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(54) **SLURRY HANDLING AND VAPOR CAPTURE USING MOBILE TRANSPORT**

(71) Applicant: **ROYCO ROBOTICS, LLC**, Austin, TX (US)

(72) Inventors: **Suman Deb ROY**, New York, NY (US); **Cole STOUT**, Austin, TX (US)

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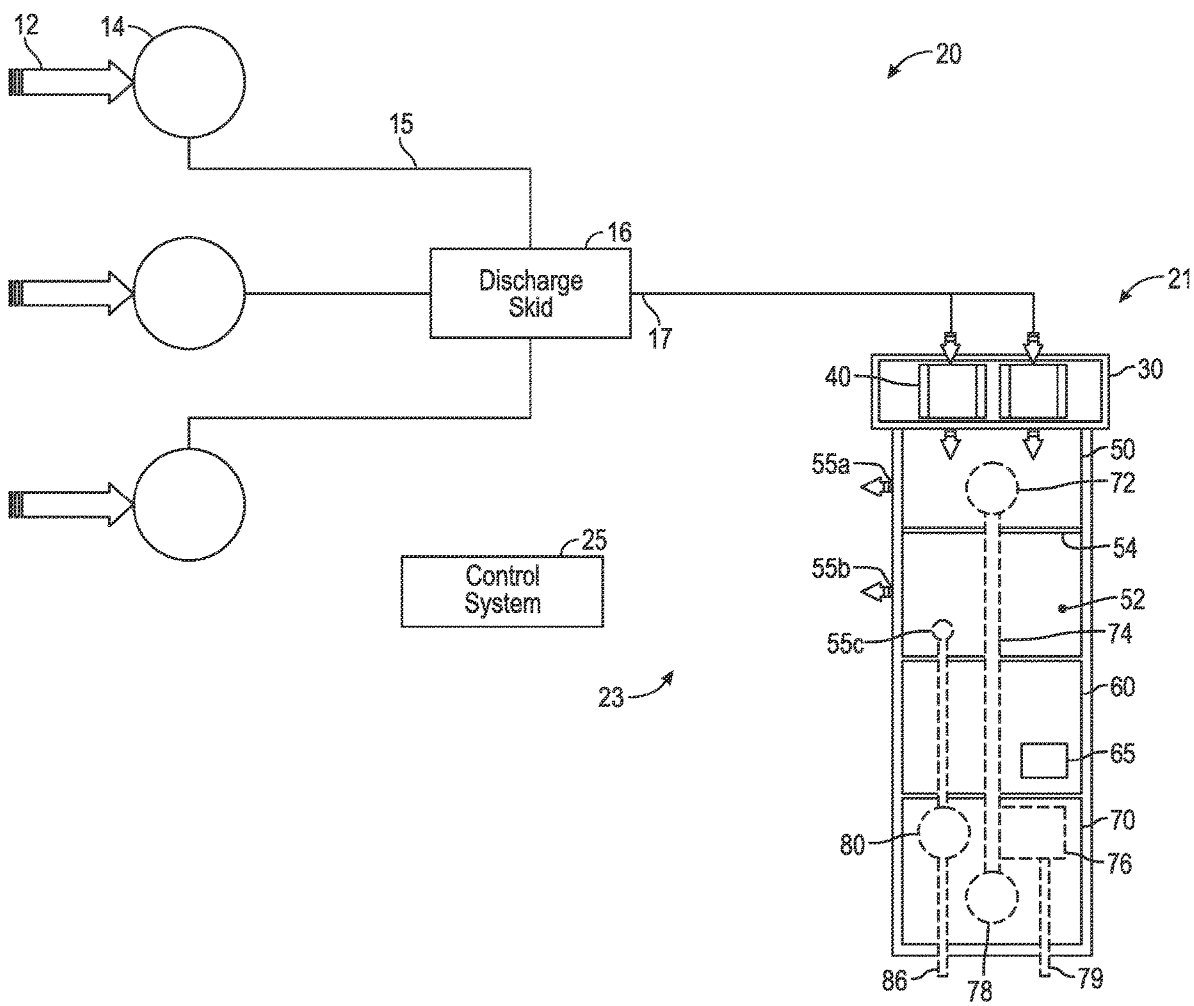
CPC *E21B 43/34* (2013.01)

(57) **ABSTRACT**

A mobile transport is used for slurry at a wellsite. An enclosure on the mobile transport has a chamber configured to hold the slurry, and a weighing assembly on the mobile transport is configured to weigh solid content of the slurry discharged from the wellsite to the chamber. One or more level sensors on the mobile transport are configured to measure a level of the slurry in the chamber, and one or more gas sensors on the mobile transport are configured to measure a property (e.g., content, proportion, etc.) of gas content in the chamber. A vapor recovery assembly on the mobile transport is in communication with the chamber. The vapor recovery assembly is configured to draw the gas content of the slurry from the chamber or capture any gas out and prevent it from emitting into the atmosphere. A control system is in operational communication with the weighing assembly, the one or more level sensors, the one or more gas sensors, and the vapor recovery assembly. The control system is configured to control the vapor recovery assembly at least in response to the measured property of the gas content in the chamber and can be configured or adjusted on demand remotely. The recovered gas can be fed into the sales pipeline for use at or beyond the facility.



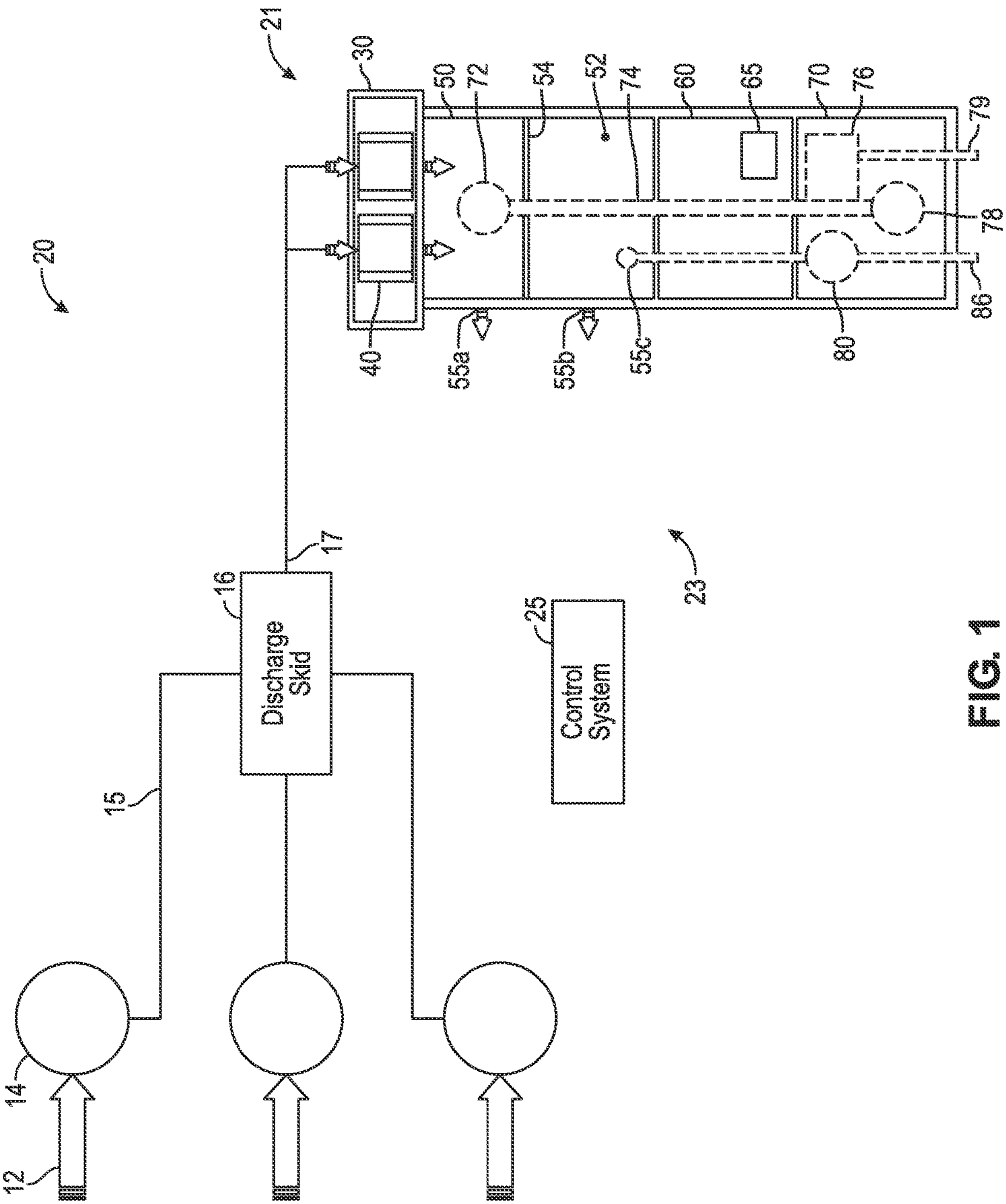

20
21
30
50
72
54
52
74
60
65
70
76
79
78
86
80
40
55a
55b
55c
17
16
Discharge Skid
15
25
Control System
23
14
12

FIG. 1

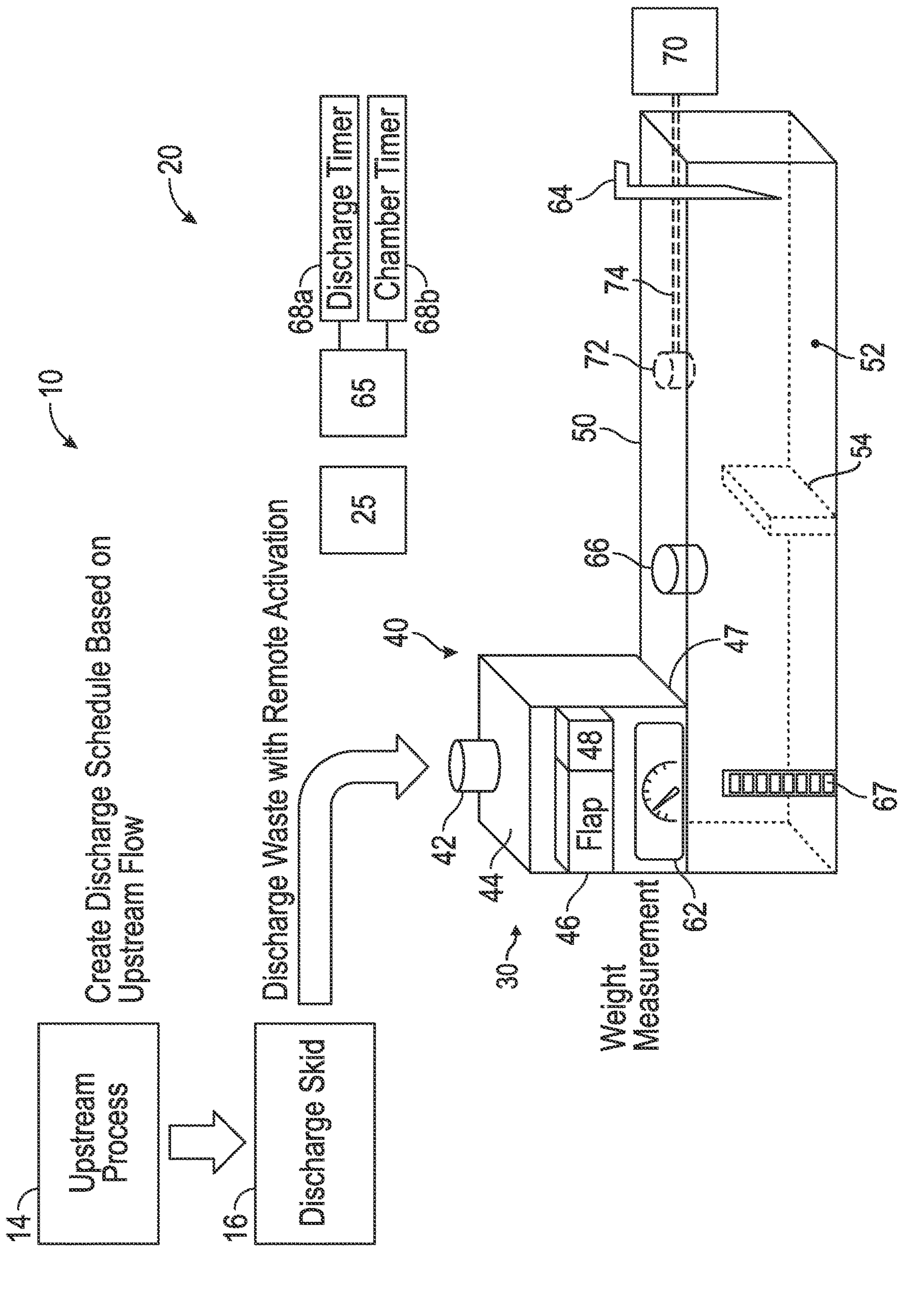

10
20
14
Upstream Process
16
Discharge Skid
Create Discharge Schedule Based on Upstream Flow
Discharge Waste with Remote Activation
25
65
68a
Discharge Timer
Chamber Timer
68b
70
64
74
72
50
52
54
66
40
47
42
44
48
Flap
67
46
62
30
Weight Measurement

