difference lifting weight is so extreme that the bandwidth of the adaptable gain is not sufficient to accommodate the lift or lower. This would be the case in the event that the lifted vehicle radically changed weight during a lift or lower operation.

A lift or lower may be accomplished from any of the columns in the lifting ensemble. Once a lift or lower is initiated on a column this column declares itself the command column and no other column can be used for controlling the lift ensemble until the lifting or lowering operation is complete by the command column. Once the operation is complete any of the columns can now become the command column and thus initiate a lifting or lowering operation or any other command of the system. The only event that can remove control from a command column during a lifting or lowering operation is the issue of an emergency stop from any other column. The emergency stop sets the stopping column as lead and control column and remains as such until the stop is cleared at the column.

FIG. **9** provides a flow diagram outlining steps involved in parking a wireless portable lift system configured in accordance with certain embodiments of the present invention. The park operation is used as a way to transfer the lifted weight of the column system from the hydraulic cylinder to a set of stationary metal stops when the lift is used a single height for a prolonged period of time. It is also used to provide the user of the lifting system with an additional margin of safety when working under the vehicle on the column lift system as the weight supported by a set of metal stops on the lifting column as opposed to the hydraulic lifting cylinder. In the park mode of operation the hydraulic lift mechanism lowers the weight of the vehicle on to the nearest set of mechanical stops and locks the stops into position to assure no movement up or down of the vehicle being lifted.

When the park command is executed by the operator the command is placed in the common command data buffer and the command is then sent to all of the command buffers in the lifting ensemble. The height of the column lift is compared with all other lifts to assure that the lifting system is in sync and all lifts are within a predetermined height. The lifts height is compared to the heights of the fixed stops that are on each of the steel columns. If there is a metal stop below the current position of the lift then the control processor will verify that the same condition exists for all of the lifts through the common communication buffer. If all heights are the same and all target stops are the same the gain of the lower command is set very low. The weight of the vehicle is determined and stored. The parking paws are released and set to engage the designated stop. The lower command is given to all lifts through the common communication buffer. The weight supported by the hydraulic system is monitored and the vehicle is lowered until weight is removed from the hydraulic system. When the predetermined weight remains on the hydraulic system the lowering is halted. All units report to each other on the common communication bus that the park has been accomplished and the operator is given a park indication on the operator's console. In the event that weight has not been removed from all of the hydraulic systems the control processor will enter an error mode indicating that one or more of the parking paws has failed and a park is not possible and the unit halts. The operator is then asked to intervene and check the system for a mechanical fault.

If the park command is issued by the operator and the lift happens to be on one of the metal stops or if any of the positions of the lifts are ambiguous with respect to the position of the metal stops, the park command will not be executed and the operator is asked to raise or lower the lift system until the ambiguity can be resolved. This is done to assure that the metal parking paws will engage with the metal stops on the columns. The control processors assure that there is a prescribed clearance above each stop before the park can be executed. This prescribed clearance must be met or exceeded before a coordinated park can be executed. The operators console returns to the command mode.

FIG. **10** provides a flow diagram outlining steps involved in un-parking a wireless portable lift system configured in accordance with certain embodiments of the present invention. The un-park operation is used to return the column lift system from the park or column weight supported mode to a hydraulic weight supported mode so that the vehicle can be lifted or lowered. The un-park command is issued by the operator from any of the columns operator consoles. On a un-park common command buffer is loaded and sent to all of the columns. If the ensemble is complete and no stops exist the gain of the lifting PWM will be adjusted to a prescribed value, and the command will be given to lift the vehicle a prescribed amount. The individual weights will be monitored and when the derivative of the weight is zero for all of the columns during the lift sequence, and the columns are raised an additional prescribed amount to assure clearance of the stops, the un-park is said to be successful. The parking paws are retracted on all lifts and verified, and the lift is returned to the lifting and lowering mode of operation, or the command mode. The un-park can be accomplished from any of the column lift consoles like the park can be accomplished from any of the column lift consoles.

FIG. **11** provides a flow diagram outlining steps involved in operating a wireless portable lift system in a paired mode. The paired operation is used to allow the lift system to move any two of the lift columns of a lift ensemble and operate them independently of the other lifts in the ensemble. During this time other columns in the lift system are locked out from moving unless an E-stop occurs. It is recommended that the paired lifts be assigned to positions opposite each other on either side of the vehicle under lift. The control processors using the intelligent communications processors of the lifting system will verify that the two lifts that have been operator assigned as paired lifts have assigned positions opposite each other in the lifting ensemble. In the event that the two columns do not have opposite positions in the ensemble the control processors will prevent the unit from entering the paired operation. This aspect is to provide a margin of safety for the operator during an asymmetric lift operation.

Once the operator has selected a valid pair of lifts to be independently operated, the system will lock all other lifting columns in the ensemble. The communication processor will update all command buffers, post all column heights to the common data buffer and set a low raise/lower PID control gain in each of the paired columns that have been selected. The paired set may be operated from either of the paired columns operator consoles. The unit will now allow the operator to operate the paired lifts up or down and allow the raise/lower movement as long as the difference in height of the paired group is within a prescribed distance from the height of the remainder of the lifting columns. This is done to provide a margin of safety to the operator and the vehicle under lift during an asymmetric lifting operation. The units may be parked in any position within the predetermined range of operation. The units will remain in the paired operation until the operator executes an un-pair operation from the operator's console of the two selected lifts.

FIG. **12** provides a flow diagram outlining steps involved un-pairing a wireless portable lift system configured in accordance with certain embodiments of the present invention. The un-pair operation is used to return a lifting ensemble from the paired operation and return the ensemble to its full coordinated column lifting mode. The un-pair command can be given from either of the paired column's operator console. Once the command is given the control processors of the paired columns recall the height of the rest of the ensemble and compare it to the current height of the two paired columns. The processor will then issue a small PID raise/lower gain to the control program, the processor will then place on the common data bus for the paired units gains, destination weights, and heights, and using the communication processors perform a coordinated move the columns in a direction that will make the paired column assume the height of the rest of the ensemble. This move is executed by the raise/lower portion of the control programs in each of the lifts. During this lower or lift, the lift weight of each of the rejoining columns is monitored to assure that the column does not assume a dominant or slacker weight of the columns in the ensemble, but will assume its divided share of the weight. Once the predetermined heights and weights are reached the ensemble is returned to the full ensemble mode with all columns assuming equal partnership.

FIG. **13** provides a flow diagram outlining steps involved in operating an adaptive communication system of a wireless portable lift system configured in accordance with

certain embodiments of the present invention. The adaptive communication system in each of the column lifts provides communication of all command and control information and in addition provides for a continuous synchronous updating of a common data buffer in each of the lifts. The common data buffer is in the same form in all of the lift systems as no lifting system is either a master or slave. Each common data buffer in each lift contains the status and operation of all lifts in the ensemble. This common data buffer is maintained in the control processor of each column lift in the working ensemble. The data buffer contains, communication channel data, frequency data, and current protocol data, all column weights, heights, operational and health status of all lifts, assigned lift positions of all lifts, current mode of operation of all lifts, and a current roll call of all lifts in the ensemble, the buffer also contains security information or encryption data needed to interpret all lift communication and to validate command data. The buffer also contains whether there are other lifts, not in the ensemble, in the working vicinity and whether they are joined in an ensemble.

The command data buffer is continually kept up to date by the poling of all of the ensemble columns by the first unit in the ensemble. (The first unit is defined as the first unit powered up or the beacon unit. This unit can be any of the columns. The only requirement is that it is the first unit powered up.) Any unit can initiate the pole of all units. The poling is an asked and answered protocol followed by all data on the member of an ensemble. This reply is heard by all columns and logged in each column. The data is sent in an encrypted form with parity, and a cyclic redundancy check (CRC) to insure security. The roll call contains multiple calls and requests and retries to insure valid data and provide for data collision reduction. In the event that a column is absent from the roll call or a roll call ceases for a predetermined length of time, the ensemble goes into an error mode with the loss of a column. If the unit returns the error code is removed and normal operation is resumed.

If the communication processor is the first column to come on line, the communication processor assumes the polling task. The communication processor with the polling task assumes the task of determining the clearest channel that is to be used by the ensemble for all data and determines the hop sequence based on the assessment of channel activity at the time of power up. The polling processor also is responsible for the periodic assessment of the RF environment in order to keep the used channels as clear as possible. This process is initiated when excessive communication errors are detected on one or more of the column's data. This communication processor is responsible for establishing the encryption key that will be used by the formed ensemble. All of this channel data is placed on the beacon so that joining columns can adjust their communication processors accordingly. The polling processor will maintain the beacon until all of the units that are to be joined have been acquired. Once all units are joined the secure communication occurs to all columns in the form of an asked and answer on the secure channels and designated encryption key. This roll call and movement of the common data buffers continues until the ensemble is dissolved. The communication processor is frequency agile, encryption key agile, protocol agile. All communication processors are the same and can assume the polling task if they are the first that are powered up of an ensemble.

FIG. **14** provides a flow diagram outlining steps involved in operating an E-stop system of a wireless portable lift system configured in accordance with certain embodiments of the present invention. The E-stop is an overriding system interrupt. The E-stop performs two operations. First the E-stop removes power from all of the MOSFETS that drive the pump and valves of the unit where the E-stop is executed. This action causes the dump valve to open and the output of the pump to be jettisoned to the dump tank. The dump valve is executed in the event of the failure of the main power contactor in the ON position. The E-stop assures that the hydraulic circuit is broken thus assuring a positive stop to the hydraulic circuit. This action assures that the unit where the local E-stop is pressed comes to a positive halt. Second the E-stop alerts the control processor of the condition, places the E-stop message in the common communication buffer and the intelligent communications processor broadcasts an E-stop message so all other lift columns are also sent into the E-stop mode as well. The broadcast E-stop message causes a termination of power to the active hydraulic components of all of the members of the ensemble. The E-stopped unit now becomes the command and the lead unit for purposes of control of the column lift ensemble. In the event of a communication and control buffer failure the column will offending column lift will exhibit a communication failure causing all columns go into a failure to sync and halt all motion. In the event of the failure of or locking of any of the control processors the separate COP WATCHDOG processor in the effected column will perform a cold reset of the processor causing a loss of ensemble communication thus causing the entire ensemble to halt. There are three levels of emergency stop. A controlled stop under processor control, a stop by the issuing of the halt command in the common communication buffer thus causing the entire ensemble to halt, and a COP WATCHDOG system reset resulting in loss of system sync and halting of the entire ensemble. If the later occurs, this failure requires the E-stop to be cleared and the system to be restarted from scratch. If the first occurs the E-stop can be cleared by resetting the E-stop button and the ensemble will continue with the lift operations.