FIG. 2

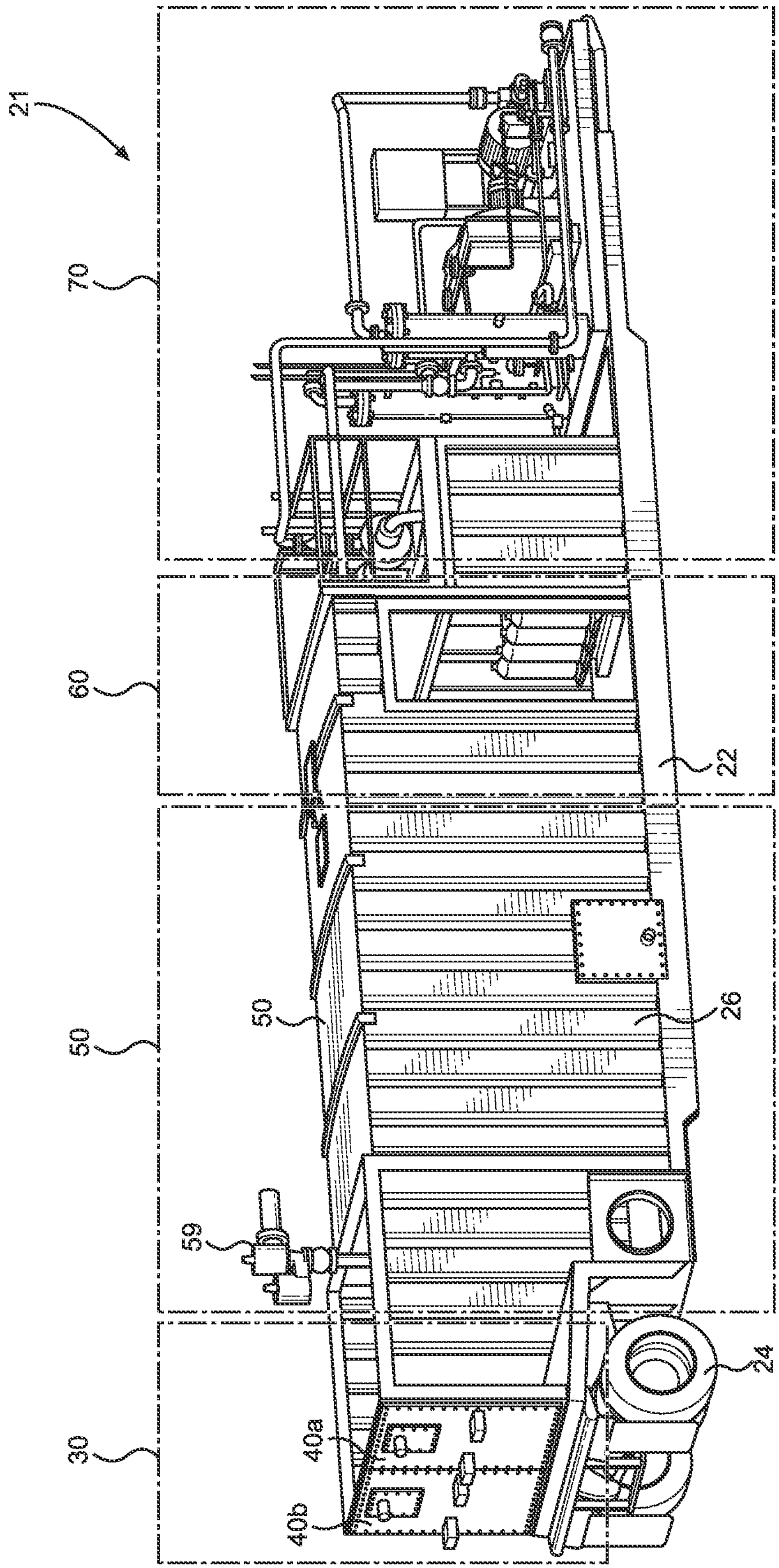


FIG. 3A

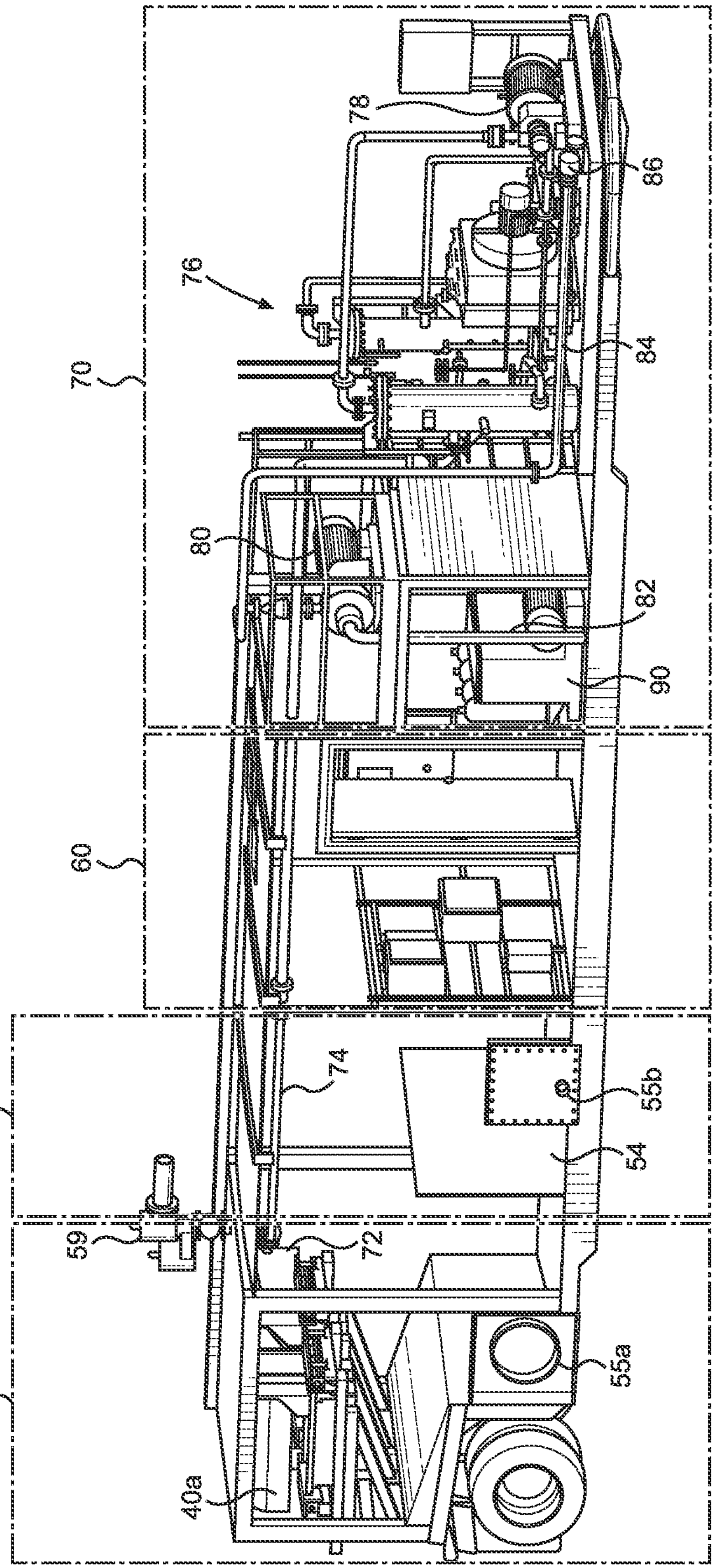


FIG. 3B

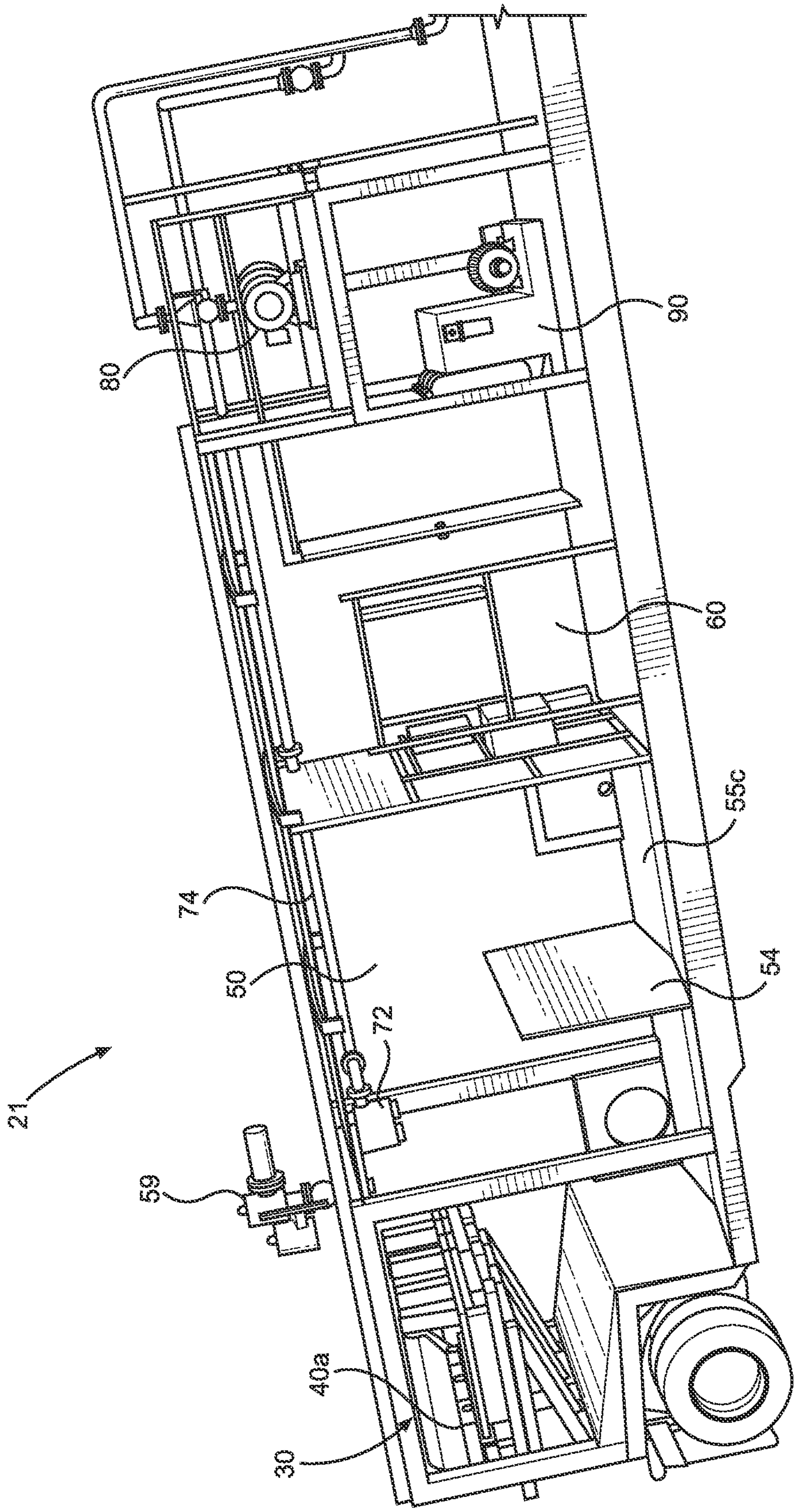


FIG. 3C

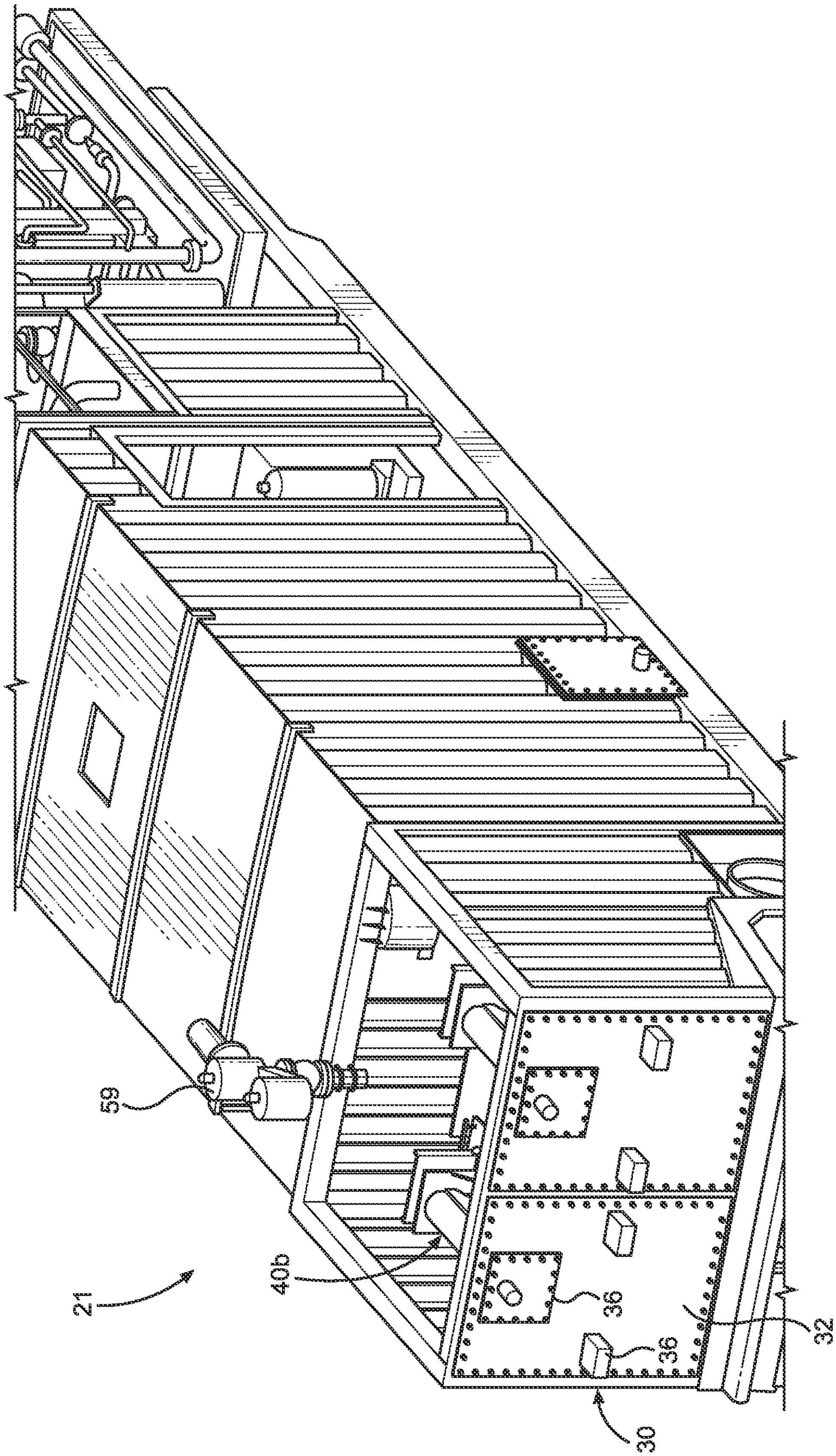


FIG. 4A

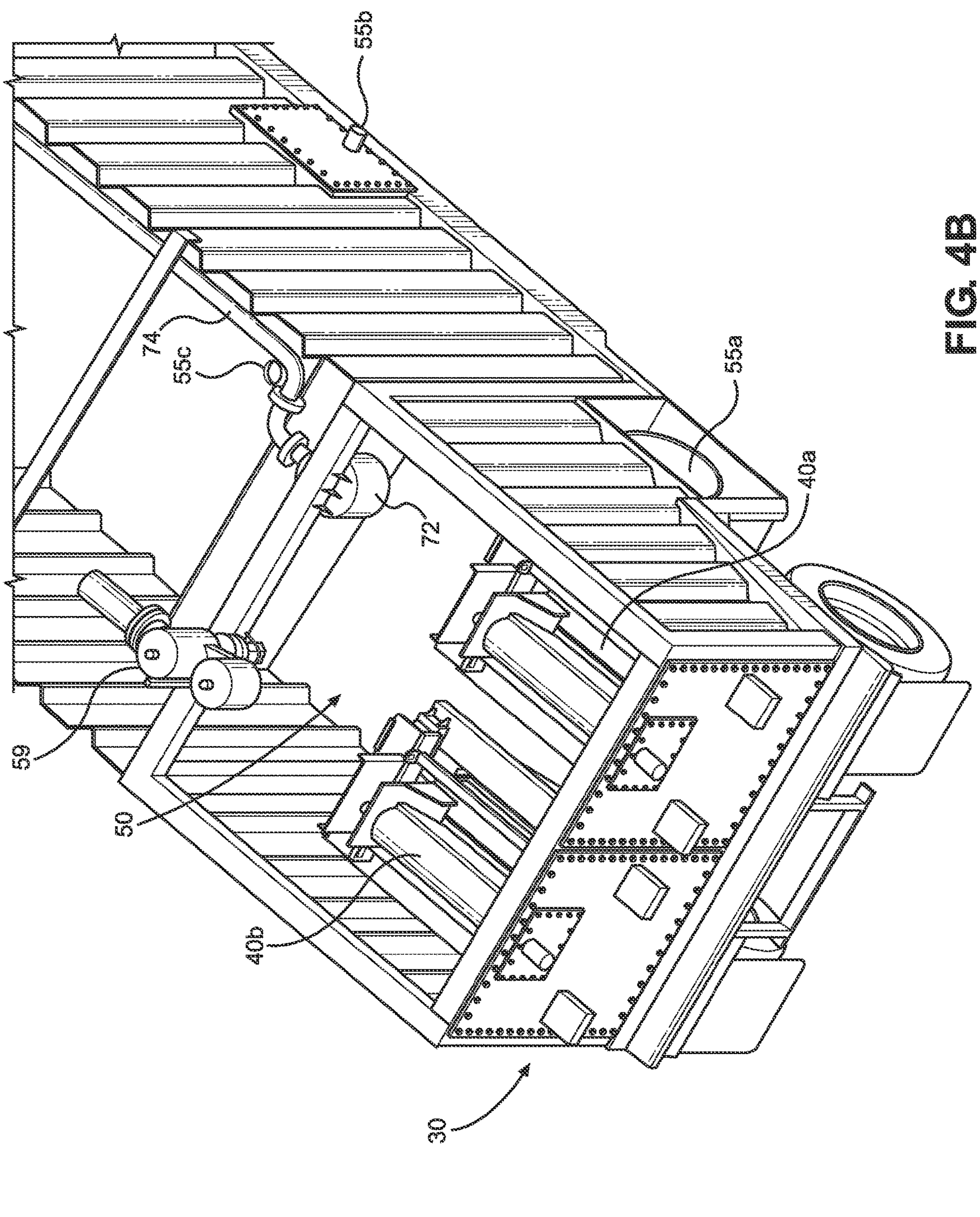


FIG. 4B

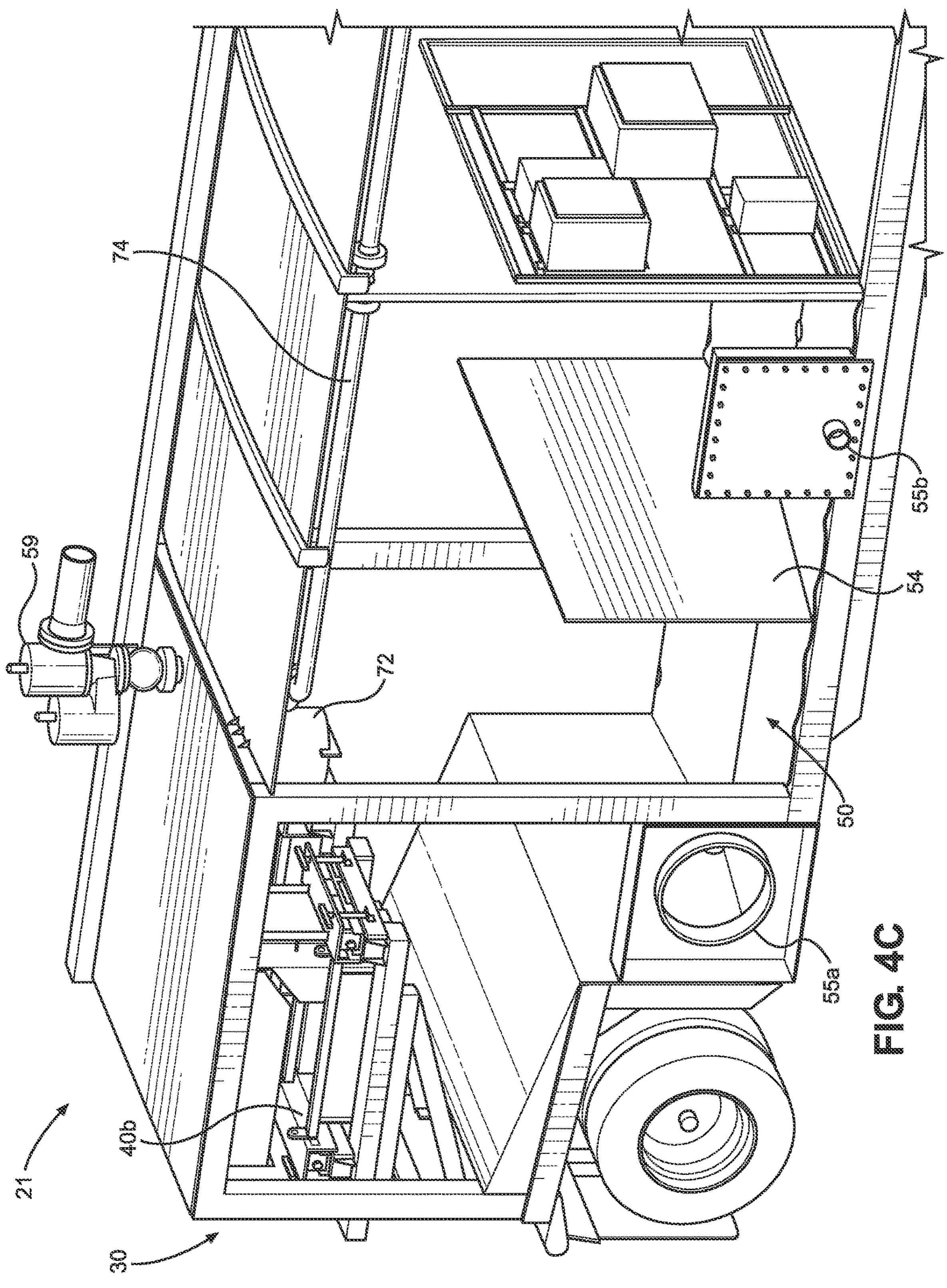