The E-stop is designed to be a positive halt to the column lift system. The same result as a cop watchdog stop can be obtained if the operator turns the main power switch off on any one of the ensemble. The ensemble has to restart from scratch. A cop watchdog and a power down is an absolute halt of the column lift system requiring operator intervention.

FIGS. **15**-**18** provide simplified representations of wireless portable lift system configurations within which one or more of the inventive features discussed above can be implemented. Although each of the lift systems depicted in FIGS. **15**-**18** show four lifts, it should be understood than any number of lifts can be used.

FIG. **15** depicts a wireless portable lift system utilizing a remote control module that provides two-way wireless communication with each individual lift of the system. In the embodiment depicted in FIG. **15**, the individual lifts only communicate with one another via the remote control module. As such, direct lift-to-lift two-way wireless communication need not be used during operation of the lift system. Each lift of the system can include a height sensor so that the information wirelessly communicated between the lifts and the remote control module can include information regarding the height of the carriage assembly of each lift. The remote control module employed in the system of FIG. **15** can be configured in the manner describe above with reference to FIGS. **1**-**4**.

FIG. **16** depicts a wireless portable lift system utilizing a remote level sensor located on a vehicle as the vehicle is being raised and lowered. The level sensor can be used to gather and wirelessly transmit information regarding the level condition of the vehicle. In the embodiment depicted in FIG. **16**, the level detector only communicates with a master lift having a height sensor. Using height information gathered from the height sensor on the master lift and level information gathered from the remote level sensor, the master lift can determine the height of all the slave lifts. In such a configuration, it may not be necessary for the lifts to employ two-way communication with one another. Rather, the master lift can communicate instructions to the slave lifts without receiving feedback from the slave lifts, while still ensuring that the vehicle being lifted is not undesirably out of level.

FIG. **17** depicts a wireless portable lift system utilizing a remote height sensor located on a vehicle as the vehicle is being raised and lowered. The remote height sensor can be used to gather and wirelessly transmit information regarding the height of the vehicle to a master lift. In certain embodiments, the remote height sensor can be a directional height sensor that also gathers information regarding the level condition of the vehicle. In such an embodiment, the height detector need only communicate with the master lift. Using height and level information from the height detector, the master lift can determine the height of all the lifts. In such a configuration, it may not be necessary for the lifts to employ two-way communication with one another. Rather, the master lift can communicate instructions to the slave lifts without receiving feedback from the slave lifts, while still ensuring that the vehicle being lifted is not undesirably out of level.

FIG. **18** depicts a wireless portable lift system utilizing velocity controllers, rather than height sensors, to ensure that the vehicle is maintained in a substantially level condition during raising and lowering. In such an embodiment, it is not necessary for height signals to be communicated between lifts. Rather, each lift is set to only operate within a certain narrow velocity range, so that the relative heights of the lifts stay within a certain narrow range. Such a velocity controller can be used instead of height sensors or in conjunction with height sensors to ensure proper leveling of the vehicle during lifting.

It is to be understood that while certain forms of the present invention have been illustrated and described herein, it is not to be limited to the specific forms or arrangement of parts described and shown.

The invention claimed is:

1. A wireless portable vehicle lift system comprising:
- a plurality of substantially identical individual lifts;
- a detachable remote control physically connected in wired communication with one of said individual lifts; and
- an adaptive communication system for providing wireless communication between said individual lifts, wherein said adaptive communication system is configured to automatically scan a plurality of communication channels and determine a clearest communication channel for wireless communication between said individual lifts,
- wherein each of said individual lifts comprises—
  - a base for supporting said individual lift on a floor or the ground,
  - a post coupled to said base and extending upwardly from said base,
  - a carriage configured to engage a wheel of a vehicle,
  - a lifting actuator configured to vertically shift said carriage relative to said post,

a height sensor configured to measure a height of said carriage and/or vehicle,

a rechargeable battery,

a battery charger,

an e-stop button,

a transceiver configured to operate on said clearest communication channel, and

a user interface comprising a display screen,

wherein said user interface is configured to display height information, weight information, and battery status information,

wherein said user interface is configured to display a pass code screen that prompts the lift operator to enter a pass code,

wherein each of said individual lifts is configured to track and/or store lift data relevant to safety, maintenance, and/or proper operation of said lift system,

wherein each of said individual lifts is configured to provide a notification of maintenance needs based on said lift data,

wherein said lift system is configured to be selectively operated in a paired mode where two of said individual lifts are paired with one another and operate independently of the other of said individual lifts that are not paired.

2. The vehicle lift system of claim **1**, wherein said adaptive communication system enables each of said individual lifts to track its own actions and the actions of all other individual lifts of said lift system to there by provide collective intelligence that enables coordinated lifting a vehicle with none of said individual lifts being a dedicated master lift or slave lift.

3. The vehicle lift system of claim **1**, wherein each of said individual lifts comprises an interface microprocessor configured to process information relating to said user interface, a control microprocessor configured to process information relating to at least said height sensor and said lifting actuator, and a common area of memory shared by said interface and control microprocessors.

4. The vehicle lift system of claim **3**, wherein each of said individual lifts comprises a communication microprocessor configured to process information relating to wireless communication between said individual lifts, wherein said communication microprocessor shares said common area of memory with said interface and control microprocessors.

5. The vehicle lift system of claim **3**, wherein said common area of memory comprises a communication buffer resident in said control microprocessor.

6. The vehicle lift system of claim **1**, wherein said adaptive communication system is configured to scan communication channels and determine said clearest communication channel during initial establishment of a secure communication link between said individual lifts.

7. The vehicle lift system of claim **1**, wherein said adaptive communication system is configured to transmit a beacon signal from a first of said individual lifts to be powered up, wherein said beacon signal is maintained during establishment of a secure communication link between all said individual lifts of said lift system.

8. The vehicle lift system of claim **1**, wherein none of said individual lifts are a master lift or a slave lift, wherein said adaptive communication system is configured to use one of said individual lifts as a pseudo master lift for communication purposes, wherein said pseudo master lift poles said individual lifts for data.

9. The vehicle lift system of claim **8**, wherein the same one of said individual lifts is maintained as said pseudo master lift during operation of said lift system.

10. The vehicle lift system of claim **1**, wherein said lifting actuator is a hydraulic actuator.

11. A wireless portable vehicle lift system comprising:

a plurality of substantially identical individual lifts;

an adaptive communication system for providing wireless communication between said individual lifts of said lift system, wherein said adaptive communication system is configured to automatically scan a plurality of communication channels and determine a clearest communication channel for wireless communication between said individual lifts, wherein each of said individual lifts comprises—

a base for supporting said individual lift on a floor or the ground,

a post coupled to said base and extending upwardly from said base,

a carriage configured to engage a wheel of a vehicle and configured to be vertically shiftable relative to said post,

a rechargeable battery,

a battery charger,

an e-stop button,

a transceiver configured to operate on said clearest communication channel, and

a user interface comprising a display screen.

12. The vehicle lift system of claim **11**, wherein said adaptive communication system is configured to scan communication channels and determine said clearest communication channel during initial establishment of a secure communication link between said individual lifts.

13. The vehicle lift system of claim **11**, wherein said adaptive communication system is configured to scan communication channels and determine said clearest communication channel on a periodic basis during operation of said lift system.

14. The vehicle lift system of claim **11**, wherein said adaptive communication system is configured to i) determine said clearest communication channel during initial establishment of a secure communication link between said individual lifts and ii) periodically assess and update said clearest communication channel during operation of said lift system.

15. The vehicle lift system of claim **11**, wherein said adaptive communication system is configured to transmit a beacon signal from a first of said individual lifts to be powered up, wherein said beacon signal is maintained during establishment of a secure communication link between all said individual lifts of said lift system.

16. The vehicle lift system of claim **11**, wherein said adaptive communication system is configured to use one of said individual lifts as a polling lift to ask for data from other of said individual lifts in said lift system, wherein each of said individual lifts is capable of operating as said polling lift, wherein said adaptive communication system is configured such that each of said individual lifts replies to said polling lift with data about said individual lift, wherein said replies are heard by all of said individual lifts, wherein each of said individual lifts comprises a data buffer, wherein data from said replies of said individual lifts is stored in said data buffer of each of said individual lifts.

17. The vehicle lift system of claim **11**, further comprising a remote control configured for wired communication with at least one of said individual lifts, wherein said remote control is configured to be removably attached to said at least one of said individual lifts.

18. The vehicle lift system of claim **11**, wherein each of said lifts is configured to track and/or store lift data relevant to safety, maintenance, and/or proper operation of said lift system, wherein each of said individual lifts is configured to provide a notification of maintenance needs based on said lift data, wherein said user interface is programmed to include a pass code screen that prompts the operator to enter a pass code, wherein said lift system is configured to be selectively operated in a paired mode where two of said individual lifts are paired with one another and operate independently of the other of said individual lifts that are not paired, wherein said lift system is configured to lock out from movement said individual lifts that are not paired, wherein each individual lift, when initially turned on, is configured to perform a self-check of systems that control lift movement, display lift data, and/or receive commands from a lift operator, wherein said display screen is configured to display height information, weight information, and battery status information, wherein each of said individual lifts comprises an adaptive frequency hopping transceiver configured to operate on a plurality of frequencies.

19. The vehicle lift system of claim **11**, wherein each of said individual lifts comprises an interface microprocessor configured to process information relating to said user interface, a lift sensor, a lift actuator, a control microprocessor configured to process information relating to said lift sensor and lift actuator, a communication microprocessor configured to process information relating to wireless communication between said individual lifts, a common area of memory shared by said interface, control, and communication microprocessors, wherein said interface, control, and communication microprocessors are configured to push and pop commands and/or data between one another using said common area of memory, wherein said adaptive communication system is configured to continuously update said common area of memory of each of said individual lifts with information about all of said individual lifts to there by provide collective intelligence that enables coordinated lifting of a vehicle.

20. A method of operating a wireless portable vehicle lift system, said method comprising:

(a) providing a plurality of substantially identical individual lifts, wherein each individual lift comprises a base, a post, a carriage, a rechargeable battery, a display screen, and a radio frequency transceiver capable of operating on multiple channels;

(b) positioning said carriages of at least two of said individual lifts into engagement with wheels of a vehicle;

(c) establishing a secure wireless communication link between at least two of said individual lifts to thereby form a lift ensemble of said individual lifts, wherein said establishing includes—

(i) a lift operator powering up a first of said individual lifts,

(ii) said first lift automatically scanning a plurality of communication frequencies or channels and determining a communication frequency or channel of minimal noise content,

(iii) said first lift wirelessly transmitting a beacon signal,

(iv) a lift operator powering up a second of said individual lifts,

(v) said second lift detecting said beacon signal and determining that said second lift is not the first of said individual lifts to be powered up, and

(vi) said first and second lifts wirelessly exchanging lift identification information; and

(d) lifting a vehicle with said lift ensemble by vertically shifting said carriages of said individual lifts of said lift ensemble in a coordinated manner, wherein during said lifting said individual lifts wirelessly share data with one another so as to coordinate said lifting using collective intelligence of said lift ensemble.

21. The method of claim **20**, further comprising, using said frequency or channel of minimal noise content during said lifting of step (d) to wirelessly share data between said individual lifts.

22. The method of claim **21**, further comprising, during said lifting of step (d), i) periodically scanning said plurality of communication frequencies or channels to determine a clearest communication frequency or channel and ii) using said clearest communication frequency or channel for wireless communication between said individual lifts.

23. The method of claim **20**, wherein said communication frequency or channel of minimal noise content is a clearest communication channel, further comprising using said clearest communication channel for wireless communication between said individual lifts during said establishing of step (c) and/or said lifting of step (d).

24. The method of claim **20**, further comprising, during said lifting of step (d), communicating lift synchronization data and emergency data among all said individual lifts in a near real time manner.

25. The method of claim **24**, wherein said communicating includes one of said lifts transmitting a polling signal and the other of said individual lifts responding to said polling signal.

26. The method of claim **20**, wherein said lift system comprises an adaptive communication system capable of operating on multiple frequencies or channels, wherein during said lifting of step (d) said adaptive communication system (i) communicates command and control information to all of said individual lifts of said lift ensemble and (ii) provides continuous synchronous updating of a common data buffer in each of said individual lifts, wherein said updating of said common data buffer includes transmitting height information about each individual lift in said lift ensemble to said common data buffer in each of said individual lifts.

27. The method of claim **20**, further comprising operating said lift ensemble in a paired mode where two of said individual lifts raise and lower in a coordinated manner while the other of said individual lifts remain stationary.

28. The method of claim **20**, wherein each of said individual lifts further comprises a lifting actuator, a height sensor, a display microprocessor, and a control microprocessor, wherein said lifting actuator is configured to vertically shift said carriage relative to said post, wherein said height sensor is configured to provide information about the position of said carriage and/or vehicle, wherein said display microprocessor is configured to process information relating to at least said display screen, wherein said control microprocessor is configured to process information relating to at least said lifting actuator and said height sensor, wherein said display microprocessor and said control microprocessor are configured to communicate with one another.

29. The method of claim **28**, wherein said display microprocessor and said control microprocessor share a common area of memory.

30. The method of claim **28**, wherein each of said individual lifts comprise a COP watchdog configured to reset said control microprocessor in the event of a failure of or locking of said control microprocessor.

* * * * *

EXHIBIT

B

Claim Chart - Independent Claims of U.S. Patent No. 10,457,536 and Ashburn Volunteer Fire and Rescue Department's Use of Accused Wireless Portable Vehicle Lift Systems Comprising SW3 Wireless Column Lifts

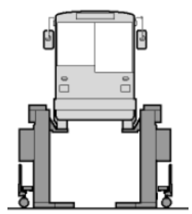
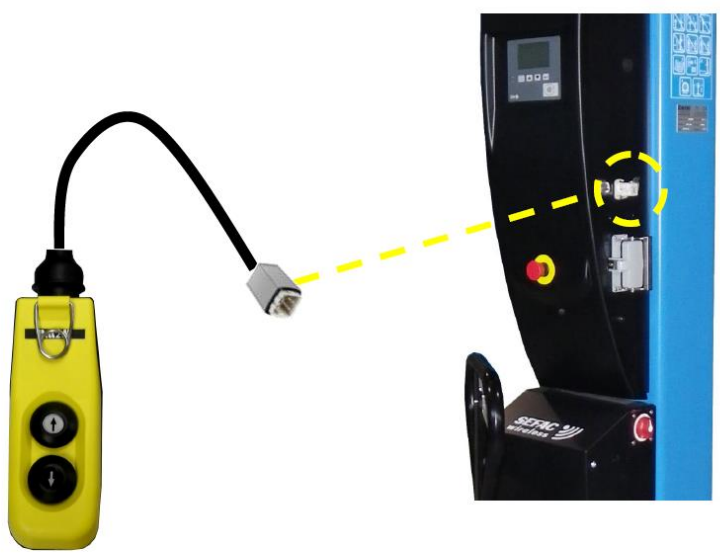
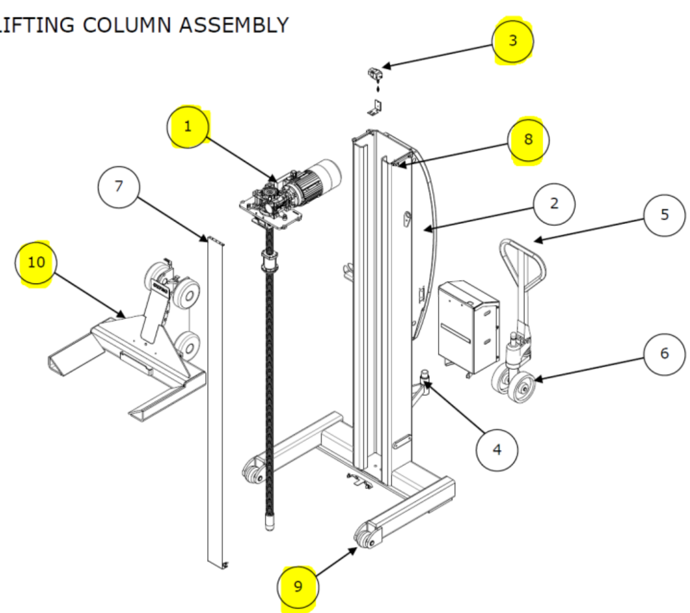
Claim 1	Accused Wireless Portable Vehicle Lift Systems
1. A ***wireless portable vehicle lift*** system comprising:	**Source: SW 2.2. Operator's Handbook** **Operator's handbook** **wireless mobile column lift**  **Machine description:** Road vehicle lift. **Type:** **SW2.2**
a ***plurality*** of ***substantially identical individual lifts***; and	**Source: SW 2.2. Operator's Handbook** Number of columns | 1 to 8, all identical (no master or slave)
a detachable ***remote control*** physically connected in wired communication with one of said individual lifts; and	**Source: SW 2.2. Operator's Handbook** **Pendant remote control:** To control the whole set, it is necessary to connect the pendant remote control to one of the lifting columns (depending on the selected operating mode): 

EXHIBIT B

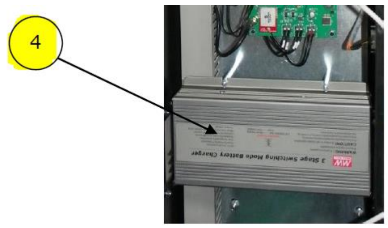
<table>
<tr><th>Claim 1</th><th>Accused Wireless Portable Vehicle Lift Systems</th></tr>
<tr><td>an adaptive communication system for providing wireless communication between said individual lifts, wherein said adaptive communication system is configured to automatically scan a plurality of communication channels and determine a clearest communication channel for wireless communication between said individual lifts,</td><td><u>Source: SW 2.2. Operator's Handbook</u>
<table>
<tr><td>⚠ 19</td><td>SWiP network unavailable</td><td>No channel available for the wireless connection.</td><td>Switch off a SEFAC set which uses the SWiP network in order to free a channel and/or switch to wire connection.</td></tr>
</table>
<u>Source: SefacUSA's U.S. Patent No. 10,005,648</u>
"A radio communication method between a plurality of columns the method comprising the steps of: providing said plurality of columns in communication by a multichannel mode comprised of a plurality radio channels … scanning transmissions of said radio channels by each column so as to detect available channels, occupied channels, and scrambled channels … selecting a free channel selected from said available channels" 11:63-12:14.

"[T]he first selected column chooses the free channel having the lowest noise level." 5:66-67.</td></tr>
<tr><td>wherein each of said individual lift comprises-
a base for supporting said individual lift on a floor or the ground,
a post coupled to said base and extending upwardly from said base,
a carriage configured to engage a wheel of a vehicle,
a lifting actuator configured to vertically shift said carriage relative to said post,
a height sensor configured to measure a height of said carriage and/or vehicle,</td><td><u>Source: SW 2.2. Operator's Handbook</u>
8.2 LIFTING COLUMN ASSEMBLY


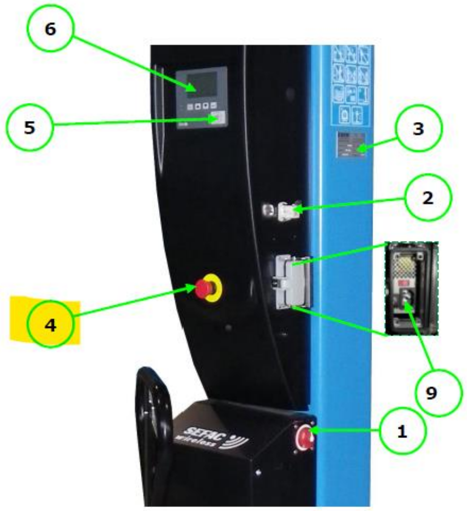
*9 – Base
*8 – Post
*10 – Carriage
*1 – Lifting Actuator
*3 – Height Sensor</td></tr>
</table>

EXHIBIT B

<table>
<tr><th>Claim 1</th><th>Accused Wireless Portable Vehicle Lift Systems</th></tr>
<tr><td>a rechargeable battery,</td><td><u>Source: SW 2.2. Operator’s Handbook</u>
8.5.3 BATTERY


SEFAC uses deep cycle type batteries, i.e. batteries that are designed for slow discharge and a significant number of charging / discharging cycles (higher mass loading).
The number of cycles depends on how the batteries are being used. The following recommendations will help you optimise the lifespan of your batteries:
•Do not recharge the battery before the low battery indicator appears. In fact, any recharge cycle that is begun “consumes” the battery life irrespective of the duration of the cycle;</td></tr>
<tr><td>a battery charger,</td><td><u>Source: SW 2.2. Operator’s Handbook</u>