FIG. 4C

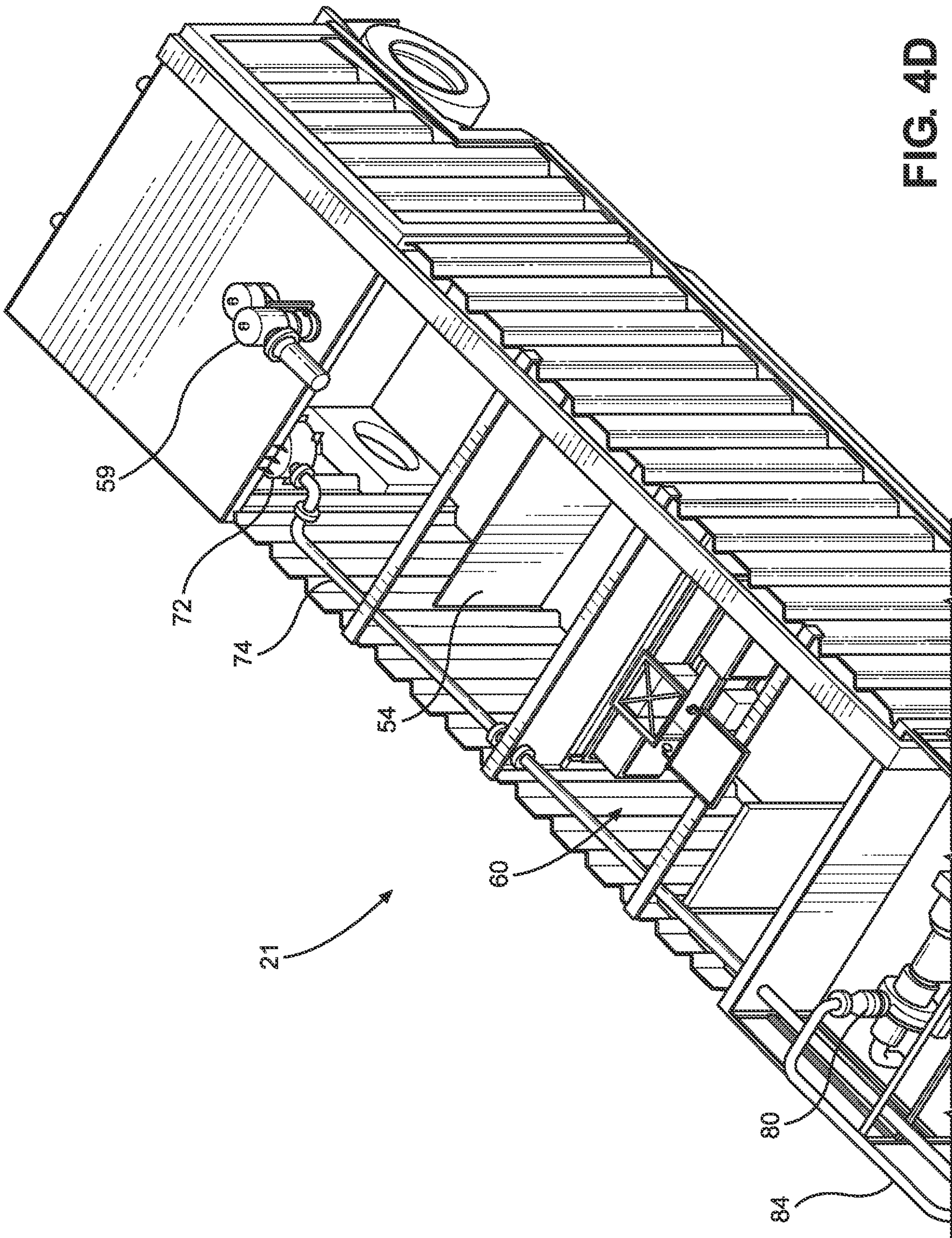


FIG. 4D

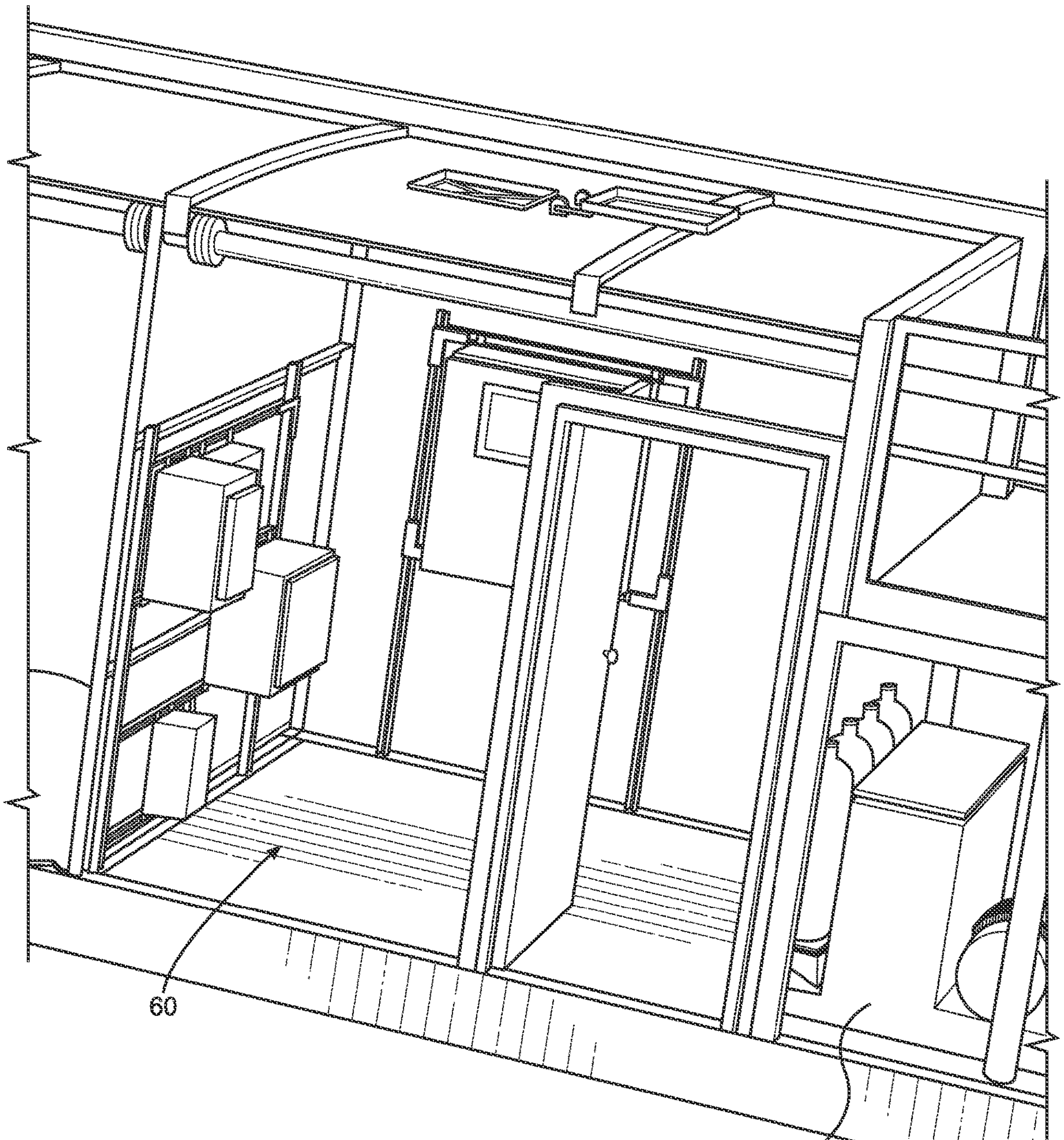


FIG. 5

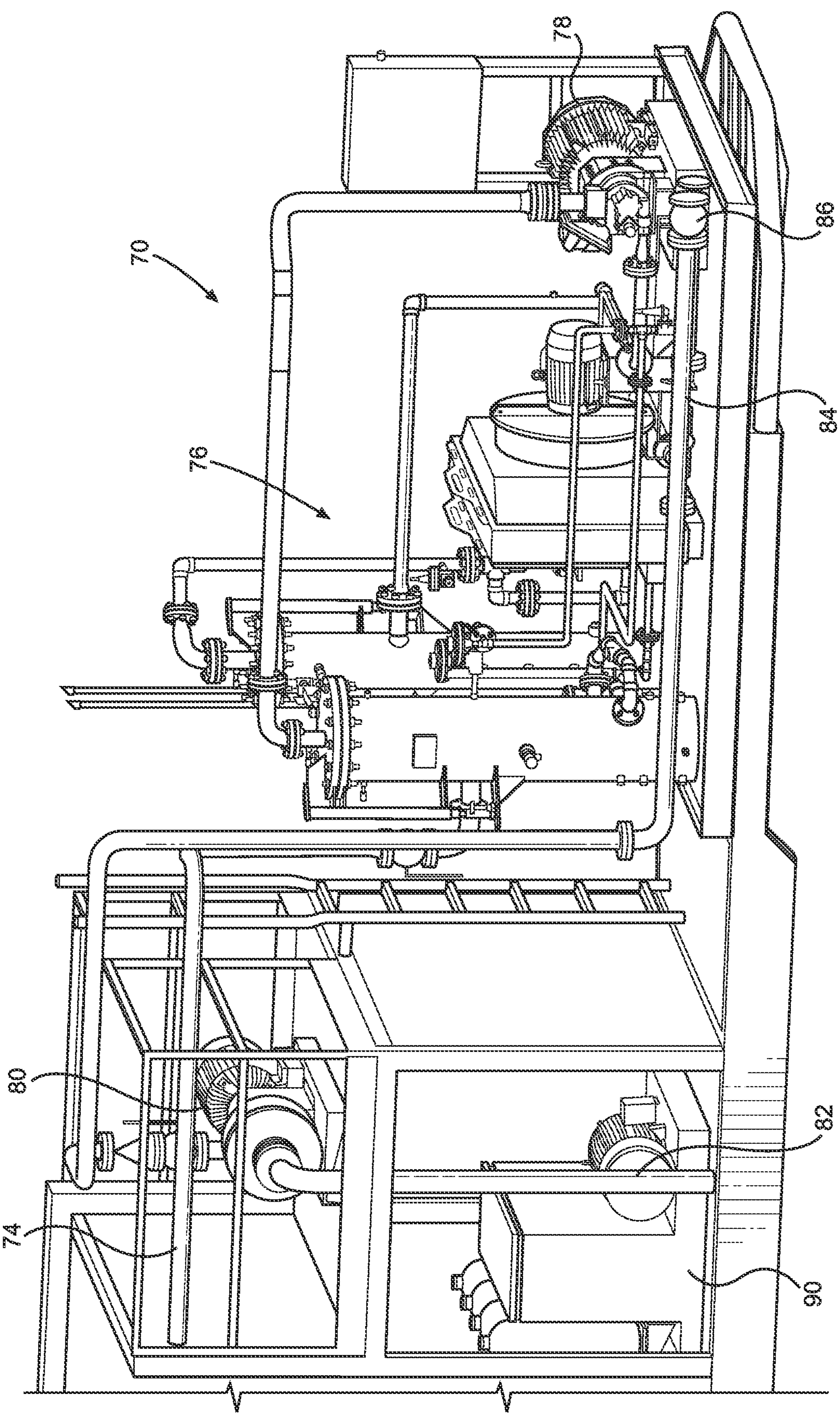


FIG. 6A

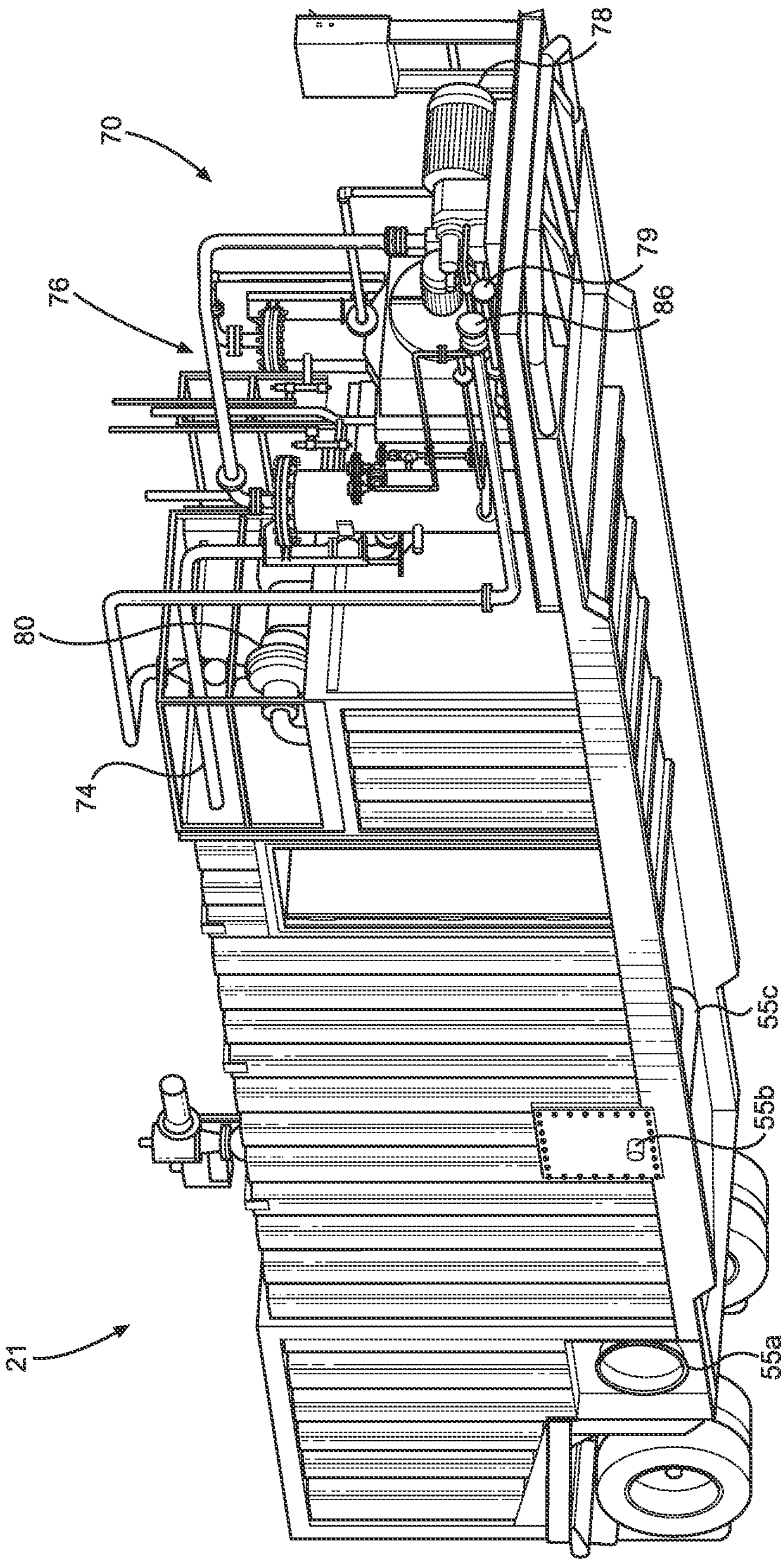


FIG. 6B

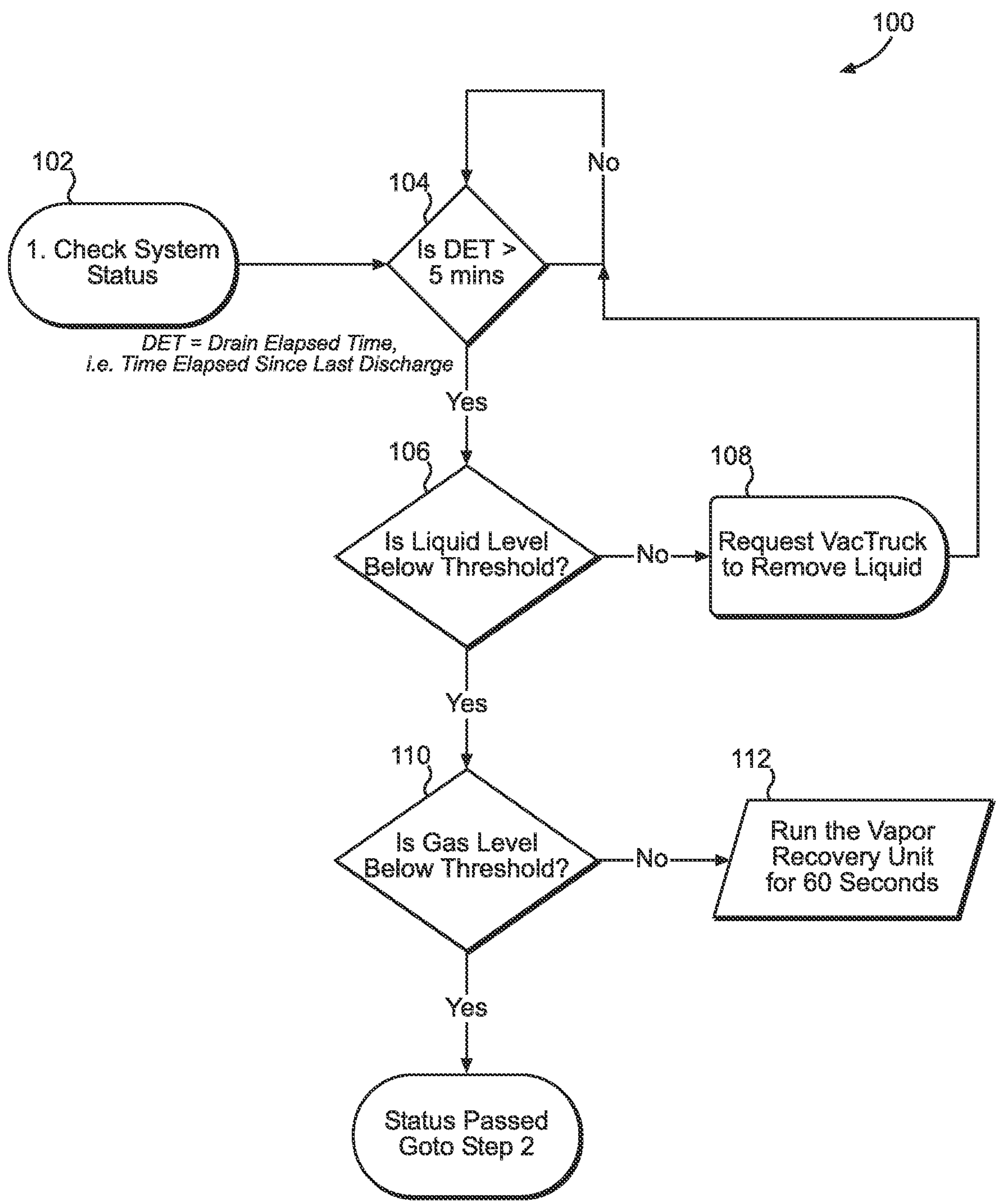

100
102
1. Check System Status
104
Is DET > 5 mins
No
DET = Drain Elapsed Time, i.e. Time Elapsed Since Last Discharge
Yes
106
Is Liquid Level Below Threshold?
No
108
Request VacTruck to Remove Liquid
Yes
110
Is Gas Level Below Threshold?
No
112
Run the Vapor Recovery Unit for 60 Seconds
Yes
Status Passed Goto Step 2