<table><tr><th>ITEM</th><th>DESCRIPTION</th><th>PART NUMBER</th></tr><tr><td>1</td><td>Inverter</td><td>5010006C</td></tr><tr><td>2</td><td>Logic board</td><td>5029061</td></tr><tr><td>3</td><td>Electric relays</td><td>5002076</td></tr><tr><td>4</td><td>Battery charger</td><td>5020770</td></tr></table></td></tr>
</table>

Claim 1	Accused Wireless Portable Vehicle Lift Systems
an ***e-stop button***,	**<u>Source: SW 2.2. Operator's Handbook</u>**  *4 – e-stop button

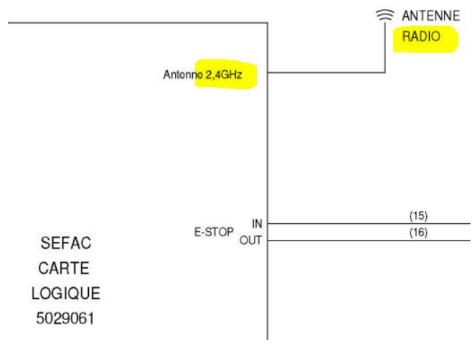
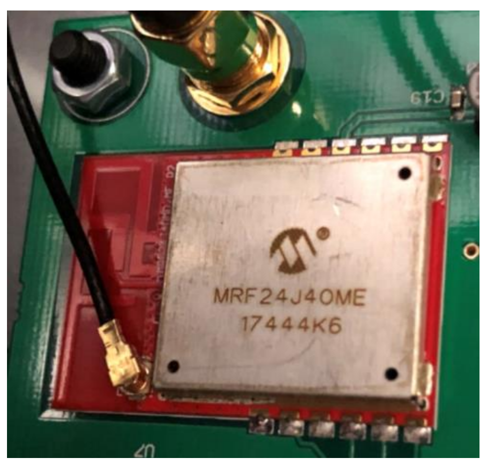
a ***transceiver*** configured to operate on ***said clearest communication channel***, and	**<u>Source: SW 2.2. Operator's Handbook</u>**  **<u>Source: SW 2.2 lift</u>**  *The ***radio frequency transceiver*** on the primary circuit board is circled above.  *The RF transceiver on the SW 2.2 is a Microchip model MRF24J40ME, which includes a MFR24J40 Microprocessor

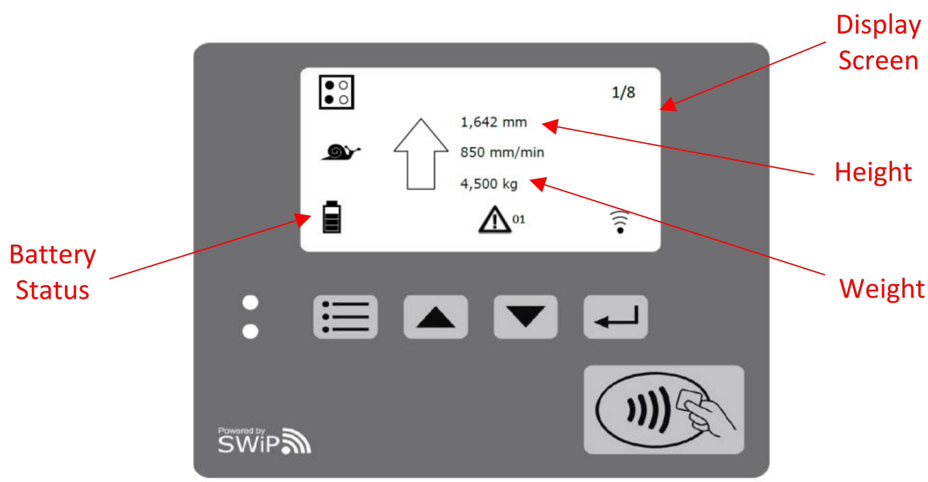
EXHIBIT B

<table>
<tr><th>Claim 1</th><th>Accused Wireless Portable Vehicle Lift Systems</th></tr>
<tr><td></td><td>
<table>
<tr><td>⚠ 19</td><td>SWiP network unavailable</td><td>No channel available for the wireless connection.</td><td>Switch off a SEFAC set which uses the SWiP network in order to free a channel and/or switch to wire connection.</td></tr>
</table>

<u>Source: SefacUSA’s U.S. Patent No. 10,005,648</u>

“A radio communication method between a plurality of columns the method comprising the steps of: providing said plurality of columns in communication by a multichannel mode comprised of a plurality radio channels … scanning transmissions of said radio channels by each column so as to detect available channels, occupied channels, and scrambled channels … selecting a free channel selected from said available channels” 11:63-12:14.

“[T]he first selected column chooses the free channel having the lowest noise level.” 5:66-67.
</td></tr>
<tr><td>a user interface comprising a display screen,
wherein said user interface is configured to display height information, weight information, and battery status information,</td><td>
<u>Source: SW 2.2. Operator’s Handbook</u>



</td></tr>
</table>

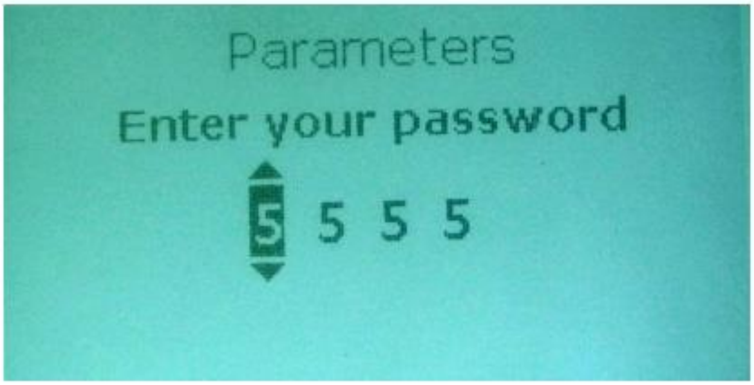
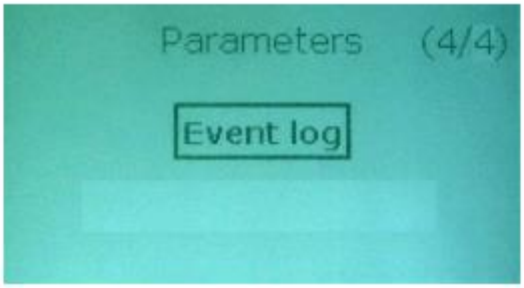
Claim 1	Accused Wireless Portable Vehicle Lift Systems
wherein said user interface is configured to display a ***pass code screen that prompts the lift operator to enter a pass code***,	**<u>Source: SW 2.2. Operator's Handbook</u>** The screen prompts you to enter your password. 
wherein each of said individual lifts is configured to track and/or store ***lift data relevant to safety, maintenance, and/or proper operation of said lift system***,	**<u>Source: SW 2.2. Operator's Handbook</u>** **Presentation of the maintenance menu** To access the maintenance menu, position the cursor on the pictogram on the screen, then press the validation key .  - Reading of the event log. 

EXHIBIT B

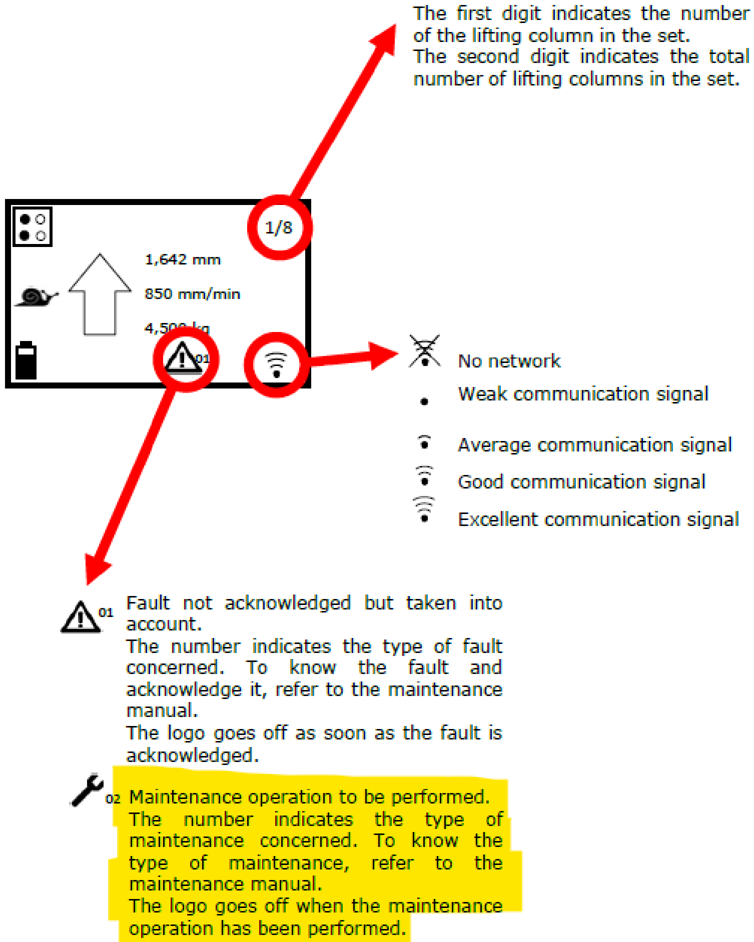
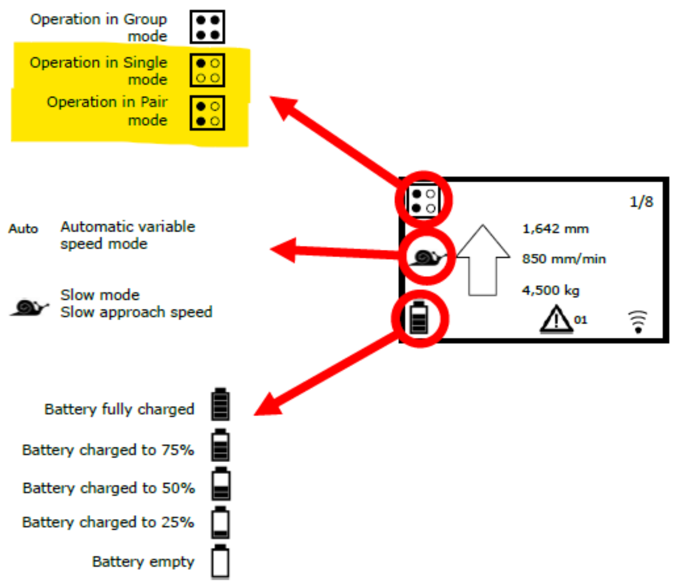
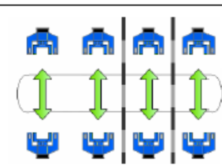
Claim 1	Accused Wireless Portable Vehicle Lift Systems
wherein each of said individual lifts is configured ***to provide a notification of maintenance needs based on said lift data***,	**<u>Source: SW 2.2. Operator's Handbook</u>** 

 EXHIBIT B

Claim 1	Accused Wireless Portable Vehicle Lift Systems
wherein said lift system is configured to be selectively operated in a ***paired mode where two of said individual lifts are paired with one another*** and ***operate independently of the other of said individual lifts that are not paired***.	**<u>Source: SW 2.2. Operator's Handbook</u>**



The table below gives a summary of the different operating modes:

OPERATION		
Pictogram on screen	Up / Down	Configuration with 4/6/8 lifting columns
⚃	Set of 4, 6 or 8 lifting columns *	
(Pair pictogram)	Pair **	
(Single pictogram)	Single **	

* The lifting columns are controlled from any lifting column.
** The lifting columns are controlled from their own control panels, using the pendant remote control.

EXHIBIT B

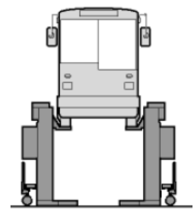
<table>
<tr><th>Claim 11</th><th>Accused Wireless Portable Vehicle Lift Systems</th></tr>
<tr><td>11. A wireless portable vehicle lift system comprising:</td><td><u>Source: SW 2.2. Operator's Handbook</u>
Operator's handbook
wireless mobile column lift

Machine description: Road vehicle lift.
Type: SW2.2</td></tr>
<tr><td>a plurality of substantially identical individual lifts; and</td><td><u>Source: SW 2.2. Operator's Handbook</u><table><tr><td>Number of columns</td><td>1 to 8, all identical (no master or slave)</td></tr></table></td></tr>
<tr><td>an adaptive communication system for providing wireless communication between said individual lifts, wherein said adaptive communication system is configured to automatically scan a plurality of communication channels and determine a clearest communication channel for wireless communication between said individual lifts,</td><td><u>Source: SW 2.2. Operator's Handbook</u><table><tr><td>⚠ 19</td><td>SWiP network unavailable</td><td>No channel available for the wireless connection.</td><td>Switch off a SEFAC set which uses the SWiP network in order to free a channel and/or switch to wire connection.</td></tr></table><u>Source: SefacUSA's U.S. Patent No. 10,005,648</u>
"A radio communication method between a plurality of columns the method comprising the steps of: providing said plurality of columns in communication by a multichannel mode comprised of a plurality radio channels … scanning transmissions of said radio channels by each column so as to detect available channels, occupied channels, and scrambled channels … selecting a free channel selected from said available channels" 11:63-12:14.

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EXHIBIT B

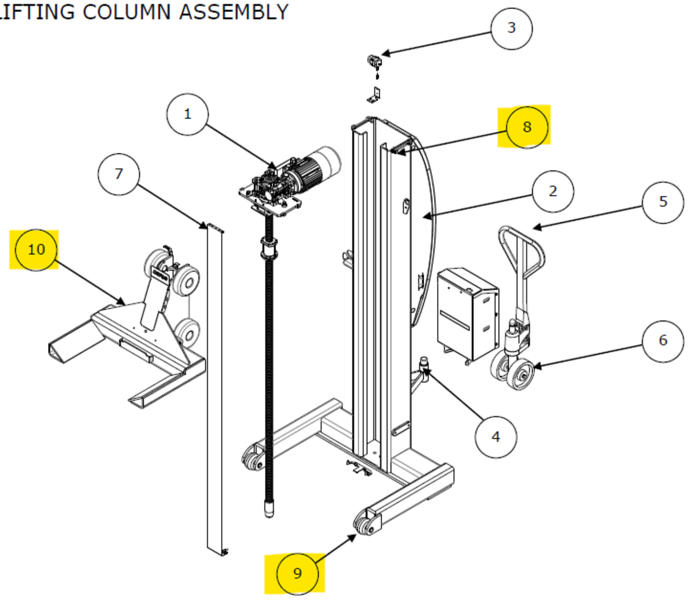
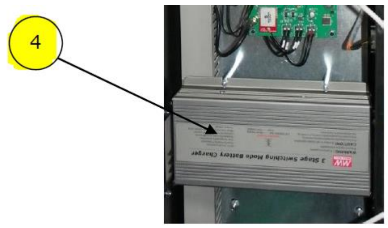
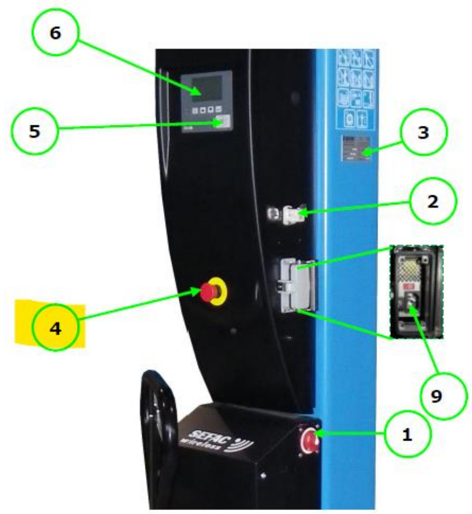
Claim 11	Accused Wireless Portable Vehicle Lift Systems
wherein each of said individual lift comprises- a ***base*** for supporting said individual lift on a floor or the ground, a ***post*** coupled to said base and extending upwardly from said base, a ***carriage*** configured to engage a wheel of a vehicle and configured to be vertically shiftable relative to said post,	**<u>Source: SW 2.2. Operator's Handbook</u>** 8.2 LIFTING COLUMN ASSEMBLY  *9 – Base *8 – Post *10 – Carriage
a ***rechargeable battery***,	**<u>Source: SW 2.2. Operator's Handbook</u>** 8.5.3 BATTERY  SEFAC uses deep cycle type batteries, i.e. batteries that are designed for slow discharge and a significant number of charging / discharging cycles (higher mass loading). The number of cycles depends on how the batteries are being used. The following recommendations will help you optimise the lifespan of your batteries: •Do not recharge the battery before the low battery indicator appears. In fact, any recharge cycle that is begun "consumes" the battery life irrespective of the duration of the cycle;

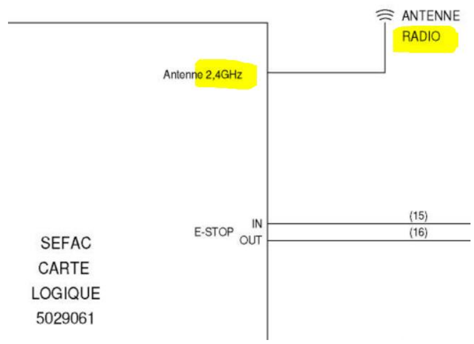
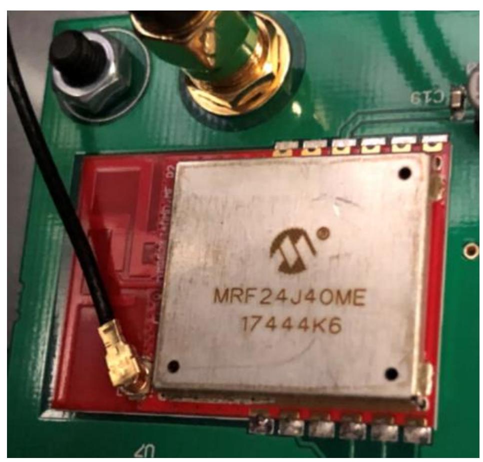
EXHIBIT B

<table>
<tr><th>Claim 11</th><th>Accused Wireless Portable Vehicle Lift Systems</th></tr>
<tr><td>a battery charger,</td><td><u>Source: SW 2.2. Operator’s Handbook</u>


<table><tr><th>ITEM</th><th>DESCRIPTION</th><th>PART NUMBER</th></tr><tr><td>1</td><td>Inverter</td><td>5010006C</td></tr><tr><td>2</td><td>Logic board</td><td>5029061</td></tr><tr><td>3</td><td>Electric relays</td><td>5002076</td></tr><tr><td>4</td><td>Battery charger</td><td>5020770</td></tr></table></td></tr>
<tr><td>an e-stop button,</td><td><u>Source: SW 2.2. Operator’s Handbook</u>


*4 – e-stop button</td></tr>
</table>

EXHIBIT B

a ***transceiver*** configured to operate on ***said clearest communication channel***, and	**Source: SW 2.2. Operator's Handbook**  **Source: SW 2.2 Lift**  *The ***radio frequency transceiver*** on the primary circuit board is circled above.  *The RF transceiver on the SW 2.2 is a Microchip model MRF24J40ME, which includes a MFR24J40 Microprocessor

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<tr><th>Claim 11</th><th>Accused Wireless Portable Vehicle Lift Systems</th></tr>
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<tr><td>⚠ 19</td><td>SWiP network unavailable</td><td>No channel available for the wireless connection.</td><td>Switch off a SEFAC set which uses the SWiP network in order to free a channel and/or switch to wire connection.</td></tr>
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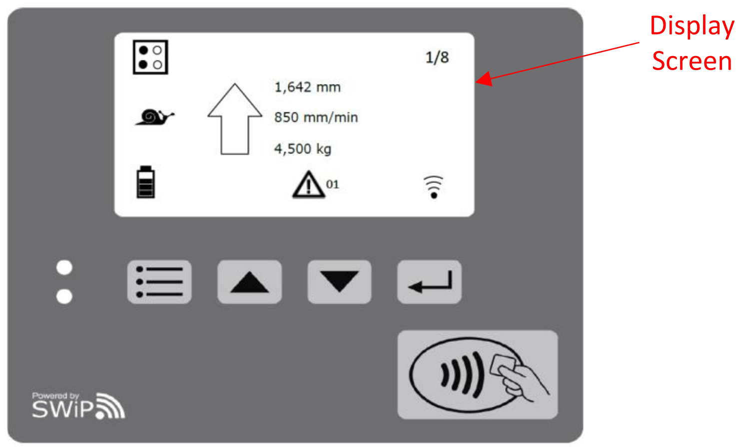
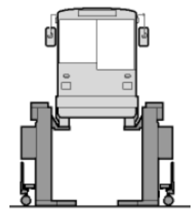
<u>Source: SefacUSA's U.S. Patent No. 10,005,648</u>