FIG. 7A

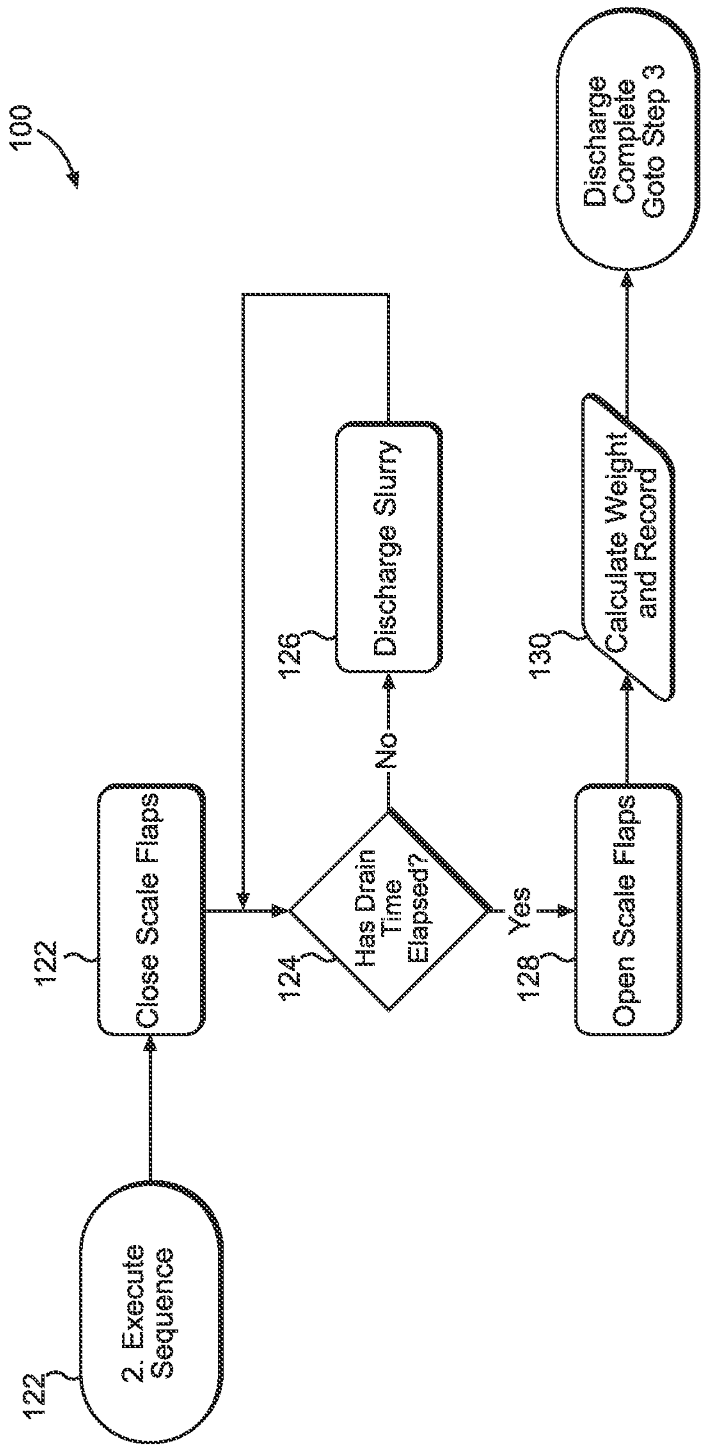

100
122
2. Execute
Sequence
122
Close Scale Flaps
124
Has Drain
Time
Elapsed?
No
126
Discharge Slurry
Yes
128
Open Scale Flaps
130
Calculate Weight
and Record
Discharge
Complete
Goto Step 3

FIG. 7B

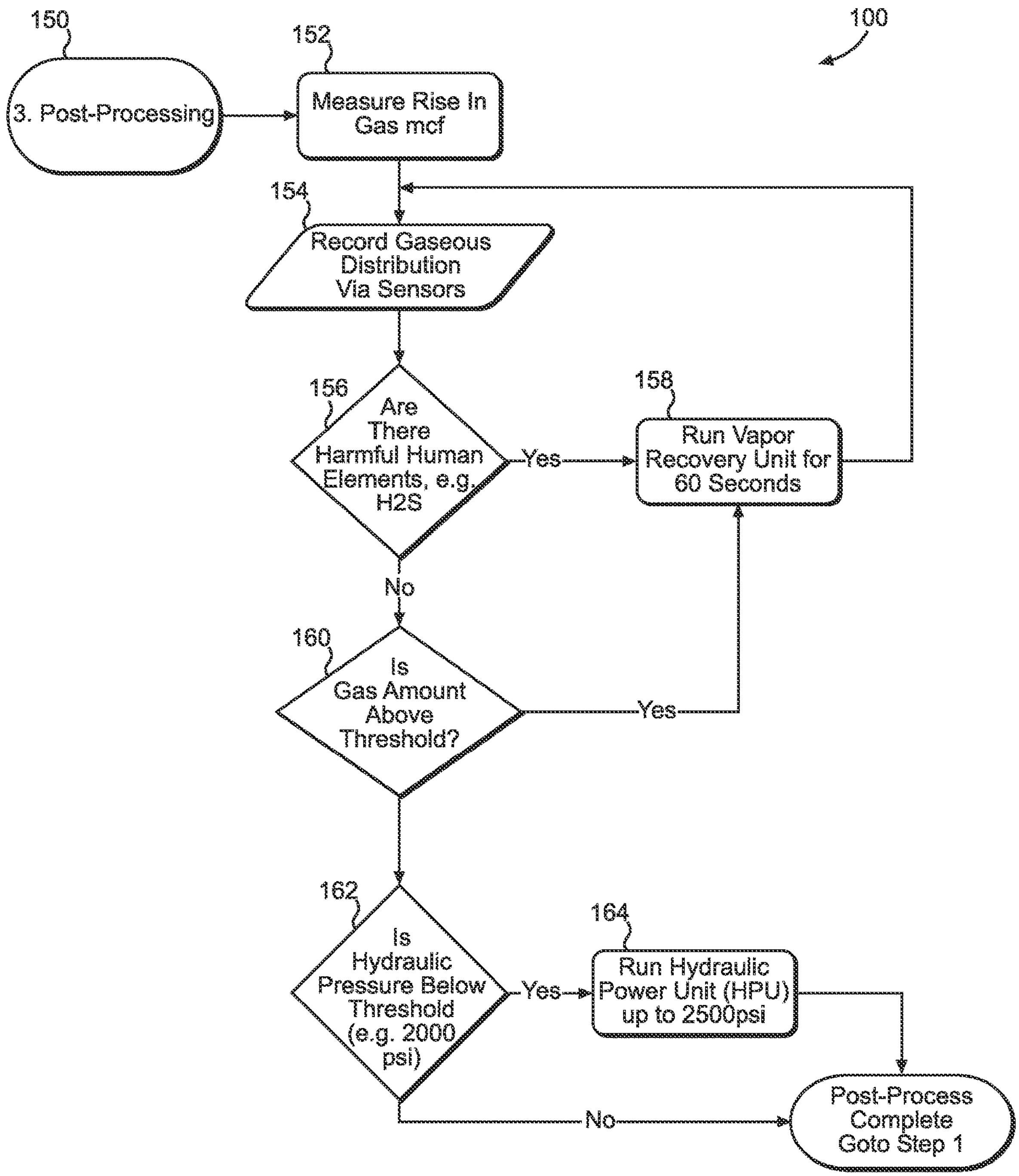

150
3. Post-Processing
152
Measure Rise In Gas mcf
154
Record Gaseous Distribution Via Sensors
156
Are There Harmful Human Elements, e.g. H2S
Yes
158
Run Vapor Recovery Unit for 60 Seconds
No
160
Is Gas Amount Above Threshold?
Yes
162
Is Hydraulic Pressure Below Threshold (e.g. 2000 psi)
Yes
164
Run Hydraulic Power Unit (HPU) up to 2500psi
No
Post-Process Complete Goto Step 1
100

FIG. 7C

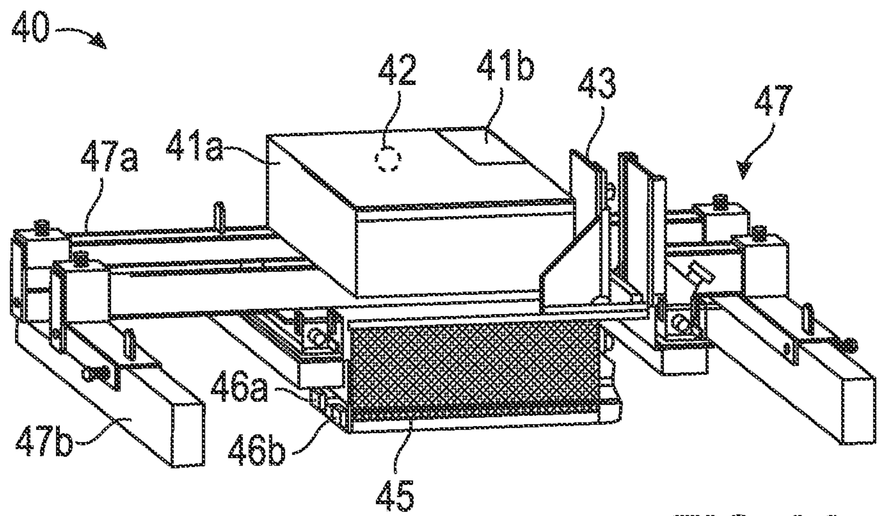


FIG. 8A

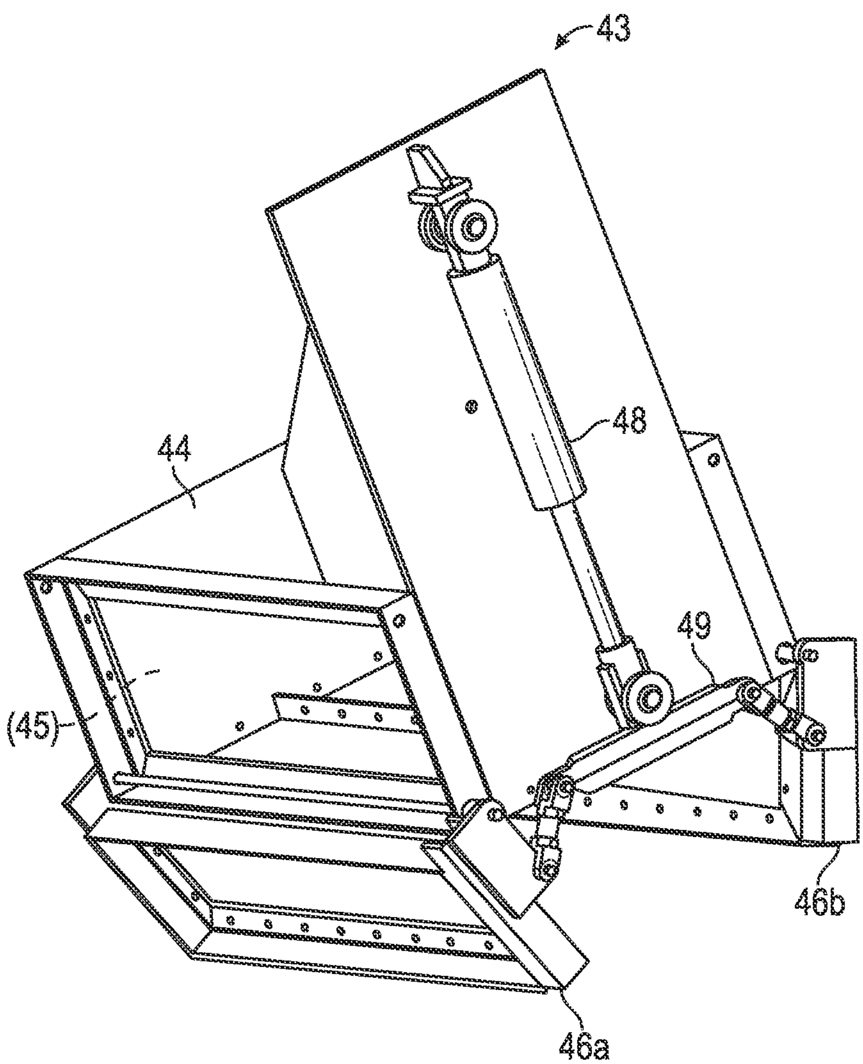


FIG. 8B

SLURRY HANDLING AND VAPOR CAPTURE USING MOBILE TRANSPORT

PRIORITY

[0001] This application claims priority to U.S. Provisional Patent Application No. 63/407,881, filed on Sep. 19, 2022, the entire disclosure of which is expressly incorporated herein.

BACKGROUND OF THE DISCLOSURE

[0002] Wellsites can use various types of systems to handle the flowback of slurry from wellbores. For example, cyclones, separators, and filters can be set up at the wellsite to handle solids (e.g., sand) contained in the flow of slurry from the wells. The sand can be naturally produced from the well or may come from previous fracturing operations. Either way, the sand and other solid material can be produced over many production phases from the wells, and operators need to handle the sand in an environmentally responsible way.

[0003] In addition to solids, natural gas, such as methane, can also be present in the flowback of slurry. Methane is a greenhouse gas at least 25 times more detrimental than CO **2** towards impacting climate change. More than 90% of natural gas that is released from a well is methane. Much of this natural gas may be vented into the atmosphere through equipment and processes in the oil and gas industry as well as other industries, such as the agriculture and textile industries. The venting of these cases increases pollution and has environmental impacts. In addition to methane, such oil and gas processes may also release Hazardous Air Pollutants (HAPs), such as benzene, toluene, xylenes, and volatile organic compounds (VOCs).