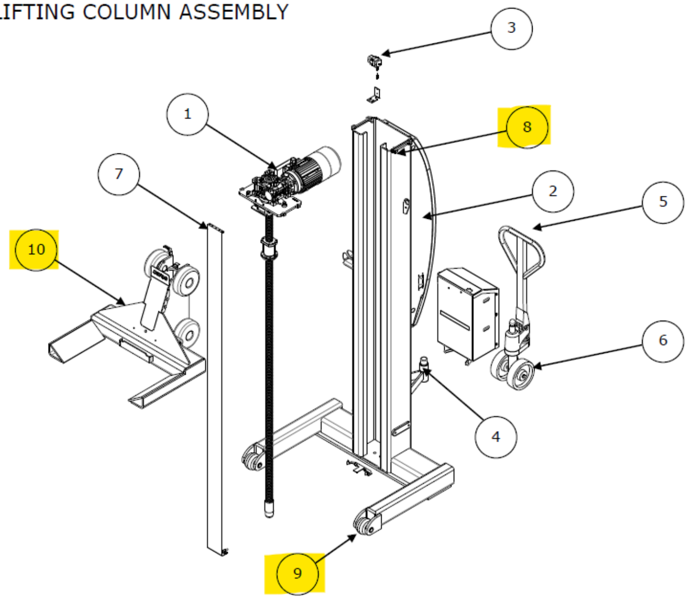
"A radio communication method between a plurality of columns the method comprising the steps of: providing said plurality of columns in communication by a multichannel mode comprised of a plurality radio channels … scanning transmissions of said radio channels by each column so as to detect available channels, occupied channels, and scrambled channels … selecting a free channel selected from said available channels" 11:63-12:14.

"[T]he first selected column chooses the free channel having the lowest noise level." 5:66-67.
</td></tr>
<tr><td>a user interface comprising a display screen.</td><td>
<u>Source: SW 2.2. Operator's Handbook</u>



</td></tr>
</table>

Claim 20	Accused Wireless Portable Vehicle Lift Systems
11. A method of operating a ***wireless portable vehicle lift system***, said method comprising:	**Source: SW 2.2. Operator's Handbook** **Operator's handbook** **wireless mobile column lift**  **Machine description:** Road vehicle lift. **Type:** **SW2.2**
(a) providing a ***plurality of substantially identical individual lifts***,	**Source: SW 2.2. Operator's Handbook** Number of columns | 1 to 8, all identical (no master or slave) **Source: Video Posted to Bobby's World Facebook Page** 

<table>
<tr><th>Claim 20</th><th>Accused Wireless Portable Vehicle Lift Systems</th></tr>
<tr><td>wherein each individual lift comprises a base, a post, a carriage,</td><td><u>Source: SW 2.2. Operator's Handbook</u>
8.2 LIFTING COLUMN ASSEMBLY


*9 – Base
*8 – Post
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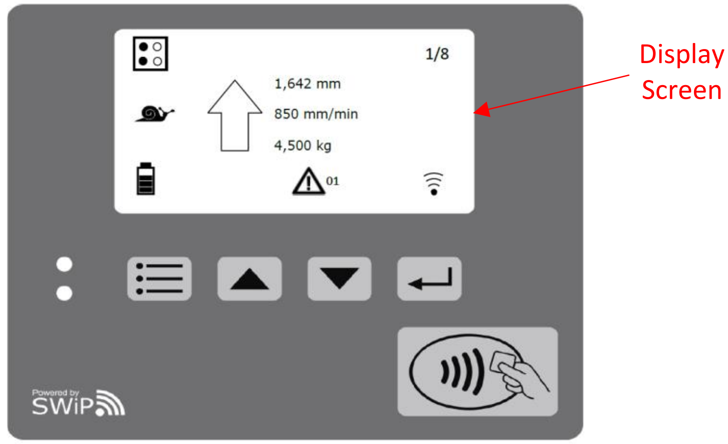
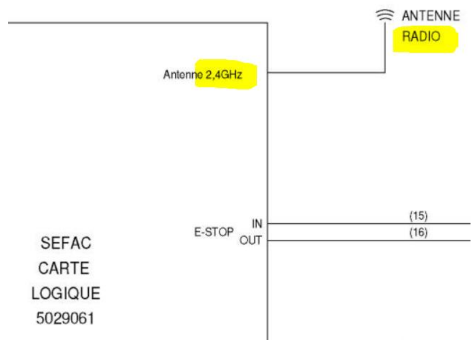
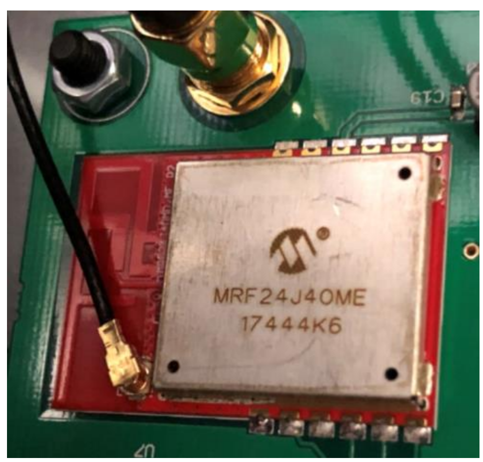
<tr><td>a rechargeable battery,</td><td><u>Source: SW 2.2. Operator's Handbook</u>
8.5.3 BATTERY


SEFAC uses deep cycle type batteries, i.e. batteries that are designed for slow discharge and a significant number of charging / discharging cycles (higher mass loading).
The number of cycles depends on how the batteries are being used. The following recommendations will help you optimise the lifespan of your batteries:
•Do not recharge the battery before the low battery indicator appears. In fact, any recharge cycle that is begun "consumes" the battery life irrespective of the duration of the cycle;</td></tr>
</table>

Claim 20	Accused Wireless Portable Vehicle Lift Systems
a ***display screen***, and	**<u>Source: SW 2.2. Operator's Handbook</u>** 

a ***radio frequency transceiver capable of operating on multiple channels***,	**<u>Source: SW 2.2. Operator's Handbook</u>**  **<u>Source: SW 2.2 Lift</u>**  *The ***radio frequency transceiver*** on the primary circuit board is circled above.  *The RF transceiver on the SW 2.2 is a Microchip model MRF24J40ME, which includes a MFR24J40 Microprocessor

<table>
<tr><th>Claim 20</th><th>Accused Wireless Portable Vehicle Lift Systems</th></tr>
<tr><td></td><td>

⚠ 19	SWiP network unavailable	No channel available for the wireless connection.	Switch off a SEFAC set which uses the SWiP network in order to free a channel and/or switch to wire connection.

<u>Source: SefacUSA's U.S. Patent No. 10,005,648</u>

"A ***radio communication*** method between a plurality of columns the method comprising the steps of: providing said plurality of columns in communication by a multichannel mode comprised of a ***plurality radio channels*** … ***scanning*** transmissions of said ***radio channels*** by each column so as to ***detect available channels***, occupied channels, and scrambled channels … ***selecting a free channel*** selected from said available channels" 11:63-12:14.

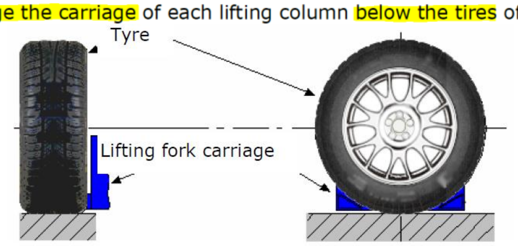
"[T]he first selected column chooses the free channel having the ***lowest noise level***." 5:66-67.

</td></tr>
<tr><td>(b) positioning said carriages of at least two of said individual lifts into engagement with wheels of a vehicle;</td><td>

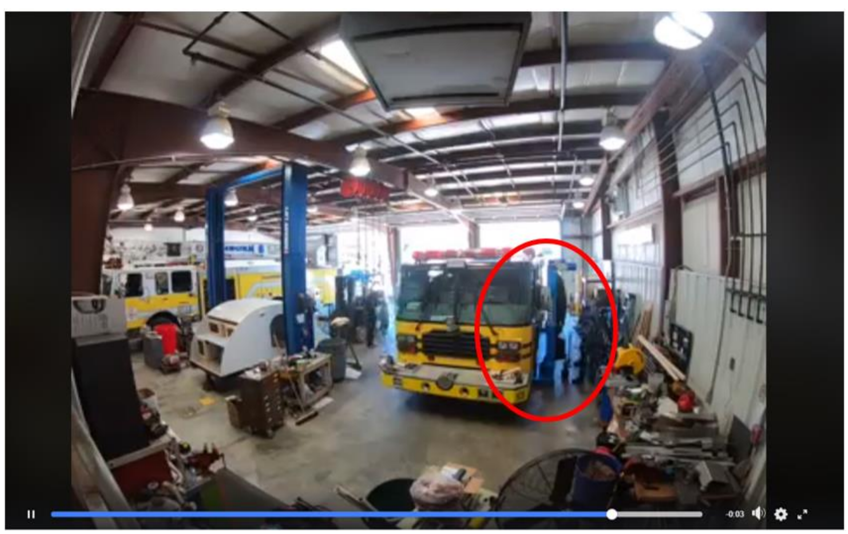
<u>Source: SW 2.2. Operator's Handbook</u>

INSTRUCTIONS RELATED TO THE LOAD TO BE LIFTED – THE OPERATOR MUST

- Fully engage the carriage of each lifting column below the tires of the vehicle.

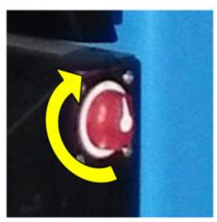


<u>Source: Video Posted to Bobby's World Facebook Page</u>



</td></tr>
</table>

<table>
<tr><th>Claim 20</th><th>Accused Wireless Portable Vehicle Lift Systems</th></tr>
<tr><td>(c) establishing a secure wireless communication link between at least two of said individual lifts to thereby form a lift ensemble of said individual lifts, wherein said establishing includes –</td><td>
<u>Source: SW 2.2. Operator's Handbook</u>
<table>
<tr><td>Control</td><td>Whole group, single or pair</td></tr>
<tr><td>Communication</td><td>Wireless, 2.4 GHz secure protocol</td></tr>
</table>
<table>
<tr><td>⚠ 19</td><td>SWiP network unavailable</td><td>No channel available for the wireless connection.</td><td>Switch off a SEFAC set which uses the SWiP network in order to free a channel and/or switch to wire connection.</td></tr>
</table>
<u>Source: SefacUSA Website</u>
"Wireless column lifts are operating with batteries and are synchronized thanks to a patented wireless communication protocol."