[0004] Venting of the gas is caused by three main factors: (1) flash losses, (2) working losses, and (3) standing losses. Often these losses are hard to track because leaking equipment causes fugitive emissions, which has been known to cause almost half of all unwanted emissions. The gases can be produced over many operational phases from the wells, and operators need to handle the gases in an environmentally responsible way. Unfortunately, the industry does not have a good way of measuring solids and gas produced during operation, and the industry also lacks the tools and techniques to remotely prevent venting or the mobility to deploy equipment on demand at any location within a few hours.

[0005] The subject matter of the present disclosure is directed to overcoming, or at least reducing the effects of, one or more of the problems set forth above.

SUMMARY OF THE DISCLOSURE

[0006] A mobile transport disclosed herein is for handling slurry at a wellsite. The mobile transport comprises an enclosure, a weighing assembly, one or more liquid level sensors, one or more gas sensors, a vapor recovery assembly, and a control system. The enclosure is disposed on the mobile transport and has a chamber configured to hold the slurry and related gases. The weighing assembly is disposed on the mobile transport and is configured to weigh solid content of the slurry discharged from the wellsite to the chamber. The one or more liquid level sensors are disposed on the mobile transport and are configured to measure a level of the slurry in the chamber, and the one or more gas sensors are disposed on the mobile transport and are configured to measure a property of gas content in the chamber. The vapor recovery assembly disposed on the mobile transport is in communication with the chamber and is configured to recover the gas content of the slurry from the chamber. Finally, the control system is in operational communication with the weighing assembly, the one or more level sensors, the one or more gas sensors, and the vapor recovery assembly. The control system is configured to control the vapor recovery assembly at least in response to the measured property of the gas content in the chamber.

[0007] A mobile transport disclosed herein is for handling slurry. The mobile transport comprises an enclosure, a weighing assembly, one or more liquid level sensors, one or more gas sensors, a vapor recovery assembly. The enclosure disposed on the mobile transport has a chamber configured to hold the slurry, and the weighing assembly disposed on the mobile transport is configured to weigh solid content of the slurry discharged to the chamber. The one or more liquid level sensors disposed on the mobile transport are configured to measure a level of the slurry in the chamber, and the one or more gas sensors disposed on the mobile transport are configured to measure a property of gas content in the chamber. The vapor recovery assembly disposed on the mobile transport is in communication with the chamber and is configured to draw the gas content of the slurry from the chamber.

[0008] A method disclosed herein for handling slurry comprises: weighing, with a weighing assembly, solid content of the slurry discharged to an enclosed chamber; measuring, with one or more liquid level sensors in the enclosed chamber, a level of the slurry in the enclosed chamber; measuring, with one or more gas sensors in the enclosed chamber, a property of gas content in the enclosed chamber; and recovering, with a vapor recovery assembly in communication with the enclosed chamber, the gas content of the slurry from the enclosed chamber by controlling the vapor recovery assembly at least in response to the measured property of the gas content in the enclosed chamber.

[0009] A mobile transport is disclosed herein for handling slurry at a wellsite. The mobile transport comprises an enclosure and a weight assembly. The enclosure is disposed on the mobile transport and has a sealed chamber configured to hold the slurry. The weighing assembly is disposed on the mobile transport and is configured to weigh solid content of the slurry discharged from the wellsite to the chamber. The weighing assembly comprises one or more weight modules that are removably mounted to and disposed in the enclosure.

[0010] The foregoing summary is not intended to summarize each potential embodiment or every aspect of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** illustrates a schematic plan view of a discharge system according to the present disclosure for discharge at a wellsite.

[0012] FIG. **2** illustrates another schematic view of the disclosed discharge system.

[0013] FIG. **3**A illustrates a perspective view of a mobile transport according to the present disclosure for use with the discharge system.

[0014] FIGS. **3**B and **3**C illustrate views of the mobile transport, showing components exposed.

[0015] FIGS. **4**A, **4**B, and **4**C illustrate end views of the mobile transport, showing details of the weighing unit.

[0016] FIG. **4**D illustrates an exposed view of the mobile transport, showing details of the weighing unit and enclosure.

[0017] FIG. **5** illustrates an exposed view of the mobile transport, showing the command module.

[0018] FIGS. **6**A and **6**B illustrate views of the mobile transport, showing details of the vapor recovery unit.

[0019] FIGS. **7**A, **7**B, and **7**C illustrate a process for vapor capture with the disclosed system having the mobile transport.

[0020] FIGS. **8**A and **8**B illustrate isolated views of components of a weight transmission module according to the present disclosure.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0021] A green completion refers to a closed loop system that reduces emissions and captures gases that would otherwise be released into the atmosphere. To do this, fluids and gases are routed to a closed tank for separation. The separate gas or condensation can be captured and sold, preventing greenhouse gases from venting into an open-air pit or an open tank. A disposal system according to the present disclosure is directed to such a closed loop system to reduce emissions and to capture gases that would otherwise be released into the atmosphere. Although disclosed herein for use in vapor capture in the oil and gas industry to reduce venting of natural gas into the atmosphere, the disposal system of the present disclosure can be used in other industries in which vapors, gases, and other emissions can be captured rather than vented. For example, the disposal system can be used with equipment and processes in other industries, such as the agriculture and textile industries.

[0022] FIG. **1** schematically illustrates a plan view of a disposal system **20** according to the present disclosure. The disposal system **20** handles the flowback of slurry from well(s) at wellsite(s). For example, the disposal system **20** can be used with a flow management arrangement **10** to handle the flowback of slurry having borehole fluid, gases, solid materials (e.g., sand), etc. In general, the flowback is referenced herein as a slurry, which can include liquid, gas, and solids. The flow management arrangement **10** is preferably a closed system to prevent emissions or vapor leaks as the slurry is delivered to the disposal system **20**. In turn, the disposal system **20** is also a closed system to prevent emission or vapor leaks so the vapor can be captured and can then be stored, transported by other means, or used for another purpose.

[0023] The disposal system **20** includes a mobile transport **21** that can be moved to any wellsite on demand. When set up, the mobile transport **21** is configured to receive the slurry, weigh the waste, and perform vapor capture. Thus, as discussed below, the mobile transport **21** is a mobile unit that can be placed at a wellsite and can be used for vapor capture. Gas content from the captured vapor can then be collected on-site from the mobile transport **21** and can be stored, transported by other means, or used for another purpose. Waste and liquid from the slurry can be evacuated from the mobile transport **21** as the mobile transport **21** continues its vapor capture operations.

[0024] The entire disposal system **20** can operate in parallel to any flowback or oil and gas processes without interrupting the existing processes that are controlled by other equipment. In this way, the mobile transport **21** disclosed herein provides environmental benefits during solid recovery, waste management, and environmental gas/solid measurement operations while reducing the release of greenhouse gases into the atmosphere.

[0025] The disposal system **20** can include a control system **23** that can integrate the operation of the mobile transport **21** with the flow management arrangement **10** at the wellsite and with any remote monitoring systems. For example, the control system **20** can include a centralized control unit **25** having remote processing capabilities that can communicate with local control unit(s) **65** of one or more of the transports **21**. The centralized control unit **25** can be located at the wellsite or can be remote. Wired or wireless communications can be used between elements of the centralized control unit **25** and the local control unit(s) **65** of the one or more mobile transports **21**. Remote access for users can also be available to the centralized control unit **25** using appropriate application interfaces.

[0026] For its part, the mobile transport **21** includes a vapor capture system, which includes a weighing assembly **30**, a vapor capture enclosure **50**, a mobile command module **60** (having the local control unit **65**), and a vapor recovery assembly **70**.

[0027] The weighing assembly **30** includes one or more weight modules **40***a-b* installed on the transport **21**. These module **40***a-b* can be removably mounted on the vapor capture enclosure **50**. Each of the weight modules **40***a-b* includes an inlet **42** that can be connected to upstream processes or disposal equipment **14**, **16** of the flow management arrangement **10**. These upstream processes **14**, **16** can include flowback handling equipment **14**, such as cyclones, separators, and filters, which handle sand contained in flowback **12** from the wells. Additionally, the upstream processes **14**, **16** can include a discharge skid **16** that delivers the waste (slurry of solids, sand, liquids, or the like) to the transport **21**.

[0028] The slurry and weighed waste from the weighing assembly **30** fills a volume or chamber **52** of the vapor recovery enclosure **50**. A weir plate **54** inside the chamber **52** can separate the solid waste from the liquid waste. When full of slurry and waste, the vapor capture enclosure **50** can be evacuated using a vacuum truck or it can be hauled away. For example, an outlet **55***a* can be provided on the solid waste side of the enclosure **50** for solid waste to be evacuated. Another outlet **55***b* can be provided on the liquid side of the enclosure **50** for liquid waste to be evacuated. Additionally, a drain **55***c* in the enclosure **50** can connect by piping to a transfer pump **80** to pump liquid waste from an outlet **86**.

[0029] The command module **60** can be mounted on the transport **21** between the vapor capture enclosure **50** and the vapor recovery assembly **70**. As discussed in more detail below, the command module **60** includes a control unit **65** that communicates with various sensors on the transport **21**; receives, records, and reports information on the operation of the transport **21**; and controls the operation of the transport **21**. The control unit **65** can be part of or can be in communication with the centralized control unit **25** of the disposed system **20**. As will be appreciated, the control system **23** (i.e., centralized control unit **25** and/or local control unit **65**) can include one or more computer processing units, computers, servers, and the like having suitable memory storage, software, and input/output interfaces. The control system **25/65** coordinates the operation of the module(s) **40***a-b* to measure and dump/discharge the waste based on the concurrent operation of the arrangement's flow-back hardware **14** and discharge skid **16**. The control system **25/65** can further remotely coordinate the dispatching of other resources, such as disposal or vacuum trucks, to the enclosure **50** for associated transports **21** that have measured and determined the enclosure **50** to be full.

[0030] Finally, the vapory recovery assembly **70** can be mounted on the end of the transport **21** so its components are accessible and are separated from the vapor capture enclosure **50**. Components of the vapor recovery assembly **70** can be comparable to those used in the art. In fact, a preassembled skid having vapor recovery components can be mounted on the transport **21** as a unit.

[0031] The vapor recovery assembly **70** connects to the enclosure **50** to recover vapor collected from the discharge contained in the chamber **52**. In particular, a vapor inlet **72** in the enclosure **50** connects by internal piping **74** to a compression package **76** and a suction pump **78** on the assembly **70**. The vapor recovery assembly **70** can pull captured vapor from the chamber **52** and can process gas from the vapor for output to an outlet **79** of the vapor recovery assembly **70**.

[0032] Having an understanding of the disposal system **20**, the discussion turns to FIG. **2**, which schematically illustrates features of the disposal system **20**. In this schematic view, a discharge skid **16** of the flow management arrangement **10** connects an upstream process **14** to a weight module **40** of the weighing assembly **30** on the vapor capture enclosure **50**. As noted above, the disposal system **20** can be used with flowback hardware **14** and the discharge skid **16** of the flow management arrangement **10**. As is typical, slurry from well(s) (not shown) at the wellsite can be fed to the flowback hardware **14**, such as cyclones, separators, and filters, which handle sand contained in the flow from the wells. Discharged slurry of sand and reduced liquid content is then conducted by discharge conduits and the discharge skid **16** to the weighing assembly **30** and the vapor capture enclosure **50** on the mobile transport **21**.

[0033] As noted, the enclosure **50** has a chamber **52** configured to hold the slurry. The weighing assembly **30** has one or more weight units **40** configured to weigh the solid content of the slurry discharged from the wellsite to the chamber **52**. One or more level sensors **64** are configured to measure a level of the slurry in the chamber **52**, and one or more gas sensors **66** are configured to measure a property of gas content in the chamber **52**.

[0034] The vapor recovery assembly **70** disposed on the mobile transport **21** is in communication with the chamber **52**, for example, using a vapor line **74** and an inlet **72**. The vapor recovery assembly **70** is configured to draw the gas content of the slurry from the chamber **52**. Finally, the control unit **65** is in operational communication with the weighing assembly **30**, the one or more level sensors **64**, the one or more gas sensors **66**, and the vapor recovery assembly **70**. The control unit **65** is configured to control the vapor recovery assembly **70** at least in response to the measured property of the gas content in the chamber **52**.

[0035] As shown, the weight module **40** mounts in or on the vapor capture enclosure **50** to be filled with solid content of the slurry (e.g., waste, sand, etc.) of the discharged slurry. The discharge of waste by the weight module **40** is data-driven, and the disposal system **20** can predict the dispatch of operators. In particular, the inlet **42** of the weight module **40** feeds into a hopper or container **44** of the module **40**, which includes a movable gate or flap **46**. An actuator **48**, such as a hydraulic motor or the like, is actuated to open and close the flap **46** to periodically collect and hold the solid content in the module's hopper **44** and to then dump the collected content into the chamber **52** of the enclosure **50**. Details of the weight module **40** are disclosed in co-pending U.S. application Ser. No. 17/652,079 filed Feb. 22, 2022, which is incorporated herein by reference in its entirety.

[0036] While the flap **46** is closed, a weight measurement sensor or scale **62** associated with the module **40** can measure the weight of solid content in the hopper **44**. In general, the weight measurement sensor **62** can include a scale sensor associated with the flap **46** or associated with the hopper **44** of the module **40**. For example, the weight measurement sensor **62** can measure the load of the solid content as it rests under gravity against the flap **46** of the module **40**. Alternatively, the hopper **44** can be mounted on the weight sensor **62** that measures the sand in the hopper **44** minus any tare value.

[0037] Preferably, the weight measurement is timed so that any residual liquid associated with the waste slurry in the module **40** can be drained off through an outlet and into the enclosure **50**. In this way, the weight measurement can more accurately measure the amount of solid content (i.e., waste or sand) being deposited by the module **40**, as opposed to measuring the additional liquid.

[0038] The controls (i.e., control unit **25** and/or local control unit **65**) of the disclosed system **20** are configured to track the solid content of the discharges of the slurry based on the measured weight. These tracked weights can be correlated back to the sources (processes **14**, **16**, wells, etc.) of the discharges, which can serve several purposes. Moreover, the control system **25/65** can determine that a tracked amount of the solid waste in the enclosure **50** exceeds a defined threshold so an indication can be communicated, for example, that the vapor capture enclosure **50** needs to be emptied.

[0039] The disposal system **20** also includes one or more level sensors **64** that sense the level in the vapor capture enclosure **50**. In turn, the sensed level is used to determine when the enclosure **50** needs to be evacuated. To that end, the control unit **65** can include controls for actuating the flap **46**, timers **68***a-b* for timing operations of the flap **46** and the weight sensor **62**, and communication interfaces for interfacing with the one or more level sensors **64**.

[0040] The level sensors **64** can be associated with the transport **21** and can be mounted in the enclosure **50** for sensing the level to be communicated to the control system (**25/65**). The level sensor **64** uses level sensing technology for semi-solids so the disposal system **20** can estimate the fill level of the vapor capture enclosure **50**. For example, several types of level sensors **64** can be located in the enclosure **50**. The first of the level sensors **64** acts as a float and automatically cuts off hydraulic power when the level in the enclosure **50** reaches a certain threshold (e.g., 80% of height). A second of the level sensors **64** transmits digital data out to the command module **60**, and the control unit **65** can transmit the data to a network, which can include a cloud-based server architecture, allowing for continuous monitoring of enclosure's levels and notifying operators in real-time on tank level changes.

[0041] A strip of LED indicators (**67**; FIG. **2**) or other visual displays on the enclosure **50** can provide a visual indication of the amount of solid waste that has settled on the inside bed of the transport **21**. Operators can see the level from outside of the enclosure **50**. This indication can correlate to the measured value of the level sensor **64** received in the control unit **65** or a remote monitoring application.

[0042] One or more gas sensors **66** are also provided in the enclosure **50** to measure the captured vapor. The one or more gas sensors **66** can measure one or more properties of the gas content in the enclosure **50**. For example, the one or more gas sensors **66** can measure a constituent (e.g., methane, hydrogen sulfide, etc.), a pressure level, a volume, or a concentration of the gas content in the chamber **52**.

[0043] Overall, the control system **25/65** can coordinate the operation of the weight modules **40**, the level sensors **64**, and the gas sensors **66** with the other parts of the flow management system **10**, such as the discharge skid **16** and the upstream hardware **14**. This allows the disposal system **20** to notify operators at the opportune time to perform predictive maintenance (e.g., determining the tank fullness, notifying a clearance crew to clear the vapor capture enclosure **50**, etc.).

[0044] In contrast to a manual process of dumping waste, the present system **20** operates with remote capabilities and offers pre-scheduling of operations. In fact, the disposal system **20** can have synchronized start/stop operations and can measure the disposal of discharge more accurately. Moreover, the disclosed system **20** can be remotely actuated and can operate under a customizable schedule, liberating a site from needing a dedicated human presence. These and other details are discussed below.

[0045] FIG. **3**A illustrates a perspective view of the mobile transport **21** according to the present disclosure. FIGS. **3**B and **3**C also illustrate perspective views of the mobile transport **21**, showing components exposed.

[0046] In general, the transport **21** can be any suitable transportation unit or assembly, such as a trailer, a vehicle, a truck, a platform, a skid, and the like. The transport **21** shown here is a lay-down trailer having sections at different levels so the main trailer beams of the lay-down trailer can rest on the ground during operations. The mobile transport **21** can be moved using a pickup truck. As shown in this example, the mobile transport **21** includes a platform **22**, which can have wheels **24** so the transport **21** can be moved by a transport vehicle. Walls **26** and a roof **28** enclose portions of the transport **21**. As noted above, the assemblies, sections, or components of the transport **21** include the weighing assembly **30**, the vapor capture enclosure **50**, the mobile command module **60**, and the vapor recovery assembly **70**.

[0047] The weighing assembly **30** is installed at the back-end of the transport **21** at the vapor capture enclosure **50**. The weighing assembly **30** includes the one or more weight modules **40***a-b* that receive the slurry, weigh the solid content, and dump the solid content into the vapor capture enclosure **50**. Below the weight modules **40***a-b*, the bed of the enclosure **50** is angled or sloped to force the slurry to flow down to the base of the enclosure **50**. This ensures the level sensor (**64**) obtains accurate measurements.

[0048] The walls **26** and ceiling **28** of the enclosure **50** can be rated to a desired pressure limitation. The maximum gas volume capacity for the enclosure **50** can be 400 mcf. This capacity can be adjusted depending on the vapor recovery assembly **70**. The total capacity of the enclosure **50** can hold a volume of slurry of about 300 bbl. The piping used in the enclosure **50** and other parts of the transport **21** is preferably coated with a corrosion-resistant material to avoid corrosion from hydrogen sulfide (H_2S). A deflector plate may hang from the ceiling **28**, facilitating the separation of the liquid and the gaseous component (produced by spray or evaporation). It strategically directs incoming slurry, forcing the liquid and solid down but allows for the gas to settle further away from the weighing assembly and closer to the vapor recovery unit. Thus, it creates a "gas drawer", where the gas can naturally accumulate and helps in its controlled and optimized extraction of the gases.

[0049] As best shown in FIGS. **3**B and **3**C, the vapor capture enclosure **50** has an enclosed volume or chamber **52**. The floor of the chamber **52** is divided by a weir plate **54**, which is used to separate liquids and solids in the discharge dropped into the enclosure **50** from the weight module **40***a-b*. A waste discharge outlet **55***a* and a fluid discharge outlet **55***b* are provided in the sidewall **26**. These allow for connection to a vacuum truck or the like so waste and fluid can be removed. A drain **55***c* is included in the floor of the enclosure **50** on the liquid side of the weir plate, which can allow a transfer pump **80** to transfer liquid through piping **82**, **84** to a coupling **86**.

[0050] The mobile command module **60** is provided on the transport **21** next to the vapor capture enclosure **50**. (FIG. **5** illustrates an exposed view of the mobile transport **21**, showing the command module **60**.) As shown, the mobile command module **60** is fully closed off from the vapor capture enclosure **50** to ensure the environmental safety of any personnel. The command module **60** includes the necessary electronics for sensing, monitoring, and controlling operations

[0051] In particular, the command module **60** includes the control unit **65** (e.g., a programmable computer or other processing module) where the logic to autonomously operate the entire transport **21** resides. The control unit **65** also has dashboards and display panels to display all of the data of the weight sensors **62**, the level sensor **64**, the gas sensors **66**, etc. Operators can see historical discharge weights on the control unit **65** or in a remote monitoring application as well. In one example of a visual indicator, the control unit **65** can display information on an LED display on the outside of the enclosure **50** that displays the last recorded weight of the slurry during the latest discharge, enabling operators to see the weight value from a distance.

[0052] The control unit **65** connects to the gas sensors (**66**) inside the vapor capture enclosure **50** and records a property of the gas content (e.g., the type of gas emitted and the volume (mcf) produced). The recorded properties can be timestamped over days of operation. This data can be automatically recorded and can be periodically transmitted to monitoring systems and agencies like the Environmental Protection Agency (EPA). Further, gas pressure may be used to understand the relative pressure build up or vacuuming of the chamber compared to atmospheric pressure. An escape hatch on the top or on the ceiling **28** may be opened accordingly given the pressure differential.

[0053] FIGS. **4**A, **4**B, and **4**C illustrate end views of the mobile transport **21**, showing details of the weighing assembly **30** and the weight modules **40***a-b*.

[0054] As noted above, the modules **40***a-b* can be removably mounted on the vapor capture enclosure **50**. As shown, two weight modules **40**_a-b_ can be used. Both modules **40**_a-b_ can be used at the same time and can measure the discharge from separate sources. Alternatively, one may be used while the other is serviced. An appropriate mounting structure can be used to removably affix the modules **40**_a-b_ to the vapor capture enclosure **50**. During downtime or when there is no discharge scheduled for the next 15 minutes, operators can detach the modules **40**_a-b_ from the vapor capture enclosure **50** and can remove and replace them as needed.

[0055] As shown, the weighing assembly **30** includes two weight modules **40**_a-b_ positioned laterally side by side. This allows the transport **21** to serve more sources (e.g., wells) providing the slurry. The purpose of having dual weight modules **40**_a-b_ is to support a large number of wells that a single mobile transport **21** can support. Under normal operating conditions, this means vapor from about twelve wells can be simultaneously captured by one mobile transport **21**.

[0056] Further, the two weight modules **40**_a-b_ provide redundancy to operations. If one weight module **40**_a-b_ requires maintenance, the slurry can be routed to the other weight module **40**_a-b_. In fact and as described in more detail below, the weight modules **40**_a-b_ can be designed as pull-out shelves **47**. A field operator can use a forklift to easily replace the weight module **40**_a-b_, take it out for maintenance, or install it in the field. This improves production uptime and eases maintenance. Finally, the weight modules **40**_a-b_ can calculate released waste quantities, which is Y02P 80/30 of the Climate Change Mitigation scheme.

[0057] As shown in FIG. **4**A, for example, the weight modules **40**_a-b_ are supported on separate scale panels **32** that mount to the side of the weighing assembly **30** so that the weight modules **40**_a-b_ extend into the enclosure **50**. Forklift inserts **34** in the scale panels allow a forklift to install and remove the weight modules **40**_a-b_. Inlet panels **36** can be removably mounted on the scale panels **32** so servicing can be performed without the need to remove the entire module **46**_a-b_.

[0058] Showing additional details, FIG. **8**A illustrates a perspective view of a weight module **40** for the disclosed system, and FIG. **8**B illustrates an isolated view of a hopper-gate assembly **43** for the module (**40**) in FIG. **8**A. As noted, the module **40** includes the movable gate or flap **46** in the receiving hopper **44**, which has the inlet **42** for receiving the discharge from the flow management arrangement **10**. The movable flap **46** is operated by an actuator **48**, such as an electric motor, hydraulic pistons, chargeable solenoids, etc. The weight measurement sensor (**62**) is used in conjunction with the movable flap **46** in the hopper **44** to measure the weight of solid content held in the hopper **44** while the flap **46** is closed. In one embodiment of the module **40**, the hopper **44** can hold about 350 lbs. of solid (dehydrated) waste under a single discharge. This amount is approximately twice the amount that a very active well can usually make within a 10-minute time period.

[0059] In addition to these components, the weight module **40** includes a mounting structure **47**. As shown, the mounting structure **47** includes cross-support bars **47**_a_ on which the module **40** is supported and which mount on shelves **47**_b_. Mounting brackets affix these support bars **74**_a_ to the shelves **47**_b_, which can extend from the scale panel (**32**) of the weighing unit (**30**).

[0060] In addition to these components, the weight module **40** includes a hopper-gate assembly **43** having the hopper **44**, screens **45**, movable gates or flap **46**_a-b_, the actuator **48**, and a linkage **49**. For its part, the inlet **42** receives the discharge and can include a gas buster **41**_a_ for handling any free or entrained gas in the received discharge. Slurry (solids and liquids) pass through the vessel of the gas buster **41** toward the hopper-gate assembly **43**, while any gas can exit a gas vent **41**_b_ at the top of the module **40**. After the discharge has been held in the module **40** for an appropriate, controlled time for the gas buster **41**_a_ to function and for the weight of the material to be determined, the hopper-gate assembly **43** on the module **40** opens its flap doors **46**_a-b_ to drop the material into the enclosure (**50**). While the material is being held in the module **40**, fluid can escape through one or more screens **45** on the module **40**.

[0061] The hopper-gate assembly **43** includes hinged flapper doors **46**_a-b_ installed at the bottom of a hopper or walled container **44**. Only the frame of the structural elements is shown in FIG. **8**B for illustration. One or both sides of the walled hopper **44** may frame screens or filters (**45**) for dehydrating fluid from the solid material held in the hopper **44**. The flapper doors **46**_a-b_ can have panels or screens **45**. To actuate the flapper doors **46**_a-b_, an actuator **48** in the form of a hydraulic piston or the like can connect to the doors **46**_a-b_ through a linkage **49**. As will be appreciated with the benefit of this example, several mechanical configurations, actuators, and other components can be used for the disclosed module (**40**).

[0062] As noted above, the vapor recovery assembly **70** connects to the enclosure **50** to recover vapor collected from the discharge contained in the enclosed chamber **52**. The vapor recovery assembly **70** is tasked with sucking the gas content out of the vapor enclosure **50** so the vapor can be safely transmitted to a gas line to an outlet **79** instead of being vented. As shown in FIGS. **3**B-**3**C and **6**A-**6**B, a vapor inlet **72** installed in the chamber **52** connects by a vapor line **74** to a compression package **76** and an air suction pump **78**. The compression package **76** is designed specifically to capture low-pressure, wet gas streams from oil and condensate in the enclosure **50**.

[0063] In general, the compression package **76** can include a compressor, such as a liquid ring compressor, flooded rotary screw, or rotary sliding vane. The compressor is connected to the vapor inlet **74** from the chamber **50** and is connected to a source of an absorbent supply, such as water. The compressed output from the compressor can be communicated to a separator, which has a demister. Gas from the separator can be communicated to a gas outlet. Condensed hydrocarbons can be communicated from the separator, and the absorbent supply from the separator can be cooled by a cooling unit for reuse. In operation, gas content from the chamber (**52**) enters the compressor along with the absorbent supply. After the compression phase, a compressed mixture of gas, absorbent supply, and hydrocarbon enters the separator, which separates the three elements. The gas passes through the demister to remove droplets and leaves the separator from the top. Meanwhile, condensed hydrocarbons and absorbent supply are separated from the vapor stream by gravity. The absorbent supply is sent back to the compressor, after being cooled by a cooling element. Any condensed hydrocarbons can be discarded or put back into the chamber.