<u>Source: SefacUSA's U.S. Patent No. 10,005,648</u>
"The present invention … proposes a radio communication method between columns of a lift to establish and operate a bridge made up of at least two lifting columns selected in an environment including a plurality of columns able to be used for the formation and simultaneous operation of several bridges in multichannel mode …." 2:59-65.
</td></tr>
<tr><td>(i) a lift operator powering up a first of said individual lifts,</td><td>
<u>Source: SW 2.2. Operator's Handbook</u>
<table>
<tr><th colspan="3">Lifting column 1</th></tr>
<tr><td>1.</td><td></td><td>Switch on the first lifting column.
Turn the ON/OFF switch (battery switch).</td></tr>
</table>
<u>Source: SefacUSA's U.S. Patent No. 10,005,648</u>
"Phase 1 = Phase for establishing the bridge…." 5:65

"After powering on, the column is in standby awaiting selection to form a bridge." 5:45-46.
</td></tr>
</table>

<table>
<tr><th>Claim 20</th><th>Accused Wireless Portable Vehicle Lift Systems</th></tr>
<tr><td>(ii) said first lift automatically scanning a plurality of communication frequencies or channels and determining a communication frequency or channel of minimal noise content,</td><td><u>Source: SW 2.2. Operator’s Handbook</u>
<table>
<tr><td>⚠ 19</td><td>SWiP network unavailable</td><td>No channel available for the wireless connection.</td><td>Switch off a SEFAC set which uses the SWiP network in order to free a channel and/or switch to wire connection.</td></tr>
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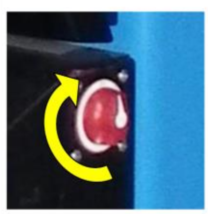
“A radio communication method between a plurality of columns the method comprising the steps of: providing said plurality of columns in communication by a multichannel mode comprised of a plurality radio channels … scanning transmissions of said radio channels by each column so as to detect available channels, occupied channels, and scrambled channels … selecting a free channel selected from said available channels” 11:63-12:14.

“[T]he first selected column chooses the free channel having the lowest noise level.” 5:66-67.</td></tr>
<tr><td>(iii) said first lift wirelessly transmitting a beacon signal,</td><td><u>Source: SefacUSA’s U.S. Patent No. 10,005,648</u>
“Phase 1 = Phase for establishing the bridge: During this phase, the first selected column chooses the free channel having the lowest noise level. It then creates a “beacon” channel on this channel and manages it, in order to allow the registration of other columns in this bridge. Each column submits its registration request in the first free slot of the beacon channel. The manager of the “beacon” channel authorizes and records the registration of the columns. The slots are assigned in the arrival order of the columns.” 5:65-6:7.</td></tr>
<tr><td>(iv) a lift operator powering up a second of said individual lifts,</td><td><u>Source: SW 2.2. Operator’s Handbook</u>
<table>
<tr><th colspan="3">Lifting column 2</th></tr>
<tr><td>7.</td><td></td><td>Switch on the second lifting column.</td></tr>
</table></td></tr>
<tr><td>(v) said second lift detecting said beacon signal and determining that said second lift is not the first of said individual lifts to be powered up, and</td><td><u>Source: SefacUSA’s U.S. Patent No. 10,005,648</u>
“Phase 1=Phase for establishing the bridge: During this phase, the first selected column chooses the free channel having the lowest noise level. It then creates a “beacon” channel on this channel and manages it, in order to allow the registration of other columns in this bridge. Each column submits its registration request in the first free slot of the beacon channel. The manager of the “beacon” channel authorizes and records the registration of the columns. The slots are assigned in the arrival order of the columns.” 5:65-6:7.</td></tr>
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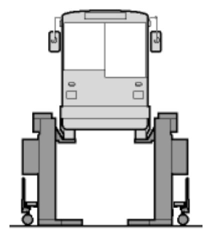
<table>
<tr><th>Claim 20</th><th>Accused Wireless Portable Vehicle Lift Systems</th></tr>
<tr><td>(vi) said first and second lifts wirelessly exchanging lift identification information; and</td><td><u>Source: SefacUSA’s U.S. Patent No. 10,005,648</u>

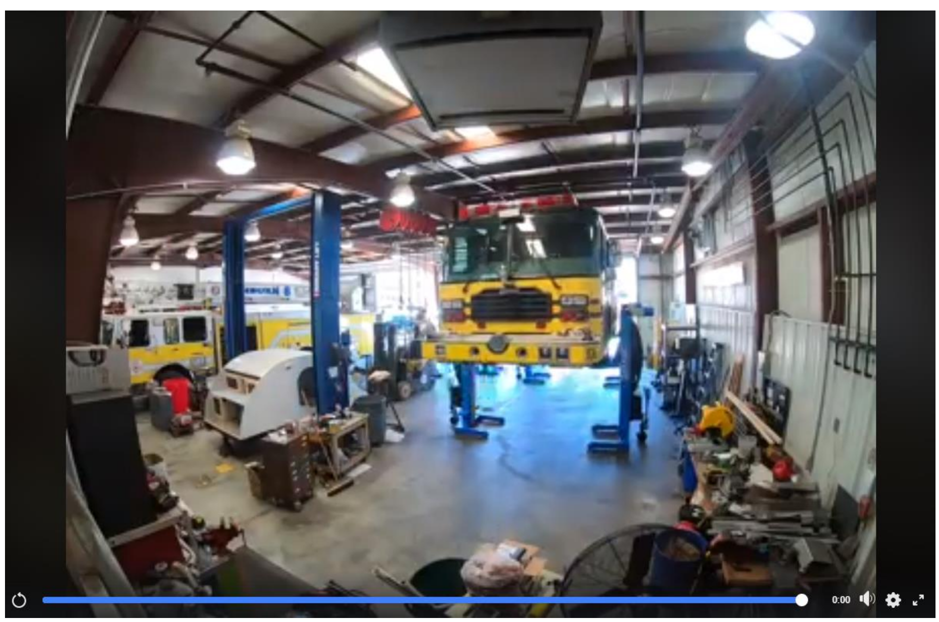
“Phase 1=Phase for establishing the bridge: During this phase, the first selected column chooses the free channel having the lowest noise level. It then creates a “beacon” channel on this channel and manages it, in order to allow the registration of other columns in this bridge. Each column submits its registration request in the first free slot of the beacon channel. The manager of the “beacon” channel authorizes and records the registration of the columns. The slots are assigned in the arrival order of the columns.” 5:65-6:7.</td></tr>
<tr><td>(d) lifting a vehicle with said lift ensemble by vertically shifting said carriages of said individual lifts of said lift ensemble in a coordinated manner,</td><td><u>Source: SW 2.2. Operator’s Handbook</u>

Product family: Vehicle lift.
Machine description: Road vehicle lift.
Type: SW2.2



Synchronisation | Automatic using electronic speed variation at +/-10 mm

<u>Source: Video Posted to Bobby’s World Facebook Page</u>

</td></tr>
</table>

Claim 20	Accused Wireless Portable Vehicle Lift Systems
wherein during ***said lifting said individual lifts wirelessly share data with one another*** so as to ***coordinate said lifting using collective intelligence*** of said lift ensemble.	**<u>Source: SefacUSA's U.S. Patent No. 10,005,648</u>** "The present invention … proposes a ***radio communication*** method between columns of a lift to ***establish and operate a bridge*** made up of ***at least two lifting columns*** …." 2:59-62. "[A]ll of the ***transmissions are heard simultaneously by all of the columns*** of the bridge and are done in 'broadcast' mode. The ***synchronization*** of the transmissions by the slots, created in the registration phase, ***is maintained during this operation phase***." 6:14-19.

JS 44 (Rev. 09/19)

CIVIL COVER SHEET

The JS 44 civil cover sheet and the information contained herein neither replace nor supplement the filing and service of pleadings or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk of Court for the purpose of initiating the civil docket sheet. *(SEE INSTRUCTIONS ON NEXT PAGE OF THIS FORM.)*

I. (a) PLAINTIFFS

Gray Manufacturing Company, Inc.

(b) County of Residence of First Listed Plaintiff: Outside of District
(EXCEPT IN U.S. PLAINTIFF CASES)

(c) Attorneys *(Firm Name, Address, and Telephone Number)*
Siddhesh V. Pandit, Maier & Maier PLLC, 345 S. Patrick Street, Alexandria, VA 22314
Tel: 703-740-8322; Email: svp@maierandmaier.com

DEFENDANTS

Ashburn Volunteer Fire and Rescue Department

County of Residence of First Listed Defendant: Loudon County, VA
(IN U.S. PLAINTIFF CASES ONLY)

NOTE: IN LAND CONDEMNATION CASES, USE THE LOCATION OF THE TRACT OF LAND INVOLVED.

Attorneys *(If Known)*

II. BASIS OF JURISDICTION *(Place an "X" in One Box Only)*

- ❒ 1 U.S. Government Plaintiff
- ☒ 3 Federal Question *(U.S. Government Not a Party)*
- ❒ 2 U.S. Government Defendant
- ❒ 4 Diversity *(Indicate Citizenship of Parties in Item III)*

III. CITIZENSHIP OF PRINCIPAL PARTIES *(Place an "X" in One Box for Plaintiff and One Box for Defendant)*

(For Diversity Cases Only)

	PTF	DEF		PTF	DEF
Citizen of This State	❒ 1	❒ 1	Incorporated *or* Principal Place of Business In This State	❒ 4	❒ 4
Citizen of Another State	❒ 2	❒ 2	Incorporated *and* Principal Place of Business In Another State	❒ 5	❒ 5
Citizen or Subject of a Foreign Country	❒ 3	❒ 3	Foreign Nation	❒ 6	❒ 6

IV. NATURE OF SUIT *(Place an "X" in One Box Only)*

Click here for: Nature of Suit Code Descriptions.