[0064] Other configurations can be used for vapor recovery. For example, a vacuum pump **78** can draw vapors from the chamber (**52**). A compressor, such as a liquid-ring compressor, is connected to the vapor line (**74**) and to an absorbent supply, such as liquid in a storage tank. The output of the compressor is connected to a scrubber, which also receives the absorbent supply. Gas from an upper outlet on the scrubber can pass to a membrane stage from which clean gas can be produced for output at the outlet **79**. The absorbent supply with any recovered product can be output from a lower outlet on the scrubber to the storage tank. The vacuum pump **78** draws a vacuum from the membrane stage to feed into the compressor at the vapor inlet.

[0065] During operation, the gas sensors (**66**) installed in the chamber (**52**) collect data of the captured vapor. Various vapor and gas properties can be measured. The control unit **65** can create and maintain a sequence of pressure set of points in the gas blanketing system, which allows for automatic capture of gas content on demand at the vapor recovery assembly **70**. The operation can save energy by not running at periodic intervals, but only on demand depending on the mcf of gas contained within the chamber.

[0066] The vapor recovery assembly **70** can use cogeneration or energy recovery methods by using the exhausted gas to power the turbine in a regenerative fashion. This involves using the compressor initially to pull in gas content and then using the pressure to power the residual turbine operation. Based on gas and slurry data collected, the speed of the compressor fan in the compression package **76** can be altered remotely, thus preventing over-condensation or vacuum.

[0067] As noted, the pressure relief valve **59** is provided in the ceiling **28** of the enclosure **50** so that pressure can be relieved should a pressure limit be reached. The pressure relief valve **59** can open if a significant pressure differential is created and the chamber **52** is too pressurized for the suction pump (**78**) of the vapor recover unit (**70**) to operate. This ensures that the system **20** can avoid a hazardous situation by preventing explosions in an over-pressurized enclosure.

[0068] Finally, as shown in FIGS. **3**B and **6**B, the transfer pump **80** uses transfer lines **82**, **84** to connect the drain **55***c* in the enclosure **50** to a coupling **86**. The transfer pump **80** can be operated to clear out the sand and slurry deposited in the chamber **52**. The transfer pump **80** can be operated to make sure that the contents do not jam the weight modules **40***a-b* when they deposit new waste into the chamber **52**.

[0069] A power unit **90** is also included on the transport **21** to power the operation of the components on the transport **21**. The power unit **80** is preferably a hydraulic system and not a pneumatic system because fugitive emissions from pneumatic systems have caused 29% of methane emissions according to an EPA 2011 study. Pneumatic systems are also notorious for vapor leaks that are hard to track down.

[0070] FIGS. **7**A, **7**B, and **7**C illustrate a process **100** for vapor capture with the disclosed system **20** having the mobile transport **21**. For clarity, references to the elements in the other figures are used in the discussion below of the disclosed process **100**.

[0071] Before every run or discharge, the status of the system **20** is checked (Block **102**). The control systems (i.e., control unit **25** and/or control unit **65**) determine if an elapsed last discharge time has been reached (Block **104**). This is the time that has elapsed since the last discharge. One time limit can be 5 minutes, but this can vary depending on the implementation. The time period can be set manually or automatically and can be adjusted during operations as needed.

[0072] The control system **25**/**65** determines if the liquid level in the enclosure **50** is below a given threshold (Decision **106**). As with other limits disclosed herein, the threshold level can vary depending on the implementation, type of slurry being discharged, etc. The threshold can be set manually or automatically and can be adjusted during operations as needed.

[0073] If the liquid level threshold has been exceeded (Yes at Decision **106**), the control system **25**/**65** can request a vacuum truck to be dispatched to the mobile transport to remove liquid. This request can be automatically generated and communicated.

[0074] In addition to determining if the liquid level threshold has been exceeded, the control system **25**/**65** determines if the gas level in the enclosure **50** is below a given threshold (Decision **108**). As with other limits disclosed herein, the threshold level can vary depending on the implementation, type of slurry being discharged, etc. The threshold can be set manually or automatically and can be adjusted during operations as needed. If the gas level threshold has been exceeded (Yes at Decision **108**), the control system **25**/**65** runs the vapor recovery assembly **70** on the transport **21**. The assembly **70** can be run for a predefined amount of time, such as 60 seconds.

[0075] Once the status check is complete, the control system **25**/**65** executes its operational sequence (Block **120**) in FIG. **7**B. Here, the control system **25**/**65** closes the scale flaps **46** of the weight modules **40***a-b* (Block **102**) to ready the weighing assembly **30** to receive a discharge of slurry. (Block **102**). The flaps **46** remain closed as the discharge is sent to the modules **40***a-b*. The slurry can be discharged to the modules **40***a-b* while the discharge time elapses (Decision **124** and Block **126**). Once the discharge time has elapsed, the control system **25**/**65** calculates and records the weight of the solid content that has been discharged (Block **128**) and opens the flaps **46** on the modules **40***a-b* to discharge the waste into the enclosure **50** (Block **130**).

[0076] Once the operational sequence is complete, the control system **25**/**65** performs post-processing operations (Block **150**) in FIG. **7**C. The control system **25**/**65** measures for any rise in gas (mcf) in the vapor capture enclosure **50** (Block **152**). The gas is analyzed using the gas sensors **66**, and the information is recorded (Block **154**).

[0077] In the analysis of the gas content, the control system **25**/**65** can determine if certain gases are present. This includes determining if particularly harmful gases are present, such as hydrogen sulfide (H_2S) (Decision **156**). If the defined gas or gasses are found, the control system **25**/**65** runs the vapory recovery assembly **70** on the transport **21** for a defined period of time, such as 60 seconds (Block **158**).

[0078] If the defined gas or gases are not found (No at Decision **156**), the control system **25**/**65** determines if the volume of gas content in the enclosure **50** is above a threshold (Decision **160**). As with other limits disclosed herein, the threshold level can vary depending on the implementation, type of flow-back being discharged, etc. The threshold can be set manually or automatically and can be adjusted during operations as needed. If the gas level threshold has been exceeded (Yes at Decision **60**), the control system **25**/**65** run the vapor recovery assembly **70** on the transport **21**. The vapor recovery assembly **70** can be run for a predefined amount of time, such as 60 seconds. Operations then return to monitoring (Block **154**).

[0079] In the process **100**, the control system **25/65** also determines if the hydraulic pressure of the operational equipment is below a threshold (e.g., 2000 psi) (Decision **162**). If so, the hydraulic pressure unit **90** is run to increase the pressure (Block **164**).

REFERENCE NUMERALS

[0080] flow management arrangement **10**
[0081] flowback **12**
[0082] upstream process **14**
[0083] conduit **15**
[0084] discharge skid **16**
[0085] conduit **17**
[0086] disposal system **20**
[0087] mobile transport **21**
[0088] platform **22**
[0089] wheels **24**
[0090] control unit **25**
[0091] walls **26**
[0092] roof or ceiling **28**
[0093] weighing assembly **30**
[0094] scale panel **32**
[0095] forklift inserts **34**
[0096] inlet panel **36**
[0097] weight module **40***a-b*
[0098] gas buster **41**
[0099] inlet **42**
[0100] hopper-gate assembly **43**
[0101] hopper **44**
[0102] screen **45**
[0103] shelves **47**
[0104] movable gates or flaps **46***a-b*
[0105] actuator **48**
[0106] linkage **49**
[0107] vapor capture enclosure **50**
[0108] enclosed volume or chamber **52**
[0109] weir plate **54**
[0110] waste discharge outlet **55***a*
[0111] fluid discharge outlet **55***b*
[0112] drain **55***c*
[0113] pressure relief valve **59**
[0114] mobile command module **60**
[0115] weight sensor or scale **62**
[0116] level sensor **64**
[0117] gas sensor **66**
[0118] timers **68***a-b*
[0119] vapor recovery assembly **70**
[0120] vapor inlet **72**
[0121] vapor line **74**
[0122] compression package **76**
[0123] suction pump **78**
[0124] outlet **79**
[0125] transfer pump **80**
[0126] transfer lines **82**, **84**
[0127] coupling **86**
[0128] hydraulic power unit **90**

[0129] The foregoing description of preferred and other embodiments is not intended to limit or restrict the scope or applicability of the inventive concepts conceived of by the Applicants. It will be appreciated with the benefit of the present disclosure that features described above in accordance with any embodiment or aspect of the disclosed subject matter can be utilized, either alone or in combination, with any other described feature, in any other embodiment or aspect of the disclosed subject matter.

What is claimed is:

1. A mobile transport for handling slurry at a wellsite, the mobile transport comprising:

an enclosure disposed on the mobile transport and having a chamber configured to hold the slurry;

a weighing assembly disposed on the mobile transport and being configured to weigh solid content of the slurry discharged from the wellsite to the chamber;

one or more liquid level sensors disposed on the mobile transport and being configured to measure a level of the slurry in the chamber;

one or more gas sensors disposed on the mobile transport and being configured to measure a property of gas content in the chamber;

a vapor recovery assembly disposed on the mobile transport and being in communication with the chamber, the vapor recovery assembly being configured to recover the gas content of the slurry from the chamber; and

a control system in operational communication with the weighing assembly, the one or more level sensors, the one or more gas sensors, and the vapor recovery assembly, the control system being configured to control the vapor recovery assembly at least in response to the measured property of the gas content in the chamber.

2. The mobile transport of claim **1**, wherein the enclosure comprises a weir plate disposed in the chamber and dividing the chamber into two sections.

3. The mobile transport of claim **2**, wherein the enclosure comprises outlets in separate communication with the two sections of the chamber.

4. The mobile transport of claim **1**, comprising a transfer pump disposed on the mobile transport and in communication with a drain in the chamber, the transfer pump being configured to pump liquid content of the slurry from the chamber to an outlet on the mobile transport.

5. The mobile transport of claim **4**, wherein the control system is configured to pump the liquid content from the chamber to the outlet at least in response to the measured level of the one or more level sensors.

6. The mobile transport of claim **1**, wherein the weighing assembly comprises one or more weight modules removably mounted to the enclosure.

7. The mobile transport of claim **1**, wherein the weighing assembly comprises:

a hopper configured to receive the slurry;

a gate disposed on the hopper and being configured to open and close communication of the hopper with the chamber;

an actuator associated with the gate and being configured to open and close the gate; and

a weight sensor associated with at least one of the hopper and the gate, the weight sensor being configured to measure a weight associated with the solid content of the slurry received in the hopper.

8. The mobile transport of claim **1**, wherein the control system is configured to track the solid content of the slurry based at least on the measured weight.

9. The mobile transport of claim **1**, wherein the one or more level sensors comprise a float sensor disposed in the chamber and in operational communication with the control system, the control system being configured to automatically turn off a portion of the mobile transport in response to the level measured by the float sensor reaching a predetermined threshold.

10. The mobile transport of claim **9**, wherein the one or more level sensors comprise a level sensor disposed in the chamber and in operational communication with the control system, the control system being configured to transmit data of the level measured by the level sensor to a network.

11. The mobile transport of claim **1**, wherein the one or more gas sensors are configured to measure at least one of a constituent, a pressure, a volume, and a concentration as the property of the gas content in the chamber.

12. The mobile transport of claim **1**, wherein the vapor recovery assembly comprises:

a suction pump in communication with the chamber of the enclosure and being configured to draw the gas content; and

a compression package in communication with the suction pump and being configured to recover gas from the gas content for a gas outlet of the mobile transport.

13. The mobile transport of claim **1**, comprising a hydraulic power unit disposed on the mobile transport and being configured to actuate the mobile transport.

14. The mobile transport of claim **1**, wherein the control system comprises a local control unit housed in a module disposed on the mobile transport between the enclosure and the vapor recovery assembly.

15. The mobile transport of claim **14**, wherein the control system further comprises a centralized control unit in communication with the local control unit and being configured to coordinate operation of the local control unit with a flow management arrangement at the wellsite.

16. The mobile transport of claim **1**, comprising a visual indicator disposed on the mobile transport and being configured to visually display the measured level in the chamber.

17. The mobile transport of claim **1**, wherein the mobile transport comprises a trailer, a vehicle, a truck, a platform, or a skid.

18. A mobile transport for handling slurry, the mobile transport comprising:

an enclosure disposed on the mobile transport and having a chamber configured to hold the slurry;

a weighing assembly disposed on the mobile transport and being configured to weigh solid content of the slurry discharged to the chamber;

one or more liquid level sensors disposed on the mobile transport and being configured to measure a level of the slurry in the chamber;

one or more gas sensors disposed on the mobile transport and being configured to measure a property of gas content in the chamber; and

a vapor recovery assembly disposed on the mobile transport and being in communication with the chamber, the vapor recovery assembly being configured to draw the gas content of the slurry from the chamber.

19. The mobile transport of claim **18**, comprising a control system in operational communication with the weighing assembly, the one or more liquid level sensors, the one or more gas sensors, and the vapor recovery assembly, the control system being configured to control the vapor recovery assembly at least in response to the measured property of the gas content in the chamber.

20. A method for handling slurry, the method comprising:

weighing, with a weighing assembly, solid content of the slurry discharged to an enclosed chamber;

measuring, with one or more liquid level sensors in the enclosed chamber, a level of the slurry in the enclosed chamber;

measuring, with one or more gas sensors in the enclosed chamber, a property of gas content in the enclosed chamber; and

recovering, with a vapor recovery assembly in communication with the enclosed chamber, the gas content of the slurry from the enclosed chamber by controlling the vapor recovery assembly at least in response to the measured property of the gas content in the enclosed chamber.

21. A mobile transport for handling slurry at a wellsite, the mobile transport comprising:

an enclosure disposed on the mobile transport and having a sealed chamber configured to hold the slurry; and

a weighing assembly disposed on the mobile transport and being configured to weigh solid content of the slurry discharged from the wellsite to the chamber,

wherein the weighing assembly comprises one or more weight modules removably mounted to and disposed in the enclosure.

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