CONTRACT
- ❒ 110 Insurance
- ❒ 120 Marine
- ❒ 130 Miller Act
- ❒ 140 Negotiable Instrument
- ❒ 150 Recovery of Overpayment & Enforcement of Judgment
- ❒ 151 Medicare Act
- ❒ 152 Recovery of Defaulted Student Loans (Excludes Veterans)
- ❒ 153 Recovery of Overpayment of Veteran's Benefits
- ❒ 160 Stockholders' Suits
- ❒ 190 Other Contract
- ❒ 195 Contract Product Liability
- ❒ 196 Franchise

REAL PROPERTY
- ❒ 210 Land Condemnation
- ❒ 220 Foreclosure
- ❒ 230 Rent Lease & Ejectment
- ❒ 240 Torts to Land
- ❒ 245 Tort Product Liability
- ❒ 290 All Other Real Property

TORTS

PERSONAL INJURY
- ❒ 310 Airplane
- ❒ 315 Airplane Product Liability
- ❒ 320 Assault, Libel & Slander
- ❒ 330 Federal Employers' Liability
- ❒ 340 Marine
- ❒ 345 Marine Product Liability
- ❒ 350 Motor Vehicle
- ❒ 355 Motor Vehicle Product Liability
- ❒ 360 Other Personal Injury
- ❒ 362 Personal Injury - Medical Malpractice

PERSONAL INJURY
- ❒ 365 Personal Injury - Product Liability
- ❒ 367 Health Care/ Pharmaceutical Personal Injury Product Liability
- ❒ 368 Asbestos Personal Injury Product Liability

PERSONAL PROPERTY
- ❒ 370 Other Fraud
- ❒ 371 Truth in Lending
- ❒ 380 Other Personal Property Damage
- ❒ 385 Property Damage Product Liability

CIVIL RIGHTS
- ❒ 440 Other Civil Rights
- ❒ 441 Voting
- ❒ 442 Employment
- ❒ 443 Housing/ Accommodations
- ❒ 445 Amer. w/Disabilities - Employment
- ❒ 446 Amer. w/Disabilities - Other
- ❒ 448 Education

PRISONER PETITIONS

Habeas Corpus:
- ❒ 463 Alien Detainee
- ❒ 510 Motions to Vacate Sentence
- ❒ 530 General
- ❒ 535 Death Penalty

Other:
- ❒ 540 Mandamus & Other
- ❒ 550 Civil Rights
- ❒ 555 Prison Condition
- ❒ 560 Civil Detainee - Conditions of Confinement

FORFEITURE/PENALTY
- ❒ 625 Drug Related Seizure of Property 21 USC 881
- ❒ 690 Other

LABOR
- ❒ 710 Fair Labor Standards Act
- ❒ 720 Labor/Management Relations
- ❒ 740 Railway Labor Act
- ❒ 751 Family and Medical Leave Act
- ❒ 790 Other Labor Litigation
- ❒ 791 Employee Retirement Income Security Act

IMMIGRATION
- ❒ 462 Naturalization Application
- ❒ 465 Other Immigration Actions

BANKRUPTCY
- ❒ 422 Appeal 28 USC 158
- ❒ 423 Withdrawal 28 USC 157

PROPERTY RIGHTS
- ❒ 820 Copyrights
- ☒ 830 Patent
- ❒ 835 Patent - Abbreviated New Drug Application
- ❒ 840 Trademark

SOCIAL SECURITY
- ❒ 861 HIA (1395ff)
- ❒ 862 Black Lung (923)
- ❒ 863 DIWC/DIWW (405(g))
- ❒ 864 SSID Title XVI
- ❒ 865 RSI (405(g))

FEDERAL TAX SUITS
- ❒ 870 Taxes (U.S. Plaintiff or Defendant)
- ❒ 871 IRS—Third Party 26 USC 7609

OTHER STATUTES
- ❒ 375 False Claims Act
- ❒ 376 Qui Tam (31 USC 3729(a))
- ❒ 400 State Reapportionment
- ❒ 410 Antitrust
- ❒ 430 Banks and Banking
- ❒ 450 Commerce
- ❒ 460 Deportation
- ❒ 470 Racketeer Influenced and Corrupt Organizations
- ❒ 480 Consumer Credit (15 USC 1681 or 1692)
- ❒ 485 Telephone Consumer Protection Act
- ❒ 490 Cable/Sat TV
- ❒ 850 Securities/Commodities/ Exchange
- ❒ 890 Other Statutory Actions
- ❒ 891 Agricultural Acts
- ❒ 893 Environmental Matters
- ❒ 895 Freedom of Information Act
- ❒ 896 Arbitration
- ❒ 899 Administrative Procedure Act/Review or Appeal of Agency Decision
- ❒ 950 Constitutionality of State Statutes

V. ORIGIN *(Place an "X" in One Box Only)*

- ☒ 1 Original Proceeding
- ❒ 2 Removed from State Court
- ❒ 3 Remanded from Appellate Court
- ❒ 4 Reinstated or Reopened
- ❒ 5 Transferred from Another District *(specify)*
- ❒ 6 Multidistrict Litigation - Transfer
- ❒ 8 Multidistrict Litigation - Direct File

VI. CAUSE OF ACTION

Cite the U.S. Civil Statute under which you are filing *(Do not cite jurisdictional statutes unless diversity)*:
35 U.S.C. § 271 et seq.

Brief description of cause:
Patent Infringement

VII. REQUESTED IN COMPLAINT:

❒ CHECK IF THIS IS A **CLASS ACTION** UNDER RULE 23, F.R.Cv.P.

DEMAND $

CHECK YES only if demanded in complaint:
JURY DEMAND: ☒ Yes ❒ No

VIII. RELATED CASE(S) IF ANY

(See instructions): JUDGE DOCKET NUMBER

DATE: 10/29/2019

SIGNATURE OF ATTORNEY OF RECORD: /s/ Siddhesh V. Pandit

FOR OFFICE USE ONLY

RECEIPT # AMOUNT APPLYING IFP JUDGE MAG. JUDGE

INSTRUCTIONS FOR ATTORNEYS COMPLETING CIVIL COVER SHEET FORM JS 44

Authority For Civil Cover Sheet

The JS 44 civil cover sheet and the information contained herein neither replaces nor supplements the filings and service of pleading or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk of Court for the purpose of initiating the civil docket sheet. Consequently, a civil cover sheet is submitted to the Clerk of Court for each civil complaint filed. The attorney filing a case should complete the form as follows:

I.(a) **Plaintiffs-Defendants.** Enter names (last, first, middle initial) of plaintiff and defendant. If the plaintiff or defendant is a government agency, use only the full name or standard abbreviations. If the plaintiff or defendant is an official within a government agency, identify first the agency and then the official, giving both name and title.

(b) **County of Residence.** For each civil case filed, except U.S. plaintiff cases, enter the name of the county where the first listed plaintiff resides at the time of filing. In U.S. plaintiff cases, enter the name of the county in which the first listed defendant resides at the time of filing. (NOTE: In land condemnation cases, the county of residence of the "defendant" is the location of the tract of land involved.)

(c) **Attorneys.** Enter the firm name, address, telephone number, and attorney of record. If there are several attorneys, list them on an attachment, noting in this section "(see attachment)".

II. **Jurisdiction.** The basis of jurisdiction is set forth under Rule 8(a), F.R.Cv.P., which requires that jurisdictions be shown in pleadings. Place an "X" in one of the boxes. If there is more than one basis of jurisdiction, precedence is given in the order shown below.
United States plaintiff. (1) Jurisdiction based on 28 U.S.C. 1345 and 1348. Suits by agencies and officers of the United States are included here.
United States defendant. (2) When the plaintiff is suing the United States, its officers or agencies, place an "X" in this box.
Federal question. (3) This refers to suits under 28 U.S.C. 1331, where jurisdiction arises under the Constitution of the United States, an amendment to the Constitution, an act of Congress or a treaty of the United States. In cases where the U.S. is a party, the U.S. plaintiff or defendant code takes precedence, and box 1 or 2 should be marked.
Diversity of citizenship. (4) This refers to suits under 28 U.S.C. 1332, where parties are citizens of different states. When Box 4 is checked, the citizenship of the different parties must be checked**.** (See Section III below**; NOTE: federal question actions take precedence over diversity cases.**)

III. **Residence (citizenship) of Principal Parties.** This section of the JS 44 is to be completed if diversity of citizenship was indicated above. Mark this section for each principal party.

IV. **Nature of Suit.** Place an "X" in the appropriate box. If there are multiple nature of suit codes associated with the case, pick the nature of suit code that is most applicable. Click here for: Nature of Suit Code Descriptions.

V. **Origin.** Place an "X" in one of the seven boxes.
Original Proceedings. (1) Cases which originate in the United States district courts.
Removed from State Court. (2) Proceedings initiated in state courts may be removed to the district courts under Title 28 U.S.C., Section 1441.
Remanded from Appellate Court. (3) Check this box for cases remanded to the district court for further action. Use the date of remand as the filing date.
Reinstated or Reopened. (4) Check this box for cases reinstated or reopened in the district court. Use the reopening date as the filing date.
Transferred from Another District. (5) For cases transferred under Title 28 U.S.C. Section 1404(a). Do not use this for within district transfers or multidistrict litigation transfers.
Multidistrict Litigation – Transfer. (6) Check this box when a multidistrict case is transferred into the district under authority of Title 28 U.S.C. Section 1407.
Multidistrict Litigation – Direct File. (8) Check this box when a multidistrict case is filed in the same district as the Master MDL docket.
PLEASE NOTE THAT THERE IS NOT AN ORIGIN CODE 7. Origin Code 7 was used for historical records and is no longer relevant due to changes in statue.

VI. **Cause of Action.** Report the civil statute directly related to the cause of action and give a brief description of the cause. **Do not cite jurisdictional statutes unless diversity.** Example: U.S. Civil Statute: 47 USC 553 Brief Description: Unauthorized reception of cable service

VII. **Requested in Complaint.** Class Action. Place an "X" in this box if you are filing a class action under Rule 23, F.R.Cv.P.
Demand. In this space enter the actual dollar amount being demanded or indicate other demand, such as a preliminary injunction.
Jury Demand. Check the appropriate box to indicate whether or not a jury is being demanded.

VIII. **Related Cases.** This section of the JS 44 is used to reference related pending cases, if any. If there are related pending cases, insert the docket numbers and the corresponding judge names for such cases.

Date and Attorney Signature. Date and sign the civil cover sheet